

**UTILIZATION PATTERN AND CONSERVATION  
STATUS OF PLANT RESOURCES OF  
MAKAWANPUR DISTRICT, CENTRAL NEPAL**



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BY  
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## DECLARATION

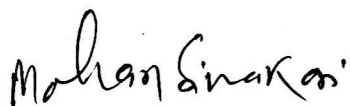
Thesis entitled "**Utilization Pattern and Conservation Status of Plant Resources of Makawanpur District, Central Nepal**" which is being submitted to the Central Department of Botany, Institute of Science and Technology (IOST), Tribhuvan University, Nepal for the award of the degree of Doctor of Philosophy (Ph.D.), is a research work carried out by me under the supervision of Prof. Dr. Mohan Siwakoti, Central Department of Botany, Tribhuvan University. This research is original and has not been submitted earlier in part or full in this or any other form to any university or institute, here or elsewhere, for the award of any degree.

Nirmala Joshi (Pradhan)

06.11. 2014

## RECOMMENDATION

This is to recommend that **Ms. Nirmala Joshi (Pradhan)** has carried out research entitled "**Utilization Pattern and Conservation Status of Plant Resources of Makawanpur District, Central Nepal**" for the award of Doctor of Philosophy (Ph.D.) in Botany under my supervision. To my knowledge, this work has not been submitted for any other degree. She has fulfilled all the requirements laid down by the Institute of Science and Technology (IOST), Tribhuvan University, Kirtipur for the submission of the thesis for the award of Ph.D. degree.



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November 2014



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**LETTER OF APPROVAL**

Date:06/11/2014

On the recommendation of **Prof. Dr. Mohan Siwakoti**, this Ph.D. thesis submitted by **Ms. Nirmala Joshi (Pradhan)**, entitled "**Utilization Pattern and Conservation Status of Plant Resources of Makawanpur District, Central Nepal**" is forwarded by Central Department Research Committee (CDRC) to the Dean, IOST, T.U.

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Nirmala Joshi (Pradhan)

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## ABSTRACT

The study is focused to document angiospermic flora, utilization pattern of useful plant resources and assess *in situ* conservation status of selected useful plants. Free-listing and semi-structured interviews applied to document traditional knowledge (TK) on medicinal plants, wild edible plants and their uses among respondents from Bankaria, Newar and Tamang ethnic groups. Smith's salience index (SI), informant consensus factor (ICF) or informant agreement ratio (IAR), relative frequency of citation (RFC), and cultural importance index (CI) were used to compare cultural salience of plants. Altogether, 695 species belonging to 472 genera and 124 families of angiospermic plants were collected from the study area. Leguminosae was the dominant family with 60 species and Compositae was the second largest family. *Merremia hirta* (Linn.) Merr., a species belonging to Convolvulaceae was collected as new addition to the flora of Nepal. A total of 189 medicinal plants, 97 wild vegetables and 65 wild fruits and nuts were documented, of which, 12 medicinal plants were found to be new method of use for the treatment of diseases. Two wild vegetables were found new addition for useful plants of Nepal. Tamang and Bankaria ethnic groups have better knowledge of utilization of medicinal and wild edible plants than the Newar ethnic group. Highest RFC and CI values were found for *Urtica dioica*, *Swertia chirayita*, *Bergenia ciliata*, and *Centella asiatica*, while SI values were highest for *Terminalia alata*, *Phyllanthus emblica* and *Astilbe rivularis*. The ICF values highlighted that the medicinal plants were commonly used for treating digestive system, infections/infestations and pregnancy/birth disorders. Similarly, *Diplazium esculentum*, *Dryopteris cochleata*, *Tectaria coadunata*, *Amaranthus lividus*, and *Dioscorea hamiltonii* are the most commonly used wild vegetables; whereas *Myrica esculenta*, *Rubus ellipticus*, *Aegle marmelos*, *Choerospondias axillaris*, and *Diploknema butyracea* are commonly used wild fruits. Based on rapid vulnerability assessment (RVA), 12 species such as *Bergenia ciliata*, *Dioscorea deltoidea*, *Asparagus racemosus*, *Paris polyphylla*, *Podophyllum hexandrum*, *Aconitum spicatum*, *Didymocarpus pedicellatus*, *Aconitum laciniatum*, *Astilbe rivularis*, *Cucurliigo orchioides*, *Rauvolfia serpentina*, and *Swertia chirayita* were

found to be highly vulnerable medicinal plants. This study contributes to the documentation of utilization pattern and conservation status of useful plant resources of Makawanpur district. The useful plant resources play a significant role in the medicine, income generation and nutrition of local communities. However, more research is needed in pharmacological screening and nutritional values of less known medicinal and edible plants for value addition.



## LIST OF ACRONYMS AND ABBREVIATIONS

asl	Above Sea Level
BPP	Biodiversity Profile Project
cm	Centimetre
CBS	Central Bureau of Statistics
CAMP	Conservation Assessment and Management Plan
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CR	Critically Endangered
CI	Cultural Important Index
DD	Data Deficient
DFO	Department of Forest
DHM	Department of Hydrology and Meterology
DMP	Department of Medicinal Plant
DDC	District Development Committee
E	Endangered
FAO	Food and Agriculture Organization
FC	Frequency of Citation
GoN	Government of Nepal
IAR	Informant Agreement Ratio
ICF	Informant Consensus Factor
km	Kilometre
kg	Kilogram
m	Metre
NPHC	National Population and Housing Census
NBS	Nepal Biodiversity Strategy
NTFP	Non-Timber Forest Product
NA	Not Available
RVA	Rapid Vulnerability Assessment
R	Rare
RFC	Relative Frequency of Citation
SN	Serial Number
SI	Smith's Index
spp.	Species
IUCN	The World Conservation Union
T	Threatened
TK	Traditional Knowledge
VDC	Village Development Committee
VU	Vulnerable
UNEP	United Nations Environment Programme
WHO	World Health Organization

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# CHAPTER 1

## 1. INTRODUCTION

### 1.1 Utilization pattern of plant resources

Plants play an important role for living beings by providing ecosystem services such as protection of watersheds, improvement of soils, change of climate, and control soil erosion. They are used as food, medicine, fibre, fuel, spices, construction materials, and fodder. They are also used for production of essential oil and beverage.

It was reported that 80% of the world's population depends on traditional medicine for their primary healthcare (WHO, 2000). More than 10000 medicinal plant species has been reported in the Himalayan region, which supports the livelihood needs of about 100 million people living in the area (Shengji, 2001). Nepal, the Himalayan country, is bestowed with 1906 species of medicinal plants (Ghimire, 2008). About 75% of the population of the country visit traditional healers for treatment of various diseases (Manandhar, 1980). Many local people have traditional knowledge of herbal treatments for minor illness such as diarrhea and dysentery, cough and cold, sore throats, muscle pain and headache. This traditional knowledge help not only to identify valuable plant resources but also provide knowledge of the system of management of natural resources. Traditional medicines systems have close relationship with nature and natural resources. Traditional medicine for preventing and controlling disease costs much less than allopathic medicine system (Joshi & Joshi, 2001).

Lange (2006) reported that an average annual trade of medicinal plants for a period of 1991-2003 was amounted 467, 000 tons with a value of US\$ 1-2 billion in the world. Major markets for trade of medicinal plants are generally found in the developed countries while developing countries are the main exporters of raw plant materials, unprocessed or little processed and mainly collected from the wild (Lange, 2006). Medicinal plants have been harvested from the wild since ancient times (Balick &

Cox, 1996). According to Malla *et al.* (1995), the annual quantities of medicinal herbs exported from Nepal has amounted to over 4000 tons during the year 1970, and reaching over 13500 tons after 1992. Edwards (1996) estimated that annually about 10-15 thousand tons of raw non-timber forest products are exported from Nepal. But in 2009, exported medicinal and aromatic plants from Nepal to India were 4,950,679 kg and 206 kg to Singapore, whereas in 2010, 6,641,877 kg to India and 117 kg to Singapore (Jenish & Probst, 2011). The gathering of medicinal plants for trade is an important aspect in Nepal. According to Subedi (2006), more than 161 wild plant species of non-timber forest products are harvested for trade in Nepal. Thus, the ethnobotanical important plants are disappearing by over harvesting due to trade pressure as well as threatened under the impacts of urbanization and cultural changes. Indigenous knowledge and their traditional uses of medicinal plants are also disappearing due to habitat loss, forest destruction and degradation, unsustainable harvesting and illegal trade. Since medicinal plants play important role in healthcare systems all over the world, especially in developing countries, research on these plants in the indigenous knowledge pattern and traditional medicine will gain much attention. Sustainable management of non-timber forest products is important because of their value as a perennial source of subsistence income and a means of conserving biodiversity. Little attention has been given to the biological, socio-economic and conservation importance of non-timber forest resources. However, a clear understanding of this resource is still lacking in Nepal.

Wild plants are also the food sources for all the human beings. Since long time, local people not only consume underground plant parts, leaves, flowers and fruits as important nutrient, but sale as vegetables and fruits in the market in different seasons (DMP, 1982). Thus wild food plants play key roles in global food and nutrition security (FAO, 2009). About 75,000 species of plants are used as edibles (Walters & Hamilton, 1993). In 2010, a total of 925 million people, almost 16% of population of developing countries are still undernourished (FAO, 2010). An estimated 80% of populations in developing countries depend on biodiversity in the form of leafy vegetables, which are good sources of protein, vitamins and minerals (Afolayan & Jimoh, 2009). The decline of indigenous food plants are due to overharvesting, land clearing for agriculture, high work load to collect, process and prepare traditional foods, loss of traditional knowledge, local populations' perceptions about wild foods

as being 'food for the poor', less preference in global market (Kuhnlein *et al.*, 2009; Bharucha & Pretty, 2010). Consequently, in many indigenous communities, traditional food products are more and more being replaced by imported or newly introduced foods (Weinberger & Swai, 2006). To overcome the decline of indigenous wild edible plants, the preferences of local communities is necessary to develop priority setting approach for domestication (Joshi *et al.*, 2013). In addition, nutrient composition data on wild foods and local/wild varieties of cultivated foods are urgently be described (Lutaladio *et al.*, 2010) and nutrient composition data will be very helpful to further explore synergies between biodiversity and nutrition (Burlingame *et al.*, 2009).

Wild vegetables are traditionally an important resource for ethnic groups subsistence (Xu *et al.*, 2004). Nepal's great biodiversity is associated with the country's exceptional diversity of topographic, climatic, and agro-ecological conditions (NBS, 2002). Different vegetation types, ranging from tropical to alpine, results in the occurrence of about 6000 species of flowering plants (Press *et al.*, 2000). Out of these, about 1500 species are considered useful (Manandhar, 2002), of which about 200 plant species are consumed as vegetables (Manandhar, 2002).

In many parts of the world, the uses of wild plants are not negligible (Pieroni *et al.*, 2007). It plays a very important role in the livelihoods of rural communities as an integral part of the subsistence strategy of people in many developing countries (Zemede & Mesfin, 2001). Wild vegetables are important sources of vitamins and minerals (Odhav *et al.*, 2007). Sundriyal and Sundriyal (2003) documented the diversity and traditional values of Himalayan wild edible plants. The nutritional value of traditional wild vegetables is high (Sundriyal & Sundriyal, 2004; Orech *et al.*, 2007). Wild plant resources reduce the vulnerability of communities to food insecurity (Misra *et al.*, 2008; Belem *et al.*, 2009). Numerous publications provide a valuable knowledge of edible wild plants in various locations of Nepal (DMP, 1982; Manandhar 1995c, 1997; Siwakoti *et al.*, 1997; Shrestha & Dhillion, 2006; Bhattarai *et al.*, 2009). However, diet surveys tend to ignore the wild plants in comparison to cultivated ones (Etkin, 1994). Increased use of traditional vegetables can contribute to enhance people's health and standard of living as well as the economic and social status. Gathering of wild vegetables for both self-consumption and selling in markets

are still very common practice in Nepal, particularly in rural areas. During food scarcity periods, a large number of people from urban and rural communities heavily depend on wild vegetables (DMP, 1982). However, many traditional wild vegetables are replaced by the introduction of exotic vegetables and improved varieties. Further, habitat degradation and poor marketing opportunities for traditional vegetables are responsible for losing their value (Joshi *et al.*, 2007). The wild vegetables are marginalized in current agricultural practice as well as poor utilization due to lack of awareness (Maikhuri *et al.*, 2004). There is an urgent need for conservation of wild plants, which can be useful in case of genetic erosion or for crop improvement (Kala, 2007). Most of the wild vegetables grown naturally are resistant to several biotic and abiotic stresses, they required fewer inputs, and are comparatively nutritionally superior than cultivated crops (Bhardwaj *et al.*, 2007). Despite these advantages, most traditional wild edible plants are generally uncultivated and underutilized (Grivetti & Ogle, 2000).

There are about 200 plant species bearing edible fruits and nuts (Manandhar, 2002). However, most of these indigenous fruits and nuts are not domesticated or cultivated, but gathered from natural areas. Many of these species are said to be threatened and continue to disappear due to deforestation, agricultural expansion and over-exploitation (Shrestha & Joshi, 1996). Together with the erosion of genetic resources of indigenous fruit and nut species, traditional knowledge of rural communities related to these species and their uses runs the risk of being lost. For most parts of Nepal, the rich plant diversity and indigenous knowledge related to it are not comprehensively documented except few attempts (DMP, 1982; Manandhar, 2002).

Efforts are under way to systematically document, collect and utilize the largely declining resources and the related knowledge on Nepalese indigenous fruit and nut species (Maden & Dhakal, 1998; Shrestha & Dhillon, 2006; Joshi *et al.*, 2009). Little is known about the nutritive values of wild fruits and nuts occurring in Nepal (Bhandari, 1978; Bajracharya, 1980). Enhanced cultivation after domestication of these species may contribute to their 'conservation through use' and to improve livelihoods of rural communities as reported for other regions of the world (Akinnifesi *et al.*, 2008).

## 1.2 Conservation status

The potential of useful plant resources are losing in nature by unsustainable harvest system and infrastructure development. Nowadays, the threatening of biodiversity is due to climate change as well in the world (Sommer *et al.*, 2010). Habitat loss and invasive alien species are also another cause of threatening the plant diversity (Hilton-Taylor *et al.*, 2009). Biodiversity is the process of being destroyed (Balmford *et al.*, 2003; Jenkins *et al.*, 2003), and increasing numbers of species are being lost on a global scale years (Pimm *et al.*, 1995). About 32000 species of plants are threatened with extinction (Walter & Gillet, 1998). Many of which are now rare, threatened or endangered. IUCN Red List system for categorizing extinction risk to species (IUCN, 2001) is widely used and has been regarded as a powerful tool for biodiversity conservation in the world (Rodrigues *et al.*, 2006). Plant conservation for Target 2 of the Global Strategy is preliminary assessment of the conservation status of all known plant species, at national, regional and international levels (UNEP, 2002).

Since the "Earth Summit" in Rio de Janeiro in 1992, check the loss of biodiversity is a global target (Baillie *et al.*, 2008). The national and international biodiversity conservation organizations developed several strategies for the estimation of the conservation status of species. In certain parts of the world, conservation of natural resources is part of the traditions of the local communities living in that area, for example the tribal communities in Gwangxi Karst Region of China (Li & Su, 1995) and Mayamba district of Sierra Leone (Lebbie & Raymond, 1995). Southeast Asia is considered a biodiversity hotspot because it harbours an exceptionally high number of endemics species that are threatened by the loss of greater than 70% of original habitats (Myers *et al.*, 2000). Southeast Asia is highlighted as an area where past and present human driven land use changes are expected to cause extinctions across a wide range of taxa (Lee & Jetz, 2008) and has the highest proportion of threatened species across all taxonomic (IUCN, 2006).

Nepal possesses about 6000 species of flowering plants, of which accounting for 0.02 % of the world's total, making it one of the rich countries in terms of biodiversity (Press *et al.*, 2000). However, this abundant biodiversity is greatly threatened by

commercial collection and habitat destruction (Shrestha & Joshi, 1996) lack of conservation awareness and over exploitation (Malla *et al.*, 1995; Edwards, 1996; Subedi, 1997; Ghimire *et al.* 2001, 2004, 2005). Chaudhary (1998) reported that major threats of the wild plant resources are over harvesting, unsustainable and habitat destruction (encroachment of agriculture, deforestation, fires, and overgrazing). In the lower altitudinal range of Nepal, threats are due to population growth, migration, urbanization, forest fire, increase of invasive plant species and expansion of agricultural land. Local knowledge about the status of plant resources, for example, has begun to be explored as a way to determine conservation priorities (Potvin *et al.*, 2002). It has long been popularly identified that consultation with indigenous people is needed for long-term biodiversity conservation (Hamilton, 2004). In 1994, IUCN adopted new criteria to assess risks of extinction at a global scale. In Nepal, there are a few reports available that indicated the conservation status of some plant species. The effective sustainable use and conservation of Nepalese plant diversity is dependent upon proper documentation of the plants species along with their distribution and ecological ranges. Therefore, the documentation of plant diversity is necessary for management and conservation of plant diversity, prevention from destruction of habitats, conservation of native species, endangered species and recognition of useful plants for proper use of them.

### **1.3 Rationale of the study**

The first floristic study in Nepal was done by Buchanan-Hamilton from 1802-1803. The history of botanical exploration in Nepal showed that major works on flora have been undertaken either in high Himalayas or in lowlands (Rajbhandari, 1976) whereas Mid-Hills, Siwalik and Mahabharat range have got little attention in flora exploration. The floristic study in Makawanpur district is still meager. An analysis and review of the available literatures and herbarium specimens housed in National Herbarium and Plant Laboratories (KATH) reveal that the floristic study of Makawanpur district was neither explored completely, systematically and intensively nor an account of the same was published in the form of flora with accurate description and nomenclature. It is essential that to have detailed knowledge of the plant wealth of the country, floras of each district of the country should be prepared. Detailed floristic study and utilization of plant resources will greatly help in economic development of livelihood as well as biodiversity conservation.

About 80% of populations in developing countries depend on biodiversity in the form of non-timber forest products (NTFPs) for food, medicines, shelter etc. (Bennett, 2002). NTFPs have attracted considerable global interest. This is due to the increasing recognition of the fact that NTFPs can provide important community needs for improving rural livelihood, contribute to household food security and nutrition help to generate employment, income and support biodiversity conservation (FAO, 1995). There is an urgent need for extensive research on floristic study and conservation of valuable plant wealth for conservation and management. This floristic study not only provides current views of the diversity, but also gives the foundation of future conservation practice of plants species of Makawanpur district.

About 70-80% of the population of the country still depends upon medicinal plants for their health problems (Manandhar, 2002). Most of these medicinal plants are collected from wild resources. Although there are a handful of ethnobotanical studies in Nepal, very few studies compare the pattern of medicinal plant use and medicinal plant cultural domain between different ethnic groups or among same ethnic group in different geographical regions. For promoting wise use and conservation of medicinal plants, the cultural domain studies are important. Cultural domains are starting point for studying people's perception of the natural world and are important aspects of local knowledge by which cultural organizations are understood (Puri & Vogl, 2005).

The plant resources also provide significant benefits to ecosystem services (Gardner *et al.*, 2009). However, forests are worldwide subject to high rates of deforestation and degradation with an estimate of 17 million hectare or 1% of total forest area per year (Byron & Arnold, 1999). About 8447 plants species are threatened that may cause extinction (IUCN, 2008). Once lost plant and can never reappear. The main causes of forest biodiversity loss are human interventions including land use changes, deforestation and fragmentation, agricultural activities, over-exploitation of resources, invasive alien species and climate change (Morris, 2010) including unsustainable management (Shrestha & Joshi, 1996).

Loss of forests not only harms biodiversity but also human well beings through the damage to ecosystem services (Balmford *et al.*, 2002). To estimate the consequence

of loss on the plant resources and also to make conservation and management plans it needs to identify the species and their utilization pattern of useful plant resource, understand their ecology, local economic and cultural importance.

Human beings living in an area are an integral part of biodiversity according to their way of using natural resources. The plants of ethno-botanic importance are maintained by different cultural groups. Indigenous knowledge is defined as a cumulative body of knowledge and beliefs handed down through generations by cultural transmission about the relationship of living beings, with one another and with their environment (Berkes, 1993). There is great linkages between indigenous people and biodiversity and also considers how this cultural domains may be retained and put to use in broader effort to use and conserve biodiversity (Berkes & Folke, 1992).

However, globalization, biodiversity loss, deforestation and environmental degradation cause the disappearance of traditional knowledge and ethnobotanical traditional knowledge (Steinberg, 1998). Knowledge on the utilization and sustainable management of the biodiversity is transmitted through generation to generation. Modern approaches for development recognize the importance of indigenous knowledge on the utilization of natural resources locally. At the global level, approaches now begin to develop considering the biodiversity documentation, conservation and preservation of indigenous knowledge as priorities.

It is essential that to have detailed knowledge of the plant wealth of the country, an inventory of plant resources and its utilization should be prepared. Makawanpur district has long history of non-timber forest products trading. At present, the useful plant resources are excessively harvested from natural habitat and utilized and traded without proper management. No detailed study on their availability in areas has been carried out. Likewise, there is lack of knowledge on their proper utilization. If the current rate of plant resources collection continues and if there are no alternative sources of plant resources then many plant resources will disappear from their natural habitat. Thus a comprehensive documentation of plant inventory, utilization pattern and its conservation status is still waiting.



#### **1.4 Research questions**

1. Are the different altitudinal zones of Makawanpur district equally rich in plant species?
2. Are three ethnic groups differ in their plant use pattern and their knowledge?
3. What are the vulnerable plant species in Makawanpur district?

#### **1.5 Objectives**

The main objective of this study was to document the plant diversity, their utilization pattern, and conservation status of plant resources in the Makwanpur district, Central Nepal.

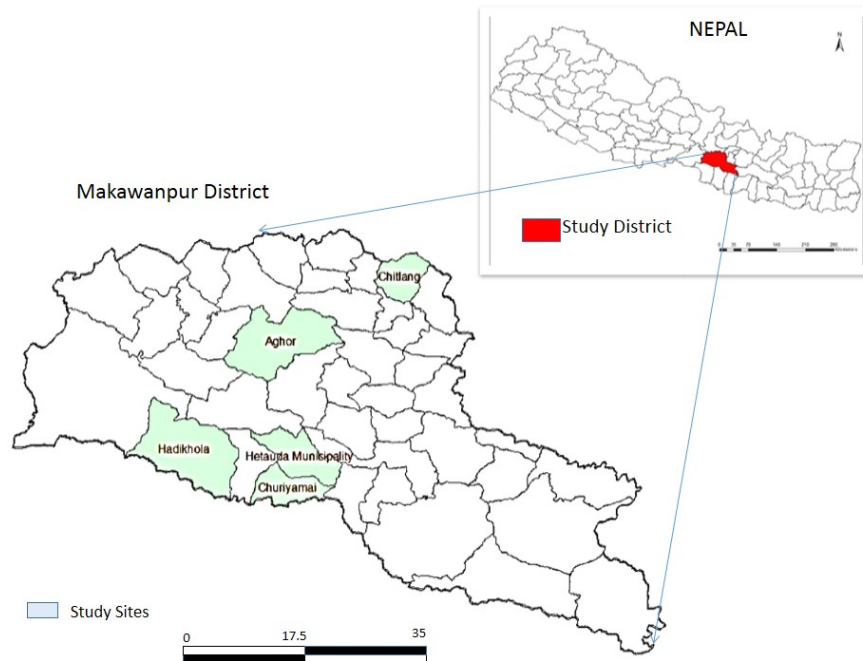
The specific objectives included:

1. To document angiospermic flora from different altitudinal zones of Makawanpur district.
2. To document ethnobotanical knowledge on utilization pattern of plant resources (medicinal and edible plants) by three indigenous communities (Bankaria, Newar, Tamang) in the Makawanpur district.
3. To assess *in situ* conservation status of selected useful (medicinal, edible) plants of the study area.

#### **1.6 Description of Study area**

Nepal is situated on the southern slopes of the central Himalayas and occupies a 147,181 km<sup>2</sup>. The country is located between latitudes 26<sup>0</sup>22' and 30<sup>0</sup>27' N and longitudes 80<sup>0</sup>40' and 88<sup>0</sup>12' E. The country has 14 zones and 75 districts. Among them, Makawanpur district lies in Narayani zone, Central Development Region of Nepal. The research was carried out in the Makawanpur district. The district covers an area of 2426 km<sup>2</sup>, making up 1.65% of the total land area of Nepal. Towards the northern part of this district, lies Mahabharat range which covers about 41% of the district area whereas in the southern part covers 59% Chure (Siwalik) of the district. It is located between latitude 27<sup>0</sup>10' N to 27<sup>0</sup> 40' N and longitude 84<sup>0</sup>41'E to 85<sup>0</sup>31'E. Its boundaries in the east is Sindhuli district, in the west is Chitwan district, in the north is Dhading, Kathmandu, Lalitpur, Kavre districts, and south is Bara, Parsa, Rautahat districts. The elevation of the district ranges from 166 m to 2584 m above sea level.

The district possesses 43 Village Development Committees (VDCs) and one municipality, Hetauda. Among these, Hetauda Municipality (500 m), Chitlang Village Development Committee (1800 m), Handikhola VDC (500 m), Churiamai VDC (600 m), Aghor Namtar VDC (2300m) were selected as study sites (Figure 1).



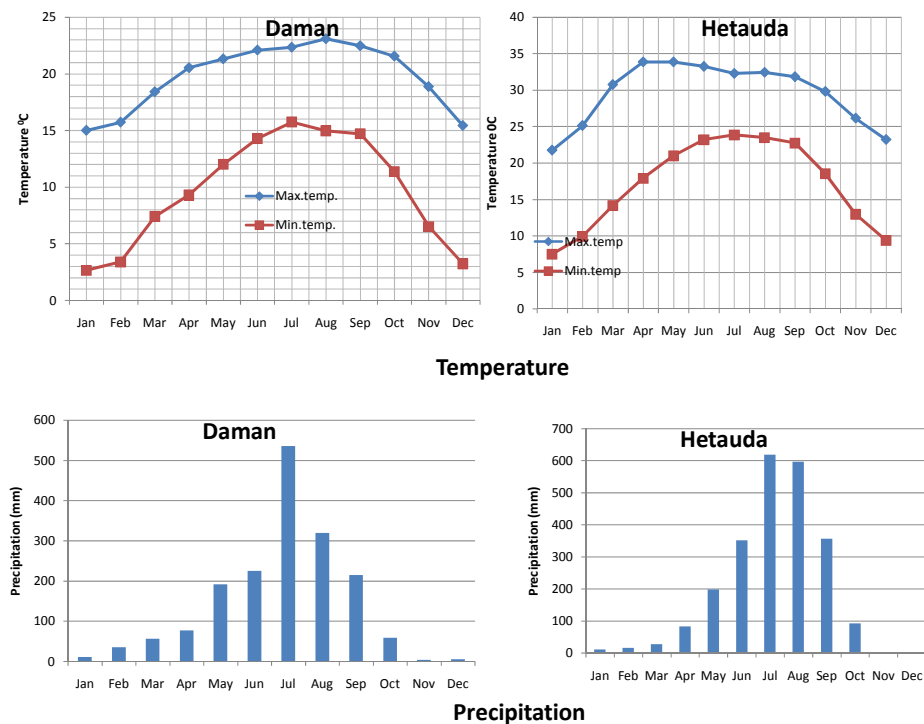
**Figure 1:** Map of Makawanpur district, Central Nepal showing research study sites.

The three altitude ranges lowland (below 1000 m), midland (1000-2000 m) and highland (above 2000 m) were selected as study sites which experience tropical to temperate climates. Three ethnic communities were selected from the study sites: Bankaria from Handikhola, Newar from Hetauda and Chitlang, Tamang from Aghor and Churiamai selected as respondents for ethnobotanical study as they were dominant communities in the study sites (Figure 1).

### 1.6.1 Soil and climate

Most part of this district belongs to Siwalik and Mid-Hills and consists of diversified soil type such as loam, sand, clay stone, sand stone and silt stone. The climate in Makawanpur district varies according to altitudinal aspect. The district has tropical, subtropical and temperate climate. Hetauda is situated in the inner valley, exist tropical climate due to their low altitude. Daman, Simbhanjyang is situated at 2584 m altitude and exists temperate type of climate. Based on the record of Daman station,

lowest recorded monthly average minimum temperature from 2001 to 2010 was 3<sup>0</sup>C in January and December whereas maximum recorded monthly average temperatures was 23<sup>0</sup>C in August at Daman (2300 m). Similarly, for ten years (2004-2013) based on Hetauda station, the highest maximum average temperature was recorded 34<sup>0</sup>C in April, May and lowest minimum average temperature was 8<sup>0</sup>C at Hetauda (500 m). Daman received an average maximum of 536 mm and minimum 4 mm of rainfall from 2001 to 2010, while Hetauda observed average maximum 618 mm and minimum 3 mm of rainfall from 2004 to 2013 (DHM, 2013) (Figure 2).



**Figure 2:** Average maximum and minimum temperature and precipitation for Daman (2001-2010); Hetauda (2004-2013) (Source: DHM, 2013).

### 1.6.2 Land use pattern

According to the Forest Research and Survey Centre, the land use pattern of this district was following: Forest area 144558 ha (59.1%), Agriculture area 61489 ha (25.1%), rivers and lakes 7% and pasture and barren land 9%, National park area 15125 ha (6.2%), shrub area, grass land, stream, drain sand dunes (DFO, 2002). Of the total forest cover in Makawanpur district, the largest proportion is tropical Sal (*Shorea robusta*) forest. The main cereal crops produced in Makawanpur are Paddy, Maize, Millet, Wheat and Barley, other cash crops such as Pulses, Oilseed, Potato, and Sugarcane (CBS, 2062 B.S, 2005 A.D.). The main rivers flowing in this district are Manohari, Rapti, Lothar,

Bagmati. The major hill ranges in the district are the Chandragiri Range, Simbhanjyang and Mahabharat Range (CBS, 2062 B.S., 2005 A.D.).

### 1.6.3 Flora

Makawanpur district has rich floral diversity due to its diverse altitudinal ranges from 166 m to 2584 m. About 250 species of non-timber forest products are reported (DFO, 2002). The common medicinal plants recorded in this district are *Swertia chirayita*, *Rubia manjith*, *Persea duthiei*, *Bergenia ciliata*, *Paris polyphylla*, *Gaultheria fragrantissima*, *Girardiana diversifolia*, *Terminalia chebula*, *Terminalia bellirica*, *Zanthoxylum armatum*, *Asparagus racemosus*, *Phyllanthus emblica*, *Cinnamomum tamala* etc.

### 1.6.4 Vegetation

Due to diverse topography, Makawanpur district exhibits different types of vegetation ranging from tropical, sub tropical, and temperate vegetation.

#### **Tropical Zone** (below 1000 m)

In the Churia region, the tropical vegetation is characterized by Sal (*Shorea robusta*.), *Terminalia alata*, *Terminalia bellirica*, *Aegle marmelos*, *Bombax ceiba*, *Cassia fistula*, *Careya arborea*, *Engelhardia spicata*, *Mallotus philippinensis*, *Oroxylum indicum*, *Cleistocalyx operculatus*, and *Semecarpus anacardium*.

#### **Subtropical zone** (1000 m-2000 m)

The subtropical forest occurs *Schima wallichii*, *Castanopsis indica*, *Myrica esculenta*. The associated species are *Alnus nepalensis*, *Berberis aristata*, *Engelhardia spicata*, *Osyris wightiana*, *Pyrus pashia*, *Rhododendron arboreum*, *Viburnum cylindricum*, and *Woodfordia fruticosa*.

#### **Temperate zone** (2000 m–3000 m).

Aghor, Daman, Simphanjyang area (2000 m-2500 m) have temperate forest and is dominated by *Quercus lamellosa*, *Quercus semecarpifolia*, *Quercus lanata*, *Cyclobalanopsis glauca*, *Rhododendron arboreum*, and *Lyonia ovalifolia*.

### **1.6.5 Population**

According to the population national census, the total population of this district is about 420,477 (NPHC, 2011a), of which 206,684 are males and 213,793 females. The household numbers are 86,127. About 83% of the population is living in rural areas.

### **1.6.6 Ethnic groups**

Nepal has 123 languages with 125 ethnic/caste groups (NPHC, 2011b). The main ethnic groups living in Makawanpur district are Tamang (49%), Brahmin (15%), Chhetri (11%), Newar (7%), Gurung (5%), marginalized groups Chepang (4%) and endangered ethnic group Bankaria (0.02%) (DDC, 2003). The ethnic groups Tamang, Bankaria and Chepang are mostly living close to forests and depend a lot on its natural resources, whereas the Newar and Chhetri traditionally are farmers and rather living in urban and peri-urban settings.

The three ethnic groups namely Bankaria, Newar and Tamang were selected to conduct the present research. These ethnic groups were selected considering the criteria such that the ethnic groups Newar are settled in urban and periurban area. Tamang is dominant in population, live close to forest whereas Bankaria is endangered ethnic groups, heavily depend their livelihood on forest resources of study area.

#### **1.6.6.1 Bankaria ethnic group**

The ethnobotanical data of the Bankaria ethnic were gathered from Handikhola VDC (Village Development Committee). This VDC is located at 400 m-600 m altitude in between latitude 27<sup>0</sup>27'02.97"N and longitude 85<sup>0</sup>55'51.68"E. The total population of Handikhola VDC is 18415, of which 8890 males, 9525 females and total household 3676 (NPHC, 2011a). Of the total population, 84 Bankaria ethnic groups live in Handikhola VDC (village head information). Bankaria is one of the highly marginalized and endangered indigenous people of Nepal (Local people perception). Their ancestral homeland is in Handikhola in Makawanpur district. They mostly live in the forests and consume Yams, Maize, Millet. They lived in the forest for 6 months and 6 months in the valley, hence, they are called Bankaria. Bankaria are animist worshipers and they worship nature and have traditional knowledge of plant resources. They weave Dhoko, Naglo, Namlo, Thunche from Bamboo for sustaining

their livelihood. Their next income generating source is vegetables, fruits, medicinal plants.

#### **1.6.6.2 Tamang ethnic group**

Tamang is one of ancient ethnic group and are one of the major Tibeto-Burmese speaking communities in Nepal. Tamangs are originated from Tibet and they were horse traders, "Ta" in Tibetan means horse; "Mang" means traders (Bista, 1967). Tamang ethnic group is divided into several subcastes such as Bajyu, Blon, Bomjon, Chyawa, Dong, Ghising, Goley, Gomden, Grandean, Lo, Lopchan, Muktan, Maktung, Ngarden, Ngarpa, Pakhrin, Payen, Shingedn, Shyangbo, Shamden, Thing, Thokur, Titon, Waiba, Yonjan (Bista, 1967).

Majority lives in Kathmandu valley, Kavrepalanchok district, Makawanpur district. They live close to forest and have very rich ethnobotanical knowledge. The majority of the Tamang settlements are scattered families in the central and western Terai. In Makawanpur district, settlements are found at elevation from 200 m to 2500 m above the sea level. They weave various types of Bamboo baskets, for storing grains and leaf umbrellas for protection against rain. The main crops of maize, wheat, barley, potatoes, millet and rice are cultivated on their land. They also collect edible mushrooms, wild tubers, ferns, and vegetables and fruits from the nearest forest.

Tamang people account 5.8% of the total population 26,630,809 million (NPHC, 2011a) of the country. Tamang population in Nepal are 1,539,830 (NPHC, 2011b). The Tamang population is well spread throughout the district and has the most dominance in the north western and central VDCs of the district. Tamang population in Makawanpur district are 185,874 (49%). The ethnobotanical data from Tamang ethnic groups were collected from Churiamai VDC (600 m altitude) is situated in between latitude  $27^{\circ}22'32.50''\text{N}$  and longitude  $85^{\circ}00'51.88''\text{E}$ . and Namtar VDC, Aghor (2000 m to 2300 m), of latitude  $27^{\circ}34'27.36''\text{N}$  and longitude  $85^{\circ}04'27.84''\text{E}$ . The total population of Churiamai is 14,274 (6846 male, 7428 female) with 2980 households. Similarly, total population of Namtar VDC is 8816 (4395 male, 4421 female) with households 1709.

### **1.6.6.3 Newar ethnic group**

The Newars are regarded as the indigenous inhabitants of Kathmandu valley (NPHC, 2011b). The term 'Newar' describes the people of both Mongoloid and Mediterranean types who speak both Nepali, an Indo-Aryan language, and Newari, a Tibeto-Burman language which includes some other half dozen dialects (Bista, 1967). Newars may also have originated in South India, with ties or distinct similarities to a Hindu community on the Malabar Coast called the nair, or nayar (Bista, 1967).

In Makawanpur district, Newar occupies 26,764 (7%). The Newars inhabit in the Village Development Committees (VDCs) of Makawanpur district like Chitlang, Bajrabarahi, Tistung, Palung and Hetauda Municipality. They have a wide range of occupation. Many are farmers, others are prominent in the retail traders. Newars have many subcastes. They have many unique festivals that they have great indigenous knowledge of plants for various cultures. The ethnobotanical data were collected from Chitlang VDC, a peri-urban and indigenous habitants of the Newar ethnic group. Chitlang VDC is an ancient Newar ethnic settlement, is located between 1750 m to 2000 m altitude above sea level. It is situated in between latitude 27°38'55.06"N and longitude 85°10'42.16"E. According to 2011 census of Nepal, the total population of Chitlang VDC is 5029 (2237 males, 2792 females) with 1172 household. Emperor Ashok who had visited Nepal in the year 273-232 or 2265 years and was installed Ashok pillars in Chitlang, called Chaitya. Chitlang village was formerly well known villages as Chilanche or Chitapur.

The other Newar ethnic groups site selected for ethnobotanical data collection was the Hetauda Municipality (500 m). Hetauda Municipality is situated in between latitude 27°24'30.36"N, 85°38'44"E longitude. Total population of Hetauda Municipality is 84671 (42194 male, 84671 female) with 19851 households (NPHC, 2011a).

### **1.7 Market system**

Market plays as a centre of place where farm products, agricultural, household items sell for economic development. Hetauda, is the main market centre and link with India in terms of goods flow. There are many wholesale shops in Hetauda town and that supply goods to smaller market places. There are some other small markets such as Basamadi, Bhainse, Bhimpheedi, Churiamai, Chaughada, Chhatiwan, Chitlang, Phaparbari, Makawanpurgadi, Hatia, Manahari, Padampokhari, Palung etc. Bhainse

and Bhimphedi are traditional market. Manahari market is located in East-West highway and market centres for most of the people of northern part of the district. Most of the goods are supplied for selling in Hetauda come from Agra, Ambhajyang, Jyamire, Kalikatar, Sarikhet, and Namtar Village Development Committee of Makawanpur district. Makawanpur is being the most important place for supplying goods such as medicinal plants, fruits, vegetables and livestock products.



## **CHAPTER 2**

### **2. PLANT DIVERSITY IN MAKAWANPUR DISTRICT**

#### **2.1 INTRODUCTION**

The Himalayan country, Nepal is one of the richest biodiversity countries in the world. Nearly 6500 species of angiospermic plants are reported (DPR, 2001). The Department of Plant Resources (former Department of Medicinal Plants) started its work on the Flora of Nepal since its establishment in 1960. Based on the botanical collections and preserved herbarium specimens in the National Herbarium and Plant Laboratories (KATH), this Department has published several local and regional floras. The local and regional floras are much more important to explore intensively and study the biodiversity, utilization and conservation strategies.

The first botanical exploration in Nepal was started by Buchanan-Hamilton from 1802-1803. The history of botanical exploration in Nepal showed that major works on flora have been undertaken particularly in high altitudinal region (Rajbhandari, 1976; 2002) whereas Churia and Mid-Hills have got little attention in flora exploration. The Makawanpur district lies in Churia and Mid-Hills, serves as important preserves for significant hot spot of plant diversity. Some botanical explorations including ethnobotanical and non-timber forest products studies were conducted in Makawanpur district (Manandhar, 1989; Bhattarai, 1991b; Sigdel, 2004). Scientifically regional flora of the country can strongly support different research and development activities of the entire nation. Most of the developing countries have felt the increased need to assess and revise their floras for economic utilization of plant wealth and to conserve rare, endangered and threatened plants.

There is an urgent need for extensive research on floristic study and conservation of valuable plant wealth for conservation and management. This floristic study not only provides current views of the plant diversity, but also gives the foundation of future conservation practice of plant species. The present study aims to document angiospermic flora of Makawanpur district. This is the first comprehensive floristic study of Makawanpur district, Central Nepal.

## **2.2 LITERATURE REVIEW**

### **2.2.1 Plant diversity in Nepal**

The floral diversity of Nepal includes Lichens 465 species (Sharma, 1995), Fungi 1822 species (Adhikari, 2000), Pteridophytes 534 species (DPR, 2000), 6973 species of Angiosperms (UNEP-WCMC, 2004), 26 species of Gymnosperms (Bista, 2006), Bryophytes 1150 species (Pradhan & Joshi, 2009), and Algae 1001 species (Prasad, 2013).

The Department of Plant Resources (former Department of Medicinal Plants) started its work on the Flora of Nepal after establishing the National Herbarium and Plant Laboratories, Godawari (KATH) since 1960. Based on the botanical explorations and preserved specimens in the National Herbarium and Plant Laboratories, Godawari (KATH), the Department published numerous bulletins, including the local floras like Notes on Flora of Rajnikung (Gokarna), Flora of Phulchoki and Godawari Flora of Nagarjun, Supplement to the Flora of Phulchoki and Godawari, Flora of Langtang and Cross Section Vegetation Survey, Catalogue of Nepalese Vascular Plants in 1976, Flora of Kathmandu Valley in 1986, Enumeration of the Flora of West Nepal, Flowering Plants of Nepal (Phanerogams), Catalogue of Nepalese Flowering Plants Part 1, 2, 3 in 2010, 2011, 2012; Endemic Flowering Plants of Nepal Part 1, 2, 3 in 2009, 2010, 2011.

Many other publications relating the Flora of Nepal have been made such as Flora and Fauna of Midland Nepal (Fleming, 1973), Fodder Trees and Tree Fodder in Nepal (Panday, 1982), Hara *et al.* (1978, 1982), Hara and Williams (1979) enumerated 5067 species under 212 families and 1494 genera, Orchids of Nepal Himalaya (Banerji & Pradhan, 1984). Similarly, "The Himalayan Plants" Ohba & Malla (1988; 1991); Koba *et al.* (1994) described the Name list of the Flowering Plants and Gymnosperms of Nepal. Nayer (1996) published "Hot spots of endemic plants of India, Nepal, and Bhutan" in which 307 species belonging to 50 families as Nepal Himalaya endemic plants were recorded. Siwakoti and Varma (1999) published "Plant Diversity of Eastern Nepal" and enumerated 743 species of flowering plants. "A Contribution to the Flora of Ganesh Himal, Central Nepal" (Ohba & Ikeda, 1999).

Press *et al.* (2000) published "Annotated Checklist of the Flowering Plants on Nepal". "Rare, endemic and endangered plants in Nepal" was published by Shrestha and Joshi (1996) and described 246 species of endemic flowering plants of Nepal. Some papers on Nepalese endemic flowering plants have been published (Joshi & Joshi, 1991; Rajbhandari, 1994). Similarly, Rajbhandari and Adhikari (2009), Rajbhandari and Dhungana (2010, 2011) described altogether 282 endemic plants in "Endemic Flowering Plants of Nepal in Part 1, 2, 3. White and Sharma (2000) published "Wild Orchids in Nepal"; Rajbhandari and Bhattarai (2001) published "Beautiful Orchids of Nepal" and describing 101 species of wild orchids. Panthi and Chaudhary (2002) studied "Angiospermic flora of Arghakhanchi district and adjoining areas" and documented 501 species. Ohba *et al.* (2008) explored floristic study in Mustang district and described 889 species of flowering plants. Under the Nepal Flora project, Flora of Nepal, Volume 3 is published in 2011 in joint collaboration between United Kingdom and Nepal, which is the first comprehensive record of angiosperms and covers from Magnoliaceae to Rosaceae which documented 600 species belonging to 21 families (Watson *et al.*, 2011).

### **2.2.2 Floristic study of Central Nepal**

The first botanical exploration in Nepal was started by Buchanan-Hamilton from 1802-1803, who visited, central Nepal, and collected 433 plant specimens from Makawanpur to Kathmandu en route area. The second botanist to visit Nepal was Nathaniel Wallich from 1820-1821 and collected plants from Kathmandu valley and Gosainkund, Rasuwa district. "*Prodomus Florae Nepalensis*" was compiled by David Don (1825) describing 738 species (Rajbhandari, 2002). Nepalese and foreign botanists collected plants from various localities from central Nepal. I. H. Burkill on 1907 visited Nepal for study of plants taking the route from Raxaul to Kathmandu and Nuwakot. L. Dhowj and K. N. Sharma from 1927-1931 collected plants from West, Central and East Nepal. Oleg Polunin in 1949 collected plants from Langtang valley. D. G. Lowndes collected plants from Manangbhot and vicinity of Marsyandi River in 1950. L. H. J. Williams, J. D. A Stainton, W. Sykes, M. L. Banerji, and T. B. Shrestha in 1954, 1962, 1965, 1967 had collected plants from Annapurna Range, South of Ganesh Himal, Langtang, Lamjung Himal, Rapti Valley respectively. Similarly, H. Kanai, G. Murata, H. Ohashi, O. Tanaka, T. Yamazaki, S. Kurosawa, M. Wakabayashi, M. Suzuki, S. Akiyama, T. Namba, M. Mikage, T. Tomimori, S.

Kjima, M. Tamura, T. Tamura, N. Shrestha, K. Komatsu, A. Takano, S. Hara, N. P. Manandhar, S. Malla, P. R. Shakya, T. B. Shrestha, S. R. Adhikari, H. Hara, H. Ohba, H. Tabata, K. Tsuchiya, Y. Konno, K. R. Rajbhandari, D. P. Joshi, M. N. Subedi in 1967, 1969, 1970, 1972, 1976, 1978, 1983, 1984, 1985, 1986, 1988, 1990, 1993, 1994, 1995, 1996, 1999, 2000, 2001 had made botanical exploration in Kathmandu Valley, Makawanpur, Gosainkunda, Chilime, Langtang, Kalinchok, Dhorpatan, Muktinath, Chitwan, Kaligandaki Valley, Marsyangdi Valleys, Ganesh Himal, Shivapuri, Manaslu, Annapurna Himal, Parsa Terai region, Jomson to Yak Kharka, and Upper Mustang area. G. Miehe collected plants from 1976 to 1977 in Annapurna and Dhaulagiri area. A. Bourrit and M. A. Farille on 1978 collected plants from Lamjung Himal and Gosainkund area. M. A. Farille in 1981 made collection in Dhorpatan, Muktinath, Lamjung Himal, Kalinchok-Rowaling. Several other botanical explorations had made between 2004 and 2005 under Darwin Initiative Project in Central and Eastern Nepal (Watson *et al.*, 2007; Pendry *et al.*, 2009).

### **2.2.3 Botanical exploration in Makawanpur district**

Makawanpur district is famous for the botanical history of Nepal where the first botanical exploration was carried out by Francis Buchanan-Hamilton in 1802 when he visited to Kathmandu (Rajbhandari, 2002). He collected about 433 plant specimens and deposited in BM (British Museum). Nathaniel Wallich from 1820-1821 followed same route as Hamilton and collected about 1834 plant specimens, deposited in K (Kew Herbarium). When the Department of Medicinal Plants was established in 1960, the systematic plant collections were started from Makawanpur by M. S. Bista in collaboration with Japanese botanist H. Kanai from 17-25 April 1969. Most of their collected plant species are deposited in KATH and TI herbarium. Similarly H. Kanai and P. R. Shakya from 12-20 November, 1970 collected plants specimens from Makawanpur and deposited the specimens in KATH and TI. K. R. Rajbhandari, P. M. Amatya, N. Bhusal, staffs of Department of Medicinal Plants collected about 444 plant specimens from Hetauda area of Makawanpur district from 5 October -12 October, 1975. P. R. Shakya, R. Rana, T. K. Rajbhandary V. L. Gurung, B. Roy in 1976 collected plants from Daman, Hetauda. Some Nepalese and foreign botanists H. Kanai and M. S. Bista in 1969, April 17-25, H. Kanai and P. R. Shakya in 1969, Nov. 12-20, and P. R. Shakya, R. Rana, T. K. Rajbhandari (1976, 13-21 July) had collected plants from various localities of Makawanpur district such as Daman, Simbhanjyang,

Brindavan, Bhainse, Tistung, Palung, Makawanpurgadi, Lothar, Hetauda, Kulekhani, Bhimphedi, Chitlang (Rajbhandari 2002; Voucher KATH Herbarium specimens).

## **2.3 MATERIALS AND METHODS**

### **2.3.1 Field sites selection and plant collection**

One of the objectives of research was to document the angiospermic flora of Makawanpur district. Based on the altitude variation, rich floral diversity, easy accessibility, and level of urbanization, plants were collected from lowland, midland and highland. The altitudinal zone of plant collection sites were categorized into lowland below 1000 m, from 1000 m-2000 m midland, highland above 2000 m and comes under tropical to temperate types of climate. The lowland sites were selected Hetauda area (Banaskhandi, Manakamana, Pipepokhara, Huprachaur, Bridravan), Churiamai, and Handikhola which comes under tropical type of climate. For midland site, Chitlang with subtropical climate, and Daman, Aghor, Simbhanjyang for highland experience temperate type of climate. Field works was carried out on 2009 January, February, March, April, May, June, July, August, September; on 2010 October and on 2011 February, March, April, June, August, October. During field visits, the plants were collected from different habitats such as forest, roadsides, riverside, farmer field, fallow land and homegardens. Local names, habit, habitat, place of collection sites and altitude were recorded in field notes.

### **2.3.2 Plant identification**

The collected specimens were identified in field with local peoples' information, personal knowledge of researcher and by consulting relevant references (Grierson & Long, 1983-2001; Hara & Williams, 1979; Hara *et al.*, 1978; 1982; Notlite, 1994, 2000; Siwakoti & Varma, 1999; Zhengyi & Raveen (1994-2001). The specimens were also cross checked with authentic voucher specimens housed in the National Herbarium and Plant Laboratories (KATH Herbarium), Godawari, Lalitpur to confirm their authentic identification. Several unidentified specimens were identified by consulting with the herbarium specimens housed in the Botanical Survey of India (BSI), Kolkota on November, 2011. Nomenclatures of the collected plant species and the six families such as Compositae (Asteraceae), Cruciferae (Brassicaceae), Labiatae (Lamiaceae), Leguminosae (Fabaceae), Umbelliferae (Apiaceae) and Graminae

(Poaceae) are followed according to literature (Hara & Williams, 1978, 1979; Hara *et al.*, 1982; Press *et al.*, 2000, Rajbhandari & Baral, 2010; Rajbhandari *et al.*, 2011, 2012; Watson *et al.*, 2011). Author (S) citation of each species is given in Appendix 1. The families and the species are arranged alphabetically within the family. The habit, locality, altitude and collection sites are also given. The collected herbarium specimens are deposited at National Herbarium and Plant Laboratories (KATH, Herbarium), Godawari, Lalitpur and Tribhuvan University Collection Herbarium (TUCH), Tribhuvan University, Central Department of Botany, Kirtipur. For the comparison of floristic study with past and present exploration of angiospermic flora in Makawanpur district, herbarium specimens housed in KATH was also studied from January 2009 to May 2009.

## **2.4 RESULTS AND DISCUSSION**

### **2.4.1 RESULTS**

#### **Floristic diversity of Makawanpur district**

The flora of Makawanpur district, Central Nepal showed wide range of plant diversity in terms of taxa and life forms. The flora comprises of 695 species belonging to 472 genera and 124 families. Among them one insectivorous plant, nine parasitic, five aquatic, three lithophytes, and most of epiphytes plants belonging to family Orchidaceae and Piperaceae were also recorded (Table 1, Appendix 1).

Out of 695 species, 542 species with 375 genera under 110 families belong to dicots, 153 species with 97 genera under 14 families to monocots (Table 1). In the floristic study, Leguminosae (Fabaceae) was the dominant family with 60 species (8.63%) and 33 genera. Similarly, Compositae (Asteraceae) with 52 species (7.48%), was the second largest family, whereas Graminae (Poaceae) and Orchidaceae 45 species (6.47%) were found to the third largest families. Then followed by family Labiatae (28 genera/33 species), Rosaceae (10/17), Acanthaceae and Rubiaceae (each with 11/16), Cyperaceae (7/15), Urticaceae (10/14), Liliaceae (9/14), Amaranthaceae ((6/13) and so on (Table 2). Thus the dominant plant families were observed in the order Leguminosae>Compositae>Graminae = Orchidaceae > Labiatae > Rosaceae > Acanthaceae = Rubiaceae>Cyperaceae>Urticaceae = Liliaceae>Amaranthaceae =

Euphorbiaceae = Polygonaceae>Moraceae with regard to their species composition (Table 2).

Analysis of distribution of angiospermic plants along altitudinal gradient in the Makawanpur district showed that the tropical region (400-1000 m) collect maximum number of species i.e. 291 species (Figure 3), whereas in altitude at 1000-2000 m and above 2000 m harbor 210 species and 195 species respectively.

**Table 1:** Floristic analysis of angiospermic flora from study sites (Hetauda, Handikhola, Churiamai, Chitlang, Aghor including Daman, Simbhanjyang) of Makawanpur district, Central Nepal.

S.N.	Family	Genera	Species
1	Acanthaceae	11	16
2	Aceraceae	1	1
3	Amaranthaceae	6	13
4	Anacardiaceae	4	6
5	Apocynaceae	7	7
6	Aquifoliaceae	1	1
7	Araliaceae	3	3
8	Asclepiadaceae	3	3
9	Balsaminaceae	1	3
10	Basellaceae	1	1
11	Begoniaceae	1	2
12	Berberidaceae	3	5
13	Betulaceae	2	2
14	Bignoniaceae	1	1
15	Bombacaceae	1	1
16	Boraginaceae	2	2
17	Buxaceae	1	1
18	Campanulaceae	3	5
19	Cannabaceae	1	1
20	Capparaceae	1	1
21	Caprifoliaceae	1	2
22	Caryophyllaceae	2	5
23	Chenopodiaceae	1	2
24	Cleomaceae	2	2
25	Combretaceae	1	3
26	Compositae (Asteraceae)	43	52
27	Convolvulaceae	5	7
28	Cordiaceae	2	2
29	Coriariaceae	1	1
30	Cruciferae (Brassicaceae)	4	3
31	Cucurbitaceae	5	6

**Table 1: (Continued)**

<b>S.N.</b>	<b>Family</b>	<b>Genera</b>	<b>Species</b>
32	Dilleniaceae	1	1
33	Dipsacaceae	1	1
34	Dipterocarpaceae	1	1
35	Droseraceae	1	1
36	Elaeagnaceae	1	2
37	Ericaceae	3	6
38	Euphorbiaceae	7	13
39	Fagaceae	3	6
40	Flacourtiaceae	1	1
41	Gentianaceae	3	6
42	Geraniaceae	1	1
43	Gesneriaceae	3	3
44	Grossulariaceae	1	1
45	Hydrangeaceae	3	3
46	Hypericaceae	1	3
47	Icacinaceae	1	1
48	Juglandaceae	2	2
49	Labiatae (Lamiaceae)	28	33
50	Lardijabalaceae	1	1
51	Lauraceae	4	6
52	Lecythidaceae	1	1
53	Leeaceae	1	1
54	Leguminosae (Fabaceae)	33	60
55	Linaceae	1	1
56	Loranthaceae	4	5
57	Lythraceae	5	7
58	Magnoliaceae	1	1
59	Malvaceae	5	7
60	Melastomaceae	3	7
61	Meliaceae	3	3
62	Menispermaceae	3	4
63	Moraceae	4	11
64	Moringaceae	1	1
65	Myricaceae	1	1
66	Myrsinaceae	2	5
67	Myrtaceae	3	3
68	Nyctaginaceae	1	1
69	Oleaceae	2	3
70	Onagraceae	2	3
71	Orobanchaceae	2	2
72	Oxalidaceae	1	3
73	Papaveraceae	4	5
74	Passifloraceae	1	1



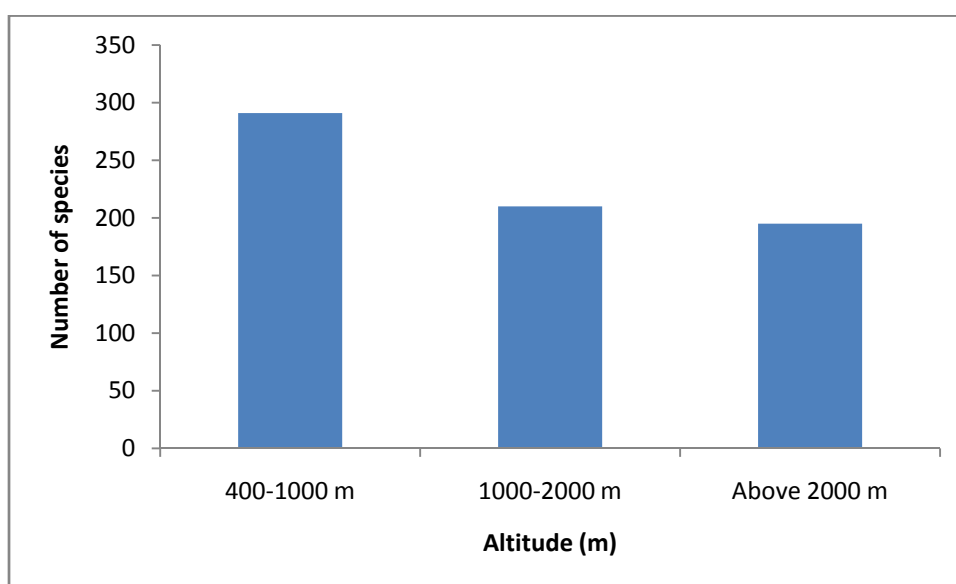
**Table 1: (Continued)**

<b>S.N.</b>	<b>Family</b>	<b>Genera</b>	<b>Species</b>
75	Phytolaccaceae	1	1
76	Piperaceae	2	6
77	Plantaginaceae	1	1
78	Plumbaginaceae	1	1
79	Polygonaceae	5	13
80	Portulacaceae	1	1
81	Primulaceae	3	4
82	Ranunculaceae	5	10
83	Rhamnaceae	1	3
84	Rosaceae	10	17
85	Rubiaceae	11	16
86	Rutaceae	5	5
87	Sambucaceae	2	4
88	Santalaceae	1	1
89	Sapindaceae	4	4
90	Sapotaceae	1	1
91	Saurauraceae	1	1
92	Saurauriaceae	1	1
93	Saxifragaceae	2	2
94	Scrophulariaceae	6	9
95	Solanaceae	3	7
96	Sterculiaceae	1	1
97	Symplocaceae	1	2
98	Talinaceae	1	1
99	Theaceae	2	2
100	Thymeleaceae	2	2
101	Tiliaceae	3	4
102	Ulmaceae	1	1
103	Umbelliferae (Apiaceae)	6	6
104	Urticaceae	10	14
105	Valerianiaceae	1	2
106	Verbenaceae	2	2
107	Violaceae	1	4
108	Viscaceae	1	1
109	Vitaceae	3	3
110	Zygophyllaceae	1	1
	<b>Total</b>	<b>375</b>	<b>542</b>
	<b>Monocot</b>		
1	Amaryllidaceae	1	1
2	Araceae	3	6
3	Commelinaceae	4	4
4	Cyperaceae	7	16

**Table 1: (Continued)**

S.N.	Family	Genera	Species
5	Dioscoreaceae	1	6
6	Eriocaulaceae	1	1
7	Graminae (Poaceae)	38	45
8	Hydrocharitaceae	1	1
9	Hypoxidaceae	2	2
10	Juncaceae	1	1
11	Liliaceae	9	14
12	Orchidaceae	21	45
13	Pontederaceae	2	2
14	Zingiberaceae	6	9
	<b>Total</b>	<b>97</b>	<b>153</b>
	<b>Grand total</b>	<b>472</b>	<b>695</b>

Source: Field survey 2009-2011



**Figure 3:** Distribution of angiospermic plants along altitudinal gradient.

**Table 2:** Top 15 angiospermic families with genera and species.

S.N.	Family	No. of genera	No. of species	% of species
1	Leguminosae	33	60	8.63
2	Compositae	43	52	7.48
3	Graminae	38	45	6.47
4	Orchidaceae	22	46	6.47
5	Labiatae	28	33	4.75
6	Rosaceae	10	17	2.45
7	Acanthaceae	11	16	2.30
8	Rubiaceae	11	16	2.30
9	Cyperaceae	7	15	2.16

**Table 2: (Continued)**

S.N.	Family	No. of genera	No. of species	% of species
10	Urticaceae	10	14	2.01
11	Liliaceae	9	14	2.01
12	Amaranthaceae	6	13	1.87
13	Euphorbiaceae	7	13	1.87
14	Polygonaceae	5	13	1.87
15	Moraceae	4	11	1.58

Dicot families, genera and species dominate over monocot (Table 3). With reference to families, dicot families (88.71%) were higher in number compared to monocot families (11.29%). With regard to genera, dicot genera (79.45%) were also higher in number as compared to monocot genera (20.55%). Similarly, dicot species (77.99%) were higher in number to monocot species (22.01%). Thus, dicots are dominant over the monocots with reference to their numerical strength.

**Table 3:** Distribution of angiospermic plant species of the study sites among families, genera and species.

Angiosperms	Families		Genera		Species	
	No.	%	No.	%	No.	%
Dicotyledons	110	88.71	375	79.45	542	77.99
Monocotyledons	14	11.29	98	20.55	153	22.01
Total	124	100	473	100	695	100

Source: Field survey 2009-2011

**Table 4:** Comparison of dominant genera in the flora of Makawanpur district with flora of Nepal.

S.N.	Genus	No. of species recorded present study	No. of species recorded (Press <i>et al.</i> , 2000)
1	<i>Dendrobium</i>	11	26
2	<i>Desmodium</i>	8	26
3	<i>Persicaria</i>	8	34
4	<i>Ficus</i>	7	41
5	<i>Dioscorea</i>	6	13
6	<i>Coelogyne</i>	5	13
7	<i>Crotalaria</i>	6	18
8	<i>Rubus</i>	6	38
9	<i>Phyllanthus</i>	5	11
10	<i>Eragrostris</i>	5	15
11	<i>Cyperus</i>	5	29

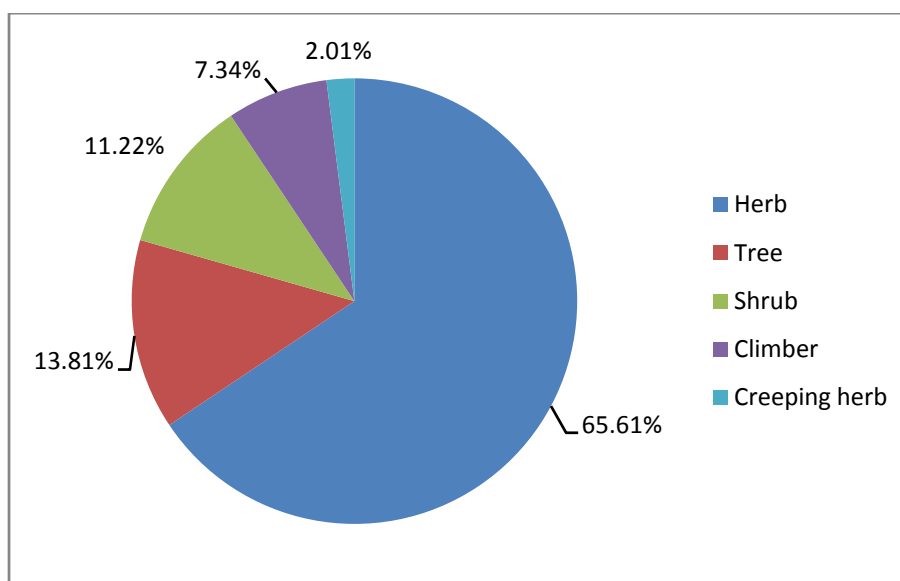
Source: Field survey 2009-2011

The genus *Dendrobium* consists of 11 species followed by *Desmodium*, *Persicaria* (each with 8 spp.), *Ficus* (with 7 spp.), *Coelogyne*, *Crotalaria*, *Dioscorea*, *Rubus* (each with 6 spp.), *Cyperus*, *Eragrostis*, *Phyllanthus*, (each with 5 spp.) (Table 4). *Amaranthus*, *Anaphalis*, *Cassia*, *Indigofera*, *Osbeckia*, *Piper*, *Solanum*, *Stellaria* (each with 4 spp.). Some genera such as *Alternanthera*, *Arisaema*, *Asparagus*, *Bauhinia*, *Clerodendrum*, *Euphorbia*, *Galium*, *Hypericum*, *Lindernia*, *Lobelia*, *Ludwigia*, *Myrsine*, *Oxalis*, *Swertia*, *Terminalia*, *Viburnum*, *Vicia*, and *Viola* have three species in each. Similarly *Achyranthes*, *Ageratina*, *Ageratum*, *Ammania*, *Berberis*, *Bidens*, *Blumea*, *Castanopsis*, *Codariocalyx*, *Commelina*, *Conyza*, *Corydalis*, *Cyclobalanopsis*, *Cyathula*, *Didymocarpus*, *Elaeagnus*, *Elatostema*, *Elschotzia*, *Eranthemum*, *Eurya*, *Gaultheria*, *Gentiana*, *Grewia*, *Hedyotis*, *Impatiens*, *Jasminum*, *Justicia*, *Leucas*, *Lindera*, *Linderbergia*, *Lonicera*, *Maesa*, *Melastoma*, *Peperomia*, *Persea*, *Pilea*, *Pogostemon*, *Polygonum*, *Potentilla*, *Pouzolzia*, *Quercus*, *Ranunculus*, *Rhododendron*, *Rotala*, *Scurrula*, *Scutellaria*, *Senecio*, *Sida*, *Strobilanthes*, *Symplocos*, *Trichosanthes*, *Valeriana*, and *Wendlandia*, have two species in each. Likewise, rests of genera are represented by single species (Appendix 1).

### **Floristic analysis of life form**

There was great diversity of life forms of the present flora. Figure 4 shows an overview of the life form of the plants collected from Makawanpur district. Overall, a majority of the documented species were herbs 456 species (65.61%), trees 96 species (13.81%), shrubs 78 species (11.22%), climbers 51 species (7.34%) and creeping herbs 14 species (2.01%).

This study shows that herbaceous plants are dominating in the forest and surroundings. Similarly, the shrub and trees species can be also observed as dominant perennial vegetation of Makawanpur district (Figure 4).



**Figure 4:** Life form of plants collected from Makawanpur district.

### Habitat

The plant collection sites were divided into five areas such as forest (primary, secondary forest, community forest), fallow land (uncultivated barren land, roadsides, riversides), homegarden, wetland (floating) and rock. Most of the plants were collected in the forest (59.42%) and fallow land (37.55%) followed by homegarden (1.58%) and wetland (1.15%) (Table 5). *Amaranthus lividus*, *A. viridis*, *Chenopodium album*, and *Malva verticillata* were found abundant in fallow land. They are also cultivated in field for selling in market. *Aegle marmelos*, *Artocarpus heterophyllus*, *Bauhinia purpurea*, *B.variegata*, *Cinnamomum tamala*, *Ficus lacor*, *Zanthoxylum armatum*, *Mentha spicata*, *Moringa oleifera*, *Morus serrata*, *Piper longum* and *Tamarindus indica* etc. are planted in homegarden. Similarly, due to high market demand *Asparagus racemosus*, *Swertia chirayita* are being cultivated in fields because they are not found plenty in forest. *Fumaria parviflora* grows at the edge of field as weed, whereas *Orobanche aegyptiaca* was found in mustard field as parasitic plants.

**Table 5:** Lists of plants collected from different habitats.

S.N.	Habitat	No. of species	Percentage (%)
1	Forest	413	59.42
2	Fallow land	261	37.55
3	Homegarden	11	1.58
4	Wetland	8	1.15
5	Rock	2	0.29

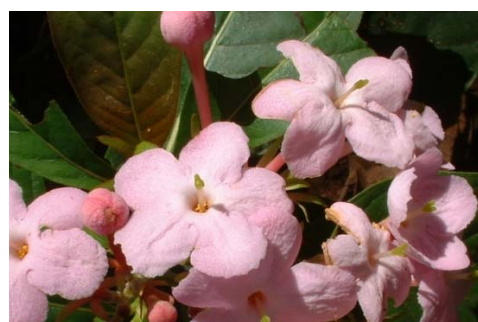
Source: Field survey 2009-2011

### Wild ornamental plants:

Most of the Orchids and many other beautiful plants with immense floriculture potential were found in Makawanpur district. Some of common species wild ornamental plants were *Impatiens bicornuta*, *Lilium nepalense*, *Mahonia napaulensis*, *Rhododendron arboreum*, *Hydrangea aspera*, *Piptanthus nepalensis*, *Reinwardtia indica*, *Woodfordia fruticosa*, *Primula denticulata*, *Pyracantha crenulata*, *Rosa multiflora*, *Luculia gratissima*, *Holmskioldia sanguinea*, and most of *Hedychium* species etc. (Figure 5).



*Impatiens bicornuta* Wall.



*Luculia gratissima* (Wall.) Sweet



*Tabernaemontana divaricata* (L.) R. Br. ex  
Roem. & Schult.



*Lilium nepalense* D. Don

**Figure 5:** Beautiful wild ornamental flowers planted in homegarden.

### New Species from Makawanpur district

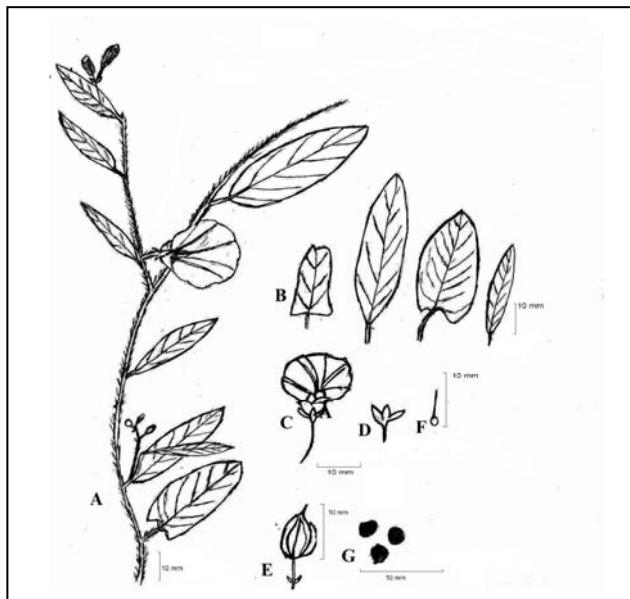
#### ***Merremia hirta* (Linn.) Merr. [Convolvulaceae]: A new record for Nepal**

Twinning or prostrate herb. Stem slender, 20 cm-150 cm long, hirsute or subglabrous, hollow, subfistular, brown. Lamina variable in shape on the same plant, linear to ovate, oblong-lanceolate, ovate-oblong or ovate, borne on one side, 2-6 x .5-2 cm, entire, obtuse to slightly emarginate or mucronate, base obtuse to cordate or truncate

or hastate, both surfaces glabrous or sparsely pilose beneath. Petiole slender, 1-2 cm long, hirsute or glabrous at maturity. Cymes axillary, 1-3 flowered; peduncles 1.5-7.5 cm, slender, pilose; pedicel slender, glabrous, 3-5 mm, longer in fruit; bracts 1-2 mm long, ovate, acute-obtuse, glabrous.



**Figure 6:** *Merremia hirta* (Linn.) Merr. growing at edge of rice field.



**Figure 7:** *Merremia hirta* (Linn.) Merr. A. Flowering branch; B. Various shapes of leaves; C. Flower; D. Sepals; E. Fruit; F. Carpel; and G. Seeds

Flowers 1.5-2 cm across. Sepals light green, glabrous, unequal, outer 2 oblong-elliptic, 3-4 mm long, 1 mm broad, accrescent in fruit, inner 3 oblong or oblong-elliptic, 4.5-6 mm, accrescent, 6-8 mm in fruit. Corolla pale yellow or yellow or whitish, campanulate, 1.5-2 cm across, glabrous, membranous with wavy margin. Stamens 3, pale yellow; anthers pale yellow, spirally twisted; filament inflated at base, hairy. Pistils included; stigma inconspicuous; style 4-5 mm long, glabrous,

persistent in fruit; ovary green, glabrous, 4-loculed. Capsule broadly ovoid to globose, thin walled, green, glabrous, light brown at maturity, papery, 6-9 mm across, 1-celled, 4-valved, crowned with stout style. Seeds dark brown, 3-4, glabrous, subglobose, 1-2 mm across (Figure 6, 7).

### **Comparison of Floristic study with plants housed in KATH herbarium**

During the present study, 695 angiospermic species were collected from Makawanpur district, Central Nepal. Out of 695 angiospermic flora, 405 species were not included in National Herbarium and Plant Laboratories, Godawari, Lalitpur (KATH) herbarium. So that, from the present study, 405 angiospermic flora have been added in KATH herbarium. Compared to angiospermic flora collected from the present study and lists of Makawanpur district plant specimens housed in KATH herbarium, 215 angiospermic species were seemed to be only preserved in National Herbarium and Plant Laboratories (KATH herbarium) (Appendix 2). In addition of 215 species with 695 angiospermic flora of present study, the flora of Makawanpur district showed the occurrence of 910 angiospermic flora.

### **2.4.2 DISCUSSION**

A total of 695 angiospermic plants have been reported from five study sites Chitlang, Churiamai, Handikhola, Hetauda (Piplepokhara, Manakamana, Brindavan, Banaskhandi), Aghor (Simphanjyang, Daman). The present study consists of 11.58% of flora accounted from the Annotated Check List of Flowering Plants of Nepal (2000), that indicated this study sites could be rich in floral diversity. Leguminosae (Fabaceae) was the dominant family with 60 species (8.63%) and first largest family, Compositae (Asteraceae) second largest family, whereas Graminae (Poaceae) and Orchidaceae were found to be the third largest families. Siwakoti and Varma (1999) studied in the tropical flora and reported 92 species from Graminae, which was the first largest family in the flora of the eastern Terai. However, BPP (1995) reported that Graminae the second largest family after Leguminosae similar to the present study. But Ohba *et al.* (2008) mentioned, Compositae was the dominant families in flora of Mustang. Dominant and most common genera with high number of species in this study sites are *Dendrobium*, *Desmodium*, *Persicaria*, *Ficus* (Table 4). Herbs were found to dominant plants with 65.61%, followed by trees with 13.8%, 11.22% shrubs and 7.34% climbers. Because most of the herbs were collected in fallow land beside



the forest and which are easy access and more abundance in the study sites. 59.42% of plants were collected from forest and 37.55% from fallow land. Most of plants occur in forest and fallow land, may be because the total land of Makawanpur district covers 59% forest and 16% fallow land (DDC, 2003). The common wetland plants of the study sites are *Ipomoea aquatica*, *Rorripa nasturtium aquaticum*. These wetland plants are consumed as vegetable.

The angiospermic floristic lists of Makawanpur district show some similarity with that of Flora of Kathmandu Valley (Central Nepal). In the present study 412 species were reported which similar to species was reported from Kathmandu Valley flora (DMP, 1986). It shows that the flora in the Makawanpur district (Central Nepal) resembles to that of Flora of Kathmandu valley (Central Nepal).

A comparison between the present study and compilation of flora of Nepal (Press *et al.*, 2000; Hara *et al.*, 1979; 1982) showed that, one species reported from Makawanpur district, new to Nepal. The newly reported species is *Merremia hirta*, which was collected from Handikhola on edge of crop field for the first time from Nepal. This species was found rare.

215 species were only listed out from KATH herbarium. In the present study, would be the results of changes of land use pattern, climate, road construction, migration of people as well as spread of rapidly invasive species *Mikamia micrantha* in the forest area. Floristic documentation of Makawanpur district would not only the results of climate change, infrastructure development, but also might be not explored places in the present study.

## **CHAPTER 3**

### **3. UTILIZATION PATTERN OF PLANT RESOURCES**

#### **3.1 MEDICINAL PLANTS**

##### **3.1.1 INTRODUCTION**

Plants are important sources of medicine in many primary health care systems. Herbal medicines serve the health needs of about 80% of the world population in the rural areas of developing countries (WHO, 2000). About 35000 to 70000 plant species that have been used for medicinal purposes in the world (Farsworth & Soejarto, 1991) and about 6500 species of which occur in Asia (Karki & Williams, 1999). In Nepal, 1700 to 1900 species of plants are commonly practiced in traditional medicine (Baral & Kurmi, 2006; Ghimire, 2008).

Many people in Nepal do not have access to the modern medicinal facilities and depend on medicinal plant resources for their health problems. About 70-80% of the population of the country still depends upon medicinal plants for their health problems (Manandhar, 2002). Most of these medicinal plants are collected from wild resources and there is no exact information on the context and extent of use, collection and also on conservation status of these plants.

Nepal is a multiethnic and multilingual country where 125 ethnic groups speaking 123 languages (NPHC, 2011b). Local knowledge for medicinal use is a "social product" that is part of the specific cultural system (Antweiler, 1998). Medicinal plant knowledge can exist in a highly anthropogenic environment with moderate plant diversity (Vandebroek *et al.*, 2004). Medicinal plants studies were carried out in Chepang tribe of Makawanpur district (Manandhar, 1989); Tamang ethnic group (Shrestha, 1988; 1989; Manandhar, 1991; Mikage, 2000; Luitel *et al.*, 2013), Tharu tribe (Dangol & Gurung, 1991), Darai tribe (Dangol & Gurung, 2000), Satar ethnic group (Siwakoti & Siwakoti, 2000), Limbu ethnic group (Siwakoti & Siwakoti, 1998) and Bankaria (Uprety *et al.*, 2008). However, most studies on medicinal plants focus on the role of these plants within one culture, i.e., one ethnic group. Although there

are a handful of ethnobotanical studies in Nepal, very few studies compare the pattern of medicinal plant use and medicinal plant cultural domain between different ethnic groups or among same ethnic group in different geographical regions. For promoting use and conservation of medicinal plants, the cultural domain studies are important. The cultural domains are starting point for studying people's perception of the natural world and are important aspects of local knowledge by which cultural organizations are understood (Puri & Vogl, 2005). Elements of a particular cultural domain (here medicinal plants domain) can be recorded and analyzed through free-listing interview methods (Martin, 1995; Puri & Vogl, 2005). This study focused on documentation of indigenous knowledge of medicinal plant use between Tamang, Bankaria and Newar ethnic groups from Makawanpur district and comparison of knowledge pattern among these ethnic groups. Further, most salient medicinal plants were identified for each ethnic group and compared between groups.

### **3.1.2 LITERATURE REVIEW**

#### **3.1.2.1 Medicinal plants in Nepal**

Medicinal plants are one of the important natural resources for the economy of the country. In Nepal, mostly ethnobotanical studies were focused on the medicinal plants. The first publication herbal encyclopedia was '*Chandra Nighantu*' in which 750 coloured plates of plants and its medicinal uses in 8 volumes, compiled at the end of 19<sup>th</sup> centuries (Malla & Shakya, 1984). Banerji (1955) studied on medicinal and food plants of east Nepal. Some of the earlier works in medicinal plants were studied by Pande (1964) and Devkota (1968). Malla and Shakya (1968) studied on 'vegetation and medicinal plants of Nepal' and listed the medicinal plants found in different ranges from Tropical (Birjung) to Alpine zone in the Langtang area of the country. On 1970, 1984, Department of Medicinal Plants published a book 'Medicinal Plants of Nepal' and its supplement volume includes 393 species and 178 species of medicinal plants respectively (DMP, 1970, 1984). Manandhar (1980) published "Medicinal Plants of Nepal Himalaya". Malla *et al.* (1996-1997) had published a book on identification manual for selected non-timber forest products of Nepal. Shrestha *et al.* (2000) have published detailed list of 1624 species of Medicinal and Aromatic Plant Database of Nepal, including 1515 species of angiosperms, 18 species of gymnosperms, 58 species of pteridophytes, 6 species of bryophytes, 18 species of lichens, and 9 species of fungi.

IUCN (2000) published "National Register of Medicinal Plants" and documented 150 medicinal and aromatic plants. Manandhar (2002) reported about 1500 species of plants as medicine, food, timber, fibre, fodder etc. Joshi and Joshi (2001) published a book 'Genetic Heritage of Medicinal and Aromatic Plants of Nepal Himalaya' that describes 286 medicinal and aromatic plants. Lama *et al.* (2001) documented some 100 medicinal plants in the book of 'Medicinal Plants of Dolpo. Rajbhandari (2001) described 562 species of ethnobotanical uses of plants in "Ethnobotany of Nepal". Watanabe *et al.* (2005) published "A Handbook of Medicinal Plants" described 108 medicinal plant species along with their chemical constituents. Baral and Kurmi (2006) have compiled about 1,792 species of medicinal plants of Nepal. Rajbhandary & Ranjitkar (2006) have published "Herbal drugs and Pharmacognosy". Ghimire *et al.* (2008) published the book titled "Non-Timber Forest Products of Nepal Himalayas". Kunwar and Bussmann (2008) studied the indigenous knowledge and use of plant resources of the Nepal Himalayas along the altitudinal and longitudinal gradient.

### **3.1.2.2 Medicinal uses in different ethnics of Nepal**

The ethnobotanical studies were documented in different ethnic groups as discussed. Sacherer (1979) studied the medicinal plants and practices by the Sherpas of Rolwaling in northern Nepal. The ethnobotanical study has undertaken in Tharu tribe of Dang district by Manandhar (1985), Tharu tribes of Chitwan district (Dangol & Gurung 1991; Mueller-Boker, 1993; 1999). Shrestha and Joshi (1993) reported on 51 species of medicinal plants of the Lele village of Lalitpur district used by the Tamang people to care the different ailments. Similarly, Moosher tribe of Dhanusha district (Manandhar, 1986), Danuwar tribes of Kamalakhaj in Sindhuli district (Manandhar, 1990), Tamang tribes of Kabhrepalanchok district (Manandhar, 1991), Tamang tribe of Kaski district (Mikage, 2000) were also studied. Shrestha and Shrestha (2000) reported a list of 82 medicinal plants from the Tamang Community of Langtang National Park, Shivapuri National Park (Singh & Siwakoti, 2009), Darai tribes of Chitawan district (Dangol & Gurung, 2000), Gurung communities of Lumjung district (Shrestha, 1998; Shrestha *et al.*, 2001), Limbu tribe of Hellock area of Tapethok VDC from Taplejung (Oli, 2003), Satar tribe (Siwakoti & Siwakoti, 2000), Limbu tribe (Siwakoti & Siwakoti 1998), Dhimal tribe (Siwakoti *et al.*, 2005). Similarly, Tamang of Kathmandu valley has also studied by Shrestha (1988), Rais and Sherpas in the upper Arun valley of eastern Nepal

(Daniggelis, 1994), Raute tribe of Dadeldhura district (Manandhar, 1995) and Bankariya (Uprety *et al.*, 2008).

### **3.1.2.3 Ethnomedicinal study in Central Development Region**

An ethnobotanical study was conducted in Rasuwa district by (Manandhar, 1980a), Nuwakot district (Manandhar, 1982), and Helambu area (Shrestha, 1989). Similarly, ethnomedicinal study was undertaken in Central Nepal by Bhattarai (1987, 1988, 1989, 1990, 1991a, 1992a, 1992b, 1994) and in central development region (Joshi & Edington, 1990). Similarly, ethnomedicinal study were carried out in Dhading district (Manandhar, 1992), Terai and Dun Valley of Nepal (Chaudhary, 1993), and Myagdi district (Manandhar, 1995a). Malla (1994) discussed a paper on medicinal herbs in the Bagmati zone, which described an economic analysis of herb cultivation and processing. Amatya (1996) studied ethno-medicinal use of plants of Bara District. Joshi and Joshi (2000) studied the ethnobotanical information of 31 species of some hilly villages of central development region of Nepal. Panthi and Chaudhary (2003) documented traditional knowledge on the treatment of various diseases in Arghakhanchi district. Poudel and Uprety (2004) surveyed non-timber forest products from Nuwakot district, listed 32 plant species used for medicine by traditional practitioners. Rai *et al.* (2004) documented 42 species of medicinal plants used for treating 45 different ailments from Thumpakhar VDC, Sindhupalchok district.

Bhattarai *et al.* (2006) documented 91 ethnomedicinal plants species from Manang district, Central Nepal. Bhattarai *et al.* (2010) also recorded the traditional uses of 121 medicinal plant species in the trans-himalayan arid zone of Mustang district, Nepal. Uprety *et al.* (2010) documented 60 medicinal plant species from Rasuwa district, Central Nepal. They also identified that Tamang people possess rich ethnopharmacological knowledge.

### **3.1.2.4 Medicinal plants study in Makawanpur district**

Bista (1976) studied the cultivation of some important medicinal plants in Hetauda. Similarly, studies on ethnobotanical research in Makawanpur district have been done by Manandhar (1989) from the Chepang tribe of some villages of Makawanpur district and reported 102 species of medicinal plants which were utilized in 27 types of diseases. Manandhar (1995b) also described 79 species of vegetables used for drug

resources. Bhattarai *et al.* (2000) documented the medicinal plant diversity in Tistung and Daman Botanical Garden and surrounding areas. Some ethnobotanical plants and Non-timber Forest Products were conducted in Makawanpur district by Bhattarai (1991b), Sigdel (2004); Luitel *et al.* (2013). Uprety *et al.* (2005) published a book entitled Traditional use of plant resources by Bankariya ethnic group of Makawanpur district, Central Nepal.

### **3.1.3 MATERIALS AND METHODS**

#### **3.1.3.1 Ethnobotanical data collection**

Field visit was carried out in Makawanpur district in between 2009 and 2011. Five study sites (Aghor, Chitlang, Churiamai, Handikhola, and Hetauda) (Figure 1) were selected to gather indigenous knowledge pattern in use of medicinal plants among three ethnic groups (Bankaria, Newar and Tamang). A free-list method was applied to obtain information about the cultural domain of medicinal plants from respondents of three ethnic groups. Free-listing is useful tool to identify the most useful plant species of cultural domain in study area (Puri & Vogl, 2005). For the free-listing interviews, respondents of both men and women of different age groups were selected randomly (Berlin & Berlin, 2005). In free-listing, it was asked to respondents of three ethnic groups (Bankaria, Newar, Tamang): "Please tell me the medicinal plants you know".

For the semi-structured interviews, the respondents of different age groups (20-40, 40-60 and above) were selected consulting with local village head, which include traders, traditional healers, local knowledgeable people and plant collectors. Respondents were selected from three ethnic groups (Bankaria, Newar, Tamang) of this district. The ethnomedicinal data of the Bankaria ethnic group was gathered from Handikhola VDC, ward. No. 7, located at altitude 500 m (lowland). A total of 30 respondents (14 female and 16 male) were interviewed. The respondents of the Newar community was selected from Chitlang VDC, Ward No. 3, 5, 9, located at 1800 m and interviewed with 20 respondents (nine female and 11 male). Similarly, 27 respondents (10 female and 17 male) were interviewed with Newar community from Hetauda municipality (500 m). Ethnomedicinal information from Tamang ethnic group was collected from Churiamai VDC, Ward No. 4 (600 m) with 44 respondents (23 female and 21 male) and Namtar VDC, Aghor village located at 2200 m with 44 respondents (20 male and 24 female).

A semi-structured interview was developed before hand following the approach of Martin (1995) (Appendix 3). Local names of medicinal plants used, kind of illness treated, the plant parts used, method of preparation, mode of administration, habitat, threats were recorded. During the interviews, herbarium specimens, plant photographs were also shown to respondents for the correct identification of plant names. In addition, the field visits were done with respondents to gather additional information and to collect mentioned medicinal plants for herbarium. Medicinal plant species was identified in the field with the help of respondents, researcher own experiences and by consulting literatures, herbarium specimens housed in National Herbarium and Plant Laboratories (KATH), Godawari, Lalitpur, Nepal.

### **3.1.3.2 Market survey**

Local markets are important as they are sources of commercially traded medicinal plants, wild edible plants. Markets help to maintain indigenous knowledge concerning wild useful plant species. Market survey is an essential part of ethnobotanical survey in the study area. Market survey was carried out in Hetauda town market, Bhimpedi, Chitlang, Churiamai, Basamadi, and Palung market. The survey was undertaken to assess the number of wild useful plants sale. The traders from different study sites were interviewed. The commercial useful plants were collected from roadside market, weekly market and whole sale market. Information regarding traded useful plants was also gathered from Department of Forest, Makawanpur district.

### **3.1.3.3 Preference ranking**

Preference ranking exercise (Martin, 1995) was conducted with ten knowledgeable respondents who already participated in the interview (two from each five study sites Aghor, Chitlang, Churiamai, Handikhola, Hetauda). The lists of preferred medicinal plants were recorded from respondents, based on respondents perceived level of trade and utilization. The medicinal plants that were found to be the most effective, were given the highest value, i.e. 5, and the one with the least effectiveness a value of 1. The scores of each species were summed and ranked.

#### **3.1.3.4 Priority setting approach for domestication**

Priority setting approach for domestication was also developed. In this work, 20 medicinal plants identified from preference ranking exercise were selected for this approach. Priority setting approach was conducted by using following seven variables: priority for sale (range 1-3), species occurrence in homegarden (yes/no), number of ethnic groups using the species (range 1-3), number of altitude zones having the species (range 1-3), ease of cultivation (range 1-3), level of threat as perceived by respondents (threatened/not threatened), possibility for processing and/or storage of the product (yes/no).

The priority setting approach variables were asked with respondents of five study sites. The values of each of these variables were then summed to obtain a priority index for domestication. Species domesticated elsewhere was excluded from the list. The remaining species was finally sorted out by the priority index to identify the species with the highest priority for domestication.

#### **3.1.3.5 Data analysis**

The medicinal plant uses were grouped in different use categories following Cook (1995). To test the knowledge on the use of plants among the three ethnic groups, it was compared with different indices together to better understand the pattern of plant knowledge and use by studied ethnic groups Bankaria, Newar and Tamang. Four importance indices were such as: Informant consensus factor (ICF) or Informant agreement ratio (IAR), Relative frequency of citation (RFC), Cultural important index (CI) were analyzed from semi-structured interviews data and Smith's salience index (SI) was analyzed from free-listing data.

#### **Smith's salience index (SI)**

Smith's salience index was used to examine species saliency or the most frequently used plant species by the ethnic groups in the study sites. The free-list data was analyzed at three ethnic groups (Bankaria, Newar and Tamang) separately. It was summarized for species frequency, Smith's salience index (Smith, 1993). Saliency index (Smith's S) was calculated for freelist data. Freelist is one type of technique designed for ethnobotanical research for ethnic groups. Freelist is a simple, accurate, quick method to collect data from a large sample of individuals.



Freelists show the salience of items in the community and variation in knowledge of the ethnic groups (Puri & Vogl, 2005). Data obtained by free-listing method are analysed by using software ANTHROAPAC 4.08 (Boragatti, 1996). Salience index accounts for frequency of mentions and positions of items in freelists and ranges from 0 to 1, showing the highest salience at 1.

### **Informant Consensus Factor (ICF)**

For consensus analysis, "informant consensus factor" (ICF) (Trotter & Logan, 1986), also called "informant agreement ratio" (IAR) (Collins *et al.*, 2006; Inta *et al.*, 2008), was calculated to measure the agreement between informants concerning which plants are used for specific use categories. ICF was calculated using the following formula (Trotter & Logan, 1986).

$$ICF = \frac{N_{ur} - N_t}{N_{ur} - 1}$$

Where  $N_{ur}$  refers to the number of use reports for each use category and  $N_t$  is the number of plant species which are used in that use category by all the informants. ICF ranges between 0 and 1. ICF values will be low (near 0) if plants are chosen randomly, or if informants do not exchange information about their use. Values will be high (near 1) shows that plant species are used by informants for that category of use which refers to high degree of consensus and a well-defined medicinal plant tradition (Heinrich *et al.*, 1998).

### **Relative Frequency of Citation (RFC)**

Relative frequency of citation (RFC) was calculated by dividing frequency of citation (FC) (the number of informants who mention the use of the species) by total number of informants in the survey (N) (Tardío & Pardo-de-Santayana, 2008). Relative frequency of citation (RFC) is an index of salience which does not consider the use-category.

$$RFC = FC/N$$

RFC varies from 0 when nobody refers to the plant as useful and 1 when all informants mention the use of the species (Tardío & Pardo-de-Santayana, 2008).

### Cultural Importance Index (CI)

To estimate the cultural significance of each species, Cultural importance index (CI) (Tardío & Pardo-de-Santayana, 2008) was used and that was calculated by the following formula:

$$CI_i = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui} / N$$

where  $u$  is the category of use,  $u_{NC}$  is the total number of different use categories ( $u_1, u_2, \dots, u_{NC}$ ),  $UR$  is the total number of use-reports for the species,  $i$  and  $N$  is the total number of informants (Tardío & Pardo-de-Santayana, 2008; Signorini *et al.*, 2009). CI is sum of the proportion of informants that mention each species use. CI is an index where (number of informants) for each species as well as its various uses were calculated. The maximum value for the index is the total number of use-categories (NC) (Tardío & Pardo-de-Santayana, 2008).

## 3.1.4 RESULTS AND DISCUSSION

### 3.1.4.1 RESULTS

#### Diversity of medicinal plants

A total of 189 medicinal plant species were collected belonging to 164 genera and 84 families. The scientific names, local names (Nepali, Bankaria, Newar, Tamang), medicinal uses, plant parts used, method of preparation, mode of administration, market availability and ethnic groups use were also documented in Table 6.

12 medicinal plant species were found to be new method of use for the treatment of diseases. Decoction of tender shoot of *Asparagus filicinus* is taken for fever. Similarly, flowers of *Dendrobium longicornu* are eaten raw for tonic; stem/bark paste of *Litsea glutinosa* is applied for bone dislocation and fracture; flowers of *Paederia foetida* are chewed for toothache; paste of *Persea duthiei* bark/wood is applied for bone fracture; stem ash *Prunus cerasoides* is applied for burns; decoction of *Scoparia dulcis* leaves is taken for throat sore; stem paste of *Scurrula parasitica* is applied for bone fracture; *Solanum nigrum* fruits are eaten for fever; decoction of *Stellaria monosperma* root are taken for diarrhea; decoction of *Tribulus terrestris* fruit is taken

for body inflammation; and decoction of *Zephyranthes carinata* bulb is taken for gastric (Figure 8).



**Figure 8:** New uses of medicinal plants for Makawanpur district: a. *Asparagus filicinus*; b. *Dendrobium longicornu*; c. *Litsea glutinosa*; d. *Paderia foetida*; e. *Persea duthiei*; f. *Prunus cerasoides*; g. *Scoparia dulcis*; h. *Scurrula parasitica*; i. *Solanum nigrum*; j. *Stellaria monosperma*; k. *Tribulus terrestris*; and l. *Zephyranthes carinata*.

**Table 6:** List of medicinal plants collected from Makawanpur district, Central Nepal.

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
1	<i>Acacia catechu</i>	Khayar (Nep), Hikhiyo (Ne)	Wood, Bark	Toothache, Body inflammation, Blood purifier	Paste, Decoction, Powder	Brush, Washing, Orally	Yes	Ba, Ne, Ta
2	<i>Acacia pennata</i>	Sikakae (Nep)	Bark, Seed	Scabies, Cuts and wounds	Decoction, Paste	Bath, Plaster	Yes	Ba
3	<i>Achyranthes aspera</i>	Uletejhar (Nep), Akamoro (Ta)	Root, Stem, Entire plant	Fever, Toothache, Itching	Decoction, Paste, Raw	Orally, Brush, Rub	No	Ba, Ta
4	<i>Achyranthes bidentata</i>	Ultekurro, Datiwan (Nep), Phrekprek (Ta)	Stem	Toothache	Raw	Brush	No	Ta
5	<i>Aconitum laciniatum</i>	Kalobikh (Nep)	Root	NA	NA	NA	No	NA
6	<i>Aconitum spicatum</i>	Bikh (Nep)	Root	NA	NA	NA	Yes	Ta
7	<i>Acorus calamus</i>	Bojho, Sutha (Ta), Safi, Bisaha (Ne)	Rhizome	Cough and cold, Throat sore,	Decoction, Dried, Raw	Orally, Chewing, Gargle	Yes	Ba, Ne, Ta
8	<i>Aechmanthera gossypina</i>	Magamanda (Ta), Knagaraitophol (Nep)	Root	Diarrhea	Juice	Orally	No	Ta
9	<i>Aegle marmelos</i>	Bel (Nep, Ta), Bya (Ne)	Fruit pulp, Fruit Shell	Diarrhea and dysentery, Vitamin, Body inflammation, Toothache, Stomache, Body strength	Powder, Juice	Orally, Brush	Yes	Ba, Ne, Ta
10	<i>Aeschynomene indica</i>	Arahari (Ba)	Entire plant	Headache, Sinusitis	Crushed	Put, Inhale	No	Ba

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
11	<i>Ageratina adenophora</i>	Banmara (Nep), Kaljhar (Ta)	Leaves	Cuts	Paste	Dressing	No	Ta
12	<i>Ageratum conyzoides</i>	Gandheghans (Nep), Raunce (Ba), Pwaeelinghyan, Nawaghyan (Ne), Ganthe (Ta)	Leaves	Bone fracture, Cuts and Wounds	Paste	Plaster, Dressing	No	Ba, Ne, Ta
13	<i>Allium wallichii</i>	Banlasun (Nep), Dundudhap (Ta)	Bulb	Cough and cold	Raw	Chewing	No	Ta
14	<i>Alnus nepalensis</i>	Utis (Nep), Kyasing (Ta), Gwayachhasi, Bonsi (Ne)	Bark, Wood,	Burns, Wounds	Decoction	Dressing	Yes	Ne, Ta
15	<i>Alstonia scholaris</i>	Chhatiwan (Nep, Ta)	Bark	Antihelminthic, Anticholera, Diabetes, Epilepsy	Decoction	Orally	Yes	Ta
16	<i>Alternanthera sessilis</i>	Saranchisag (Nep), Mambolan (Ta)	Leaves	Scabies	Paste	Dressing	No	Ta
17	<i>Amaranthus spinosus</i>	Kande latte (Nep), Kanbanka (Ne), Rangnan (Ta)	Root	Fever	Decoction	Orally	No	Ta
18	<i>Ampelocissus divaricata</i>	Purani (Nep)	Stem	Eye sight	Stem water	Drop	No	Ta
19	<i>Anaphalis busua</i>	Bokiphul (Nep), Buswan, Bhorighyan (Ne); Taptapmhendo (Ta)	Leaves	Cuts and wounds	Paste	Dressing	No	Ta
20	<i>Anaphalis triplinervis</i>	Bukiful (Nep), Taptap (Ta)	Leaves	Cuts and wounds	Paste	Dressing	No	Ta
21	<i>Anemone vitifolia</i>	Kapase, Jhule (Ta)	Root	Scabies	Paste	Dressing	No	Ta

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
22	<i>Anisomeles indica</i>	Rato charpate (Nep)	Entire plant	Tonic	Raw	Orally	No	Ta
23	<i>Ariveia viscosa</i>	Bantori (Nep), Swivamocho (New)	Seeds	Antihelmintic	Raw	Orally	No	Ba
24	<i>Artemisia indica</i>	Titepati (Nep), Chyanchin (Ta), Khafya, Dhuswan (Ne)	Leaves	Cuts and wounds, Antihelmintic, Ringworm, Diabetes	Juice, Paste, Decoction	Dressing, Orally	No	Ne, Ta
25	<i>Asparagus filicinus</i>	Kurilo (Nep)	Tender shoot	Fever	Put on fire	Orally	No	Ne
26	<i>Asparagus racemosus</i>	Satawari (Nep), Kobi (Ta)	Tender shoot/tuber	Tonic, Dysentery, Cough and cold, Fever, Urine inflammation	Decoction, roasted on fire	Orally	Yes	Ba, Ne, Ta
27	<i>Astilbe rivularis</i>	Thuloaukhadhi (Nep), Ganchhyungmran (Ta), Fakuwasa (Ne)	Rhizome	Delivery stomache	Decoction	Orally	Yes	Ne, Ta
28	<i>Azadirachta indica</i>	Nim (Nep), Niha (Ne)	Leaves, Stem	Fever, Blood pressure, Toothache	Dried raw/decoction	Orally, Brush	Yes	Ba, Ne, Ta
29	<i>Barleria cristata</i>	Kurro (Nep), Chare phela (Ba)	Flower	Throat trouble	Mashed	Chewing	No	Ba
30	<i>Bauhinia variegata</i>	Koiralo (Nep), Ambumendo (Ta), Varabo, Kunabu (Ne)	Flower/Flower bud	Blood pressure, Diarrhea and dysentery, Stomache	Decoction	Orally	Yes	Ba, Ne, Ta

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
31	<i>Begonia picta</i>	Macarkanche (Nep), Braju (Ta)	Entire plant	Wounds, Antileech	Paste	Put	No	Ne, Ta
32	<i>Berberis aristata</i>	Chutro (Nep), Kerba (Ta), Chhurasi (Ne)	Stem, Root	Eye problem	Juice	Drop with goat milk	Yes	Ne, Ta
33	<i>Bergenia ciliata</i>	Pashanbed (Nep), Bregyal (Ta), Fakuwasa, Quatiwasa (Ne)	Rhizome	Post delivery stomache	Decoction, Dried powder	Orally	Yes	Ne, Ta
34	<i>Boehmeria macrophylla</i>	Kamle (Nep), Polo (Ta.)	Leaves	Cuts and wounds	Paste	Dressing	No	Ba
35	<i>Boehmeria rugulosa</i>	Dar (Nep)	Leaves	Cuts and wounds	Paste	Dressing	No	Ba
36	<i>Boerhavia diffusa</i>	Punarva (Nep)	Root, Leaves	Jaundice	Decoction	Orally	Yes	Ba, Ne
37	<i>Bombax ceiba</i>	Sima (Nep), Simaha (Ne)	Flower	Diarrhea, Blood pressure	Decoction	Orally	No	Ba, Ne
38	<i>Caesulia axillaris</i>	Galfule (Nep)	Leaves	Cuts and wounds	Paste	Dressing	No	Ba
39	<i>Calotropis gigantea</i>	Ank (Nep)	Milk latex	Wounds, Leprosy itching, Pimples	Raw	Dressing	No	Ba
40	<i>Cannabis sativa</i>	Bhang (Nep), Ganja (Ta), Lupu (Ne)	Seeds	Antihelminthic, Cuts and wounds, Diarrhea and dysentery	Powder, Paste	Orally, Dressing	No	Ne, Ba
41	<i>Cassia fistula</i>	Rajbrikchhya (Nep), Glemhendo (Ta)	Fruit	Diarrhea and dysentery	Decoction	Orally	Yes	Ne, Ta
42	<i>Cautleya spicata</i>	Panisaro, Nakali Panchaunle (Nep)	Rhizome	Stomach disorder	Decoction	Orally	No	Ba, Ne

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
43	<i>Centella asiatica</i>	Ghodtapre (Nep), Tilikosyo(Ta), Bakulaghyan, Chotrimriya (Ne)	Entire plant, Leaves	Brain tonic, Jaundice, Urinary inflammation, Tonic, Skin inflammation, Headache	Juice, Decoction, Paste	Orally, Dressing, Put on head, Rub	Yes	Ba, Ne, Ta
44	<i>Cheilanthes arbomarginata</i>	Ranisinka, Kalosinka (Nep)	Leaves	Cuts and wounds	Paste	Dressing	No	Ba, Ne
45	<i>Chenopodium album</i>	Bethe (Nep), Nana (Ta), Ikecha (Ne)	Leaves	Antihelmintic, Eye sight	Decoction, cooked with egg	Orally	No	Ta
46	<i>Chlorophytum arundinaceum</i>	Setomuseli (Nep)	Rhizome	Tonic, Joint pain, Body strength	Decoction, Paste	Orally, Massage	Yes	Ba, Ta
47	<i>Chlorophytum nepalense</i>	Banpyaj (Nep), Chalidhap (Ta)	Tuber	Joint pain	Cooked with mustard	Massage	Yes	Ta
48	<i>Choerospondias axillaris</i>	Lapsi (Nep), Kalang (Ta), Amri (Ne)	Fruit, Seed	Cold and cough, Diarrhea	Boiled, Seed ash	Orally	No	Ta
49	<i>Chromolaena odorata</i>	Banmara (Nep), Kaljhar (Ta)	Leaves	Cuts and wounds	Paste	Dressing	No	Ta
50	<i>Cinnamomum tamala</i>	Tejpat (Nep), Sinkauli, Tejpat (Ta)	Leaves, Bark	Cough, Blood pressure, Sinusitis	Raw, Decoction, Paste	Chewing, Orally, Inhale	Yes	Ta
51	<i>Cirsium wallichii</i>	Thakal (Nep.), Wonchagalin (Ta), Chwanka (Ne)	Stem pith	Urine sensation	Raw	Orally	No	Ne, Ta
52	<i>Cissampelos pareira</i>	Batulpate, Gujargano (Nep),Tanga (Ta)	Root	Stomache, Cough, Snakebites, Gastric, Ulcer, Burning sensation	Decoction, Paste	Orally, Dressing	Yes	Ba, Ta
53	<i>Cissus javana</i>	Jogilahara (Nep)	Stem, Entire plants	Boils, Bone fracture	Juice, Paste	Drop, Plaster	No	Ba, Ta



**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
54	<i>Cleistocalyx operculatus</i>	Kymuna (Nep), Kyamuna (Ba)	Bark, Leaves	Cough, Sinusitis	Decoction, Paste	Orally, Inhale	Yes	Ba, Ta
55	<i>Clematis buchananiana</i>	Jungelahara (Nep), Brama (Ta)	Leaves	Cough and cold	Decoction	Inhale	No	Ta
56	<i>Clerodendrum indicum</i>	Chitu (Nep), Bhati (Ta)	Root, Leaves, Stem	Antihelmintic, Antilice, Toothache	Raw	Rub, Bath, Brush	No	Ta
57	<i>Clinopodium piperitum</i>	Pipermint (Nep)	Leaves	Cough and cold	Decoction	Orally, Inhale	No	Ta
58	<i>Clinopodium umbrosum</i>	Bilajor (Nep)	Leaves	Cuts and wounds	Paste	Dressing	No	Ta
59	<i>Coelogyne cristata</i>	Chandigava (Nep), Syalbal (Ta)	Pseudobulb	Boils	Paste	Dressing	No	Ta
60	<i>Colebrookea oppositifolia</i>	Dhasure (Nep), Potepote (Ta)	Stem	Appetite	Piece	Tie on neck	No	Ta
61	<i>Cordia dichotoma</i>	Gud (Nep)	Leaves	Headache	Juice	Dressing	No	Ba
62	<i>Costus speciosus</i>	Betlauri (Nep)	Rhizome	Urine inflammation, Stomache	Decoction	Orally	No	Ba
63	<i>Curculigo orchioides</i>	Banspate, Kalomuseli (Nep), Banjari (Ta)	Rhizome	Jaundice	Decoction	Orally	Yes	Ta
64	<i>Curcuma angustifolia</i>	Haledo, Kachur (Nep)	Root	Bone fracture	Paste	Plaster	Yes	Ta
65	<i>Curcuma aromatica</i>	Haludo (Nep)	Rhizome	Muscle swelling, Burns, Fever	Mustard oil+rhizome powder, Paste, Decoction	Massage, Dressing, Orally	Yes	Ba
66	<i>Cynodon dactylon</i>	Dubo (Nep), Situ (Ne), Tabang (Ta)	Leaves	Cuts and wounds	Paste	Dressing	No	Ta

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
67	<i>Cynoglossum furcatum</i>	Kuro (Nep), Boketimur (Ta), Wachuwasa (Ne)	Leaves	Cuts and wounds	Juice	Dressing	No	Ne, Ta
68	<i>Cyperus rotundus</i>	Mothe, Taukejhar (Nep)	Tuber	Stomache	Tuber+Black pepper	Orally	Yes	Ba
69	<i>Datura stramonium</i>	Dhaturo (Nep), Dhatuma (Ne)	Seeds	Dental problem	Smoke	Inhale	Yes	Ne
70	<i>Dendrobium densiflorum</i>	Sungava (Nep)	Pseudobulb	Pimples	Paste	Dressing	No	Ta
71	<i>Dendrobium longicornu</i>	Kankre, Jiwanti (Nep)	Flower	Tonic	Raw	Orally	No	Ta
72	<i>Desmodium confertum</i>	Raktmul (Nep), Cheure ko jhar (Ba), Koltechhe (Ta)	Root, Entire plant	Diarrhea and dysentery, Fever, Gastric	Decoction, Juice	Orally	No	Ba, Ta
73	<i>Desmodium microphyllum</i>	Bute kanike (Nep), Ghogi (Ta)	Entire plant	Boils, Wounds	Paste	Dressing	No	Ta
74	<i>Desmodium oojeinense</i>	Sandan, Panan (Nep)	Bark, Leaves	Dysentery	Juice, Decoction	Orally	No	Ba
75	<i>Dichroa febrifuga</i>	Bhasak (Nep), Dharmen(Ta)	Leaves	Fever	Decoction	Orally	No	Ta
76	<i>Didymocarpus pedicellatus</i>	Kumkum (Nep)	Leaves	Kidney stones	Juice, Decoction	Orally	Yes	Ta
77	<i>Dioscorea bulbifera</i>	Bantarul (Nep), Nagitise (Ta), Pangan (Ba)	Tuber	Loss of appetite	Decoction	Orally	No	Ta
78	<i>Dioscorea deltoidea</i>	Bhyakur (Nep), Ridme (Ta)	Tuber	Antifertility	Decoction	Orally	No	Ta
79	<i>Diploknema butyracea</i>	Chiuri (Nep), Singmar (Ta), Lhusi (Ne)	Seed	Rhematism, Foot crack	Oil, Paste	Massage	Yes	Ne, Ta

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
80	<i>Drymaria diandra</i>	Abhijalo (Nep), Sadhab (Ta), Kholchaghyan (Ne)	Leaves, Entire plant	Skin inflammation, Sinusitis, Fever, Gastric, Urine inflammation, Headache, Urine inflammation, Ringworm, Scabies	Juice, Paste, Decoction	Put, Inhale, Orally, Drop, Rub	No	Ba, Ne, Ta
81	<i>Duhaldea cappa</i>	Tihare, Gaitihare (Nep), Ranibang, Khabing (Ta)	Root	Indigestion, Stomache, Dysentery	Decoction	Orally	No	Ta
82	<i>Elephantopus scaber</i>	Kakrijhar, Didibhaee Jhar, Sarsrabuti (Nep), Gangop(Ta)	Entire plant, LeavesRoot	Cough and cold, Fever	Raw, Decoction	Chewed, Orally	No	Ba, Ta
83	<i>Elsholtzia blanda</i>	Bansilam (Nep), Pebamran(Ta)	Leaves	Sinusitis	Paste	Inhale	No	Ba, Ne
84	<i>Equisetum ramosissimum</i>	Harjor (Nep), Talchama (Ne), Thongachhe (Ta)	Entire plant	Scabies, Burns	Ash	Rub	Yes	Ta
85	<i>Euphorbia hirta</i>	Dudhejhar (Nep), Chhumen (Ta)	Leaves	Boils	Paste	Dressing	No	Ta
86	<i>Ficus lacor</i>	Kavro (Nep)	Latex	Boils	Fresh	Put	No	Ne
87	<i>Gaultheria fragrantissima</i>	Dhansingare (Nep), Changasai (Ta), Charasin/Ghanse (Ne)	Fruit, Leaves	Antialcoholic, Rheumatism, Body pain, Antihelmintic	Raw, Oil, Fruit	Orally, Massage	Yes	Ne, Ta
88	<i>Gaultheria nummularioides</i>	Ratigedi/Kaligedi (Nep), Malang (Ta)	Leaves	Urine sensation	Decant water	Orally	No	Ta

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
89	<i>Geniosporum coloratum</i>	Banbabari (Nep)	Leaves	Cuts and wounds, Itching	Paste	Dressing, Washing	No	Ba
90	<i>Girardiana diversifolia</i>	Allo (Nep), Kishighyan (Ne), Panchepolo (Ta)	Root	Constipation	Decoction	Orally	No	Ta
91	<i>Globba racemosa</i>	Panisaro (Nep)	Root	Headache	Paste	Dressing	No	Ta
92	<i>Glochidion velutinum</i>	Latikath (Nep), Rabogachhi (Ta)	Fruit	Pimples	Paste	Dressing	No	Ta
93	<i>Hedera nepalensis</i>	Dudhela (Nep), Kaikal (Ne), Tengili (Ta)	Fruit	Scabies	Paste	Dressing	No	Ne
94	<i>Hedyotis lineata.</i>	Charpate jhar (Nep)	Root	Stomache	Juice	Orally	No	Ta
95	<i>Heynea trijuga</i>	Ankhataruwa (Nep, Ta)	Seed	Antilice	Paste	Rub	No	Ta
96	<i>Hyptianthera stricta</i>	Aulusar (Nep), Mayukbujhang (Ta)	Root	Typhoid	Decoction	Orally	No	Ta
97	<i>Hyptis suaveolens</i>	Banbabari (Nep)	Leaves	Wounds	Paste	Dressing	No	Ta
98	<i>Jasminum humile</i>	Jaee (Nep), Ajuswan (Ne), Jai Mhendo (Ta)	Flower	Diabetes	Decoction	Orally	No	Ta
99	<i>Justicia adhatoda</i>	Asuro (Nep), Basak (Ta), Tofuswan, Aleha (Ne)	Leaves	Dislocation bones, Fever, Bone fracture, Itching, Blood pressure	Paste, Decoction	Plaster, Orally, Wash	No	Ba, Ne, Ta

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
100	<i>Lindera neesiana</i>	Siltimur (Nep), Kutumb (Ta), Katabasi (Ne)	Fruit	Stomache	Paste	Orally	Yes	Ne, Ta
101	<i>Litsea glutinosa</i>	Hadjor (Nep)	Stem, Bark	Bone dislocation, Bone fracture	Paste	Plaster	Yes	Ba, Ta
102	<i>Lobelia pyramidalis</i>	Eklebir (Nep, Ta)	Root, Leaves	Infertility, Fever	Decoction	Orally	No	Ne, Ta
103	<i>Lycopodium japonicum</i>	Narayanjhau/Banmal a (Nep)	Spores	Cuts and wounds, Boils, Crack feet	Paste	Dressing	No	Ba, Ne, Ta
104	<i>Lygodium japonicum</i>	Parewavuri/Janailaha ra (Nep, Ba)	Spores, Leaves	Boils, Cuts and wounds	Paste	Dressing	No	Ba
105	<i>Lyonia ovalifolia</i>	Angeri (Nep), Pyasima (Ne), Vemlang, Domsing (Ta)	Leaves	Itching, Scabies	Paste	Rub	No	Ta
106	<i>Maesa chisia</i>	Bilaune (Nep), Bhijin (Ta)	Bark	Ringworm	Decoction	Bath	No	Ta
107	<i>Mahonia napaulensis</i>	Jamanemandro, Swasthaniphul (Nep), Mitasi (Ne)	Bark	Eye inflammation	Decant water	Drop	Yes	Ne
108	<i>Mallotus philippnensis</i>	Rohini, Sindure (Nep), Pyongla (Ta)	Fruit powder, Bark	Toes wounds, Stomach disorder	Paste, Decoction	Orally, Dressing	No	Ba, Ta
109	<i>Meizotropis buteiformis</i>	Bhujetro (Nep), Palavi (Ne)	Fruit	Antihelmintic	Crushed	Orally	Yes	Ba

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
110	<i>Mentha spicata</i>	Babari (Nep), Silamani/Hasw anghyan (Ne), Bawari (Ta)	Leaves	Indigestion	Paste	Orally	Yes	Ne, Ta
111	<i>Millettia extensa</i>	Gaujo	Root	Remove exoparasites, Skin diseases	Juice	Rub	No	Ta
112	<i>Millettia fruticosa</i>	Ghojaghans (Nep), Goja(Ta)	Root	Skin diseases	Paste	Rub on skin	No	Ta
113	<i>Mimosa pudica</i>	Lajawati, Buharjhar (Nep), Pebamran (Ta)	Root, Leaves, Flower	Diarrhea and dysentery, Fever, Toothache, Cuts and wounds, Diabetes, Urine problem	Paste	Orally, Dressing	Yes	Ba, Ta
114	<i>Myrica esculenta</i>	Kafal (Nep), Kawasi/Kapase (Ne), Namun (Ta)	Bark, Wood	Toothache, Diarrhea and dysentery, Toothache	Decoction, Paste, Powder	Orally, Brush	Yes	Ba, Ne, Ta
115	<i>Neolamarckia cadamba</i>	Kadam (Nep), Kadamswan (Ne)	Leaves, Flowers, Fruit	Wounds between toes, Diarrhea and dysentery, Cuts and wounds	Paste, Decoction	Dressing, Orally	Yes	Ba, Ne, Ta
116	<i>Nephrolepis auriculata</i>	Paniamala (Nep), Lasin (Ne), Bhuiambali (Ta)	Tuber	Headache, Cough	Decoction	Orally	Yes	Ta
117	<i>Oroxylum indicum</i>	Tatari (Nep), Praha/Taremhe ndo (Ta)	Fruit, Seed, Bark	Wounds, Burns, Pimples, Boils	Paste	Dressing	No	Ba, Ta

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
118	<i>Osbeckia chinensis</i>	Seto chulesi (Nep), Jogiamkhara (Ne)	Leaves	Burns	Paste	Dressing	No	Ne
119	<i>Osbeckia nutans</i>	Sanoangeri (Nep)	Root	Stomache	Decoction	Orally	No	Ta
120	<i>Osbeckia stellata</i>	Chulesi (Nep), Aarbale (Ta)	Leaves	Scabies	Paste	Dressing	No	Ta
121	<i>Oxalis corniculata</i>	Amileghans, Chariamilo (Nep), Nakhru pangyun (Ta), Paulaghyan (Ne)	Leaves	Skin diseases, Ringworm	Paste, Juice	Dressing, Rub	No	Ne, Ta
122	<i>Paederia foetida</i>	Biri, Beri lahara (Nep)	Flowers	Toothache	Mashed	Chewing	No	Ba
123	<i>Paris polyphylla</i>	Satuwa (Nep), Natardap (Ta)	Rhizome	Wound, Antiseptic, Tonic, Antihelmintic	Paste, Dried posder	Dressing, Orally	Yes	Ta
124	<i>Persea duthiei</i>	Kaulo, Chiplekaulo (Nep), Lalkan, Fawyanakal (Ne)	Leaves, Bark, Wood	Bone fracture, Skin disease	Paste	Plaster	Yes	Ne, Ta
125	<i>Phoenix loureiroi</i>	Khajurki, Thakal (Nep), Kharari (Ta)	Seed	Itching	Paste	Rub	No	Ta
126	<i>Phyllanthus emblica</i>	Amala (Nep), Aura (Ta), Ambali Amba (Ne)	Fruit	Tonic, Constipation, Appetite, Cough and cold, Stomache, Vitamin, Blood purifier, Antidandruff	Raw, Powder, Decoction	Orally, Put on head, bath	Yes	Ba, Ne, Ta

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
127	<i>Phyllanthus parvifolius</i>	Khareto (Nep), Ramhagam (Ta), Chhusyaguli (Ne)	Leaves, Fruit, Seed	Bone fracture	Paste	Plaster	No	Ne, Ta
128	<i>Phytolacca acinosa</i>	Jaringosag (Nep), Jaringo (Ta)	Leaves	Eye sight, vitamin	Cooked with egg	Orally	Yes	Ta
129	<i>Picris hieracioides</i>	Bandudhe (Nep)	Leaves	Headache	Paste	Put on head	No	Ta
130	<i>Pieris formosa</i>	Gineri (Nep), Pote (Ta)	Young leaves	Scabies	Juice	Rub	No	Ne
131	<i>Piper longum</i>	Pipla (Nep), Pipi (Ne)	Fruit	Cough and cold	Decoction	Orally	Yes	Ba, Ne, Ta
132	<i>Piper wallichii</i>	Pipla (Nep), Pipi(Ne)	Fruit	Cough	Decoction	Orally	Yes	Ta
133	<i>Plantago erosa</i>	Churnajhar (Nep), Nyamnyung (Ta)	Entire plant	Antihelmintic	Paste	Orally	No	Ta
134	<i>Plumbago zeylanica</i>	Chitu (Nep), Bhati (Ta)	Root	Skin diseases	Juice	Rub	Yes	Ne
135	<i>Podophyllum hexandrum</i>	Laghupatra (Nep), Simendo (Ta)	Rhizome	Wound infection	Paste	Dressing	Yes	Ta
136	<i>Pogostemon benghalensis</i>	Rudilo (Nep), Rasangan (Ta)	Leaves	Fever, Cough and cold	Paste, Decoction	Put on head, Orally	No	Ba, Ne, Ta



**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
137	<i>Pogostemon glaber</i>	Kalorudilo (Nep)	Leaves	Cough and cold	Paste	Put on head	No	Ba
138	<i>Polygonum plebeium</i>	Sukuljhar, Jhamteghans (Nep)	Entire plant	Wound bet toes long walking	Paste	Dressing	No	Ba
139	<i>Potentilla festiva</i>	Bajradanti (Nep), Dapse (Ta)	Stem	Toothache	Paste	Brush	No	Ta
140	<i>Premna barbata</i>	Ginari (Nep), Ginar (Ta)	Stem	Fever, Cuts and wounds	Decoction, Paste	Orally, Dressing	No	Ba, Ta
141	<i>Prunus cerasoides</i>	Paiyun (Nep), Fasipa (Ne)	Stem	Burns	Paste ash	Dressing	No	Ne
142	<i>Rauwolfia serpentina</i>	Chandmaruwa (Nep)	Root	Blood pressure, Snakebites	Decoction, Paste	Orally, Dressing	Yes	Ba
143	<i>Rhododendron lepidotum</i>	Sunpati (Nep), Balu Mhendo (Ta)	Leaves	Dysentery	Powder	Orally	Yes	Ta
144	<i>Rhus wallichii</i>	Bhalayo (Nep), Grosing (Ta)	Bark	Wounds	Paste	Wounds	No	Ta
145	<i>Rubia manjith</i>	Majitho (Nep), Tinru (Ta)	Stem	Insect bite	Paste	Dressing	Yes	Ta
146	<i>Rubus ellipticus</i>	Ainselu (Nep), Polang (Ta), Airsi/Yansi (Ne)	Fruit, Root	Cold, Gastric, Indigestion, Fever, Wounds	Paste, Decoction	Dressing, Orally	No	Ba, Ne, Ta
147	<i>Rumex nepalensis</i>	Halhale (Nep), Gwayapala (Ne), Halil (Ta)	Leaves	Ringworm, Itching	Paste	Dressing	No	Ta
148	<i>Salvia plebeia</i>	Birale/Gobre (Nep)	Entire plant	Wound between toes long walking	Paste	Dressing	No	Ba

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
149	<i>Sarcococca coriacea</i>	Fitfitya (Nep), Patape (Ta)	Root	Fever	Decoction	Orally	No	Ta
150	<i>Satyrium nepalense</i>	Gamdol, Okhal (Ta)	Rhizome	NA	NA	NA	Yes	Ta
151	<i>Saussurea deltoidea</i>	Jhule, Gaekhure (Ta)	Root	Fever	Decoction	Orally	No	Ta
152	<i>Schima wallichii</i>	Chilaune (Nep), Dhusin, Gwayachhasi (Ne), Chasing, Kyasing (Ta)	Bark	Cuts and wounds, Heel cracks	Paste, Dressing	Dressing, Washing	No	Ne, Ta
153	<i>Scoparia dulcis</i>	Chinijhar (Nep), Chinumran (Ta)	Leaves	Throat sore	Decoction, Paste	Gargle, Chewing	No	Ba, Ta
154	<i>Scurrula parasitica</i>	Ainjeru (Nep), Yarasi (Ne), Jokhare (Ta)	Stem	Bone fracture	Paste	Plaster	No	Ta
155	<i>Scutellaria discolor</i>	Kalipate, Nilobutteghans (Nep), Balamran (Ta)	Entire plant, Leaves	Fever	Decoction	Orally	No	Ba, Ta
156	<i>Selinum wallichianum</i>	Bhutkesh (Nep)	Rhizome	Fever, Body pain, Fever	Decoction, Oil	Orally, Massage	Yes	Ta
157	<i>Senna tora</i>	Methijhar, Tapre (Nep), Chhinchhin (Ta)	Fruit	Rheumatism, Antihelmintic, Itching	Decoction, Paste	Orally, Dressing	No	Ba, Ta
158	<i>Shorea robusta</i>	Sal (Nep), Dhusin (Ne) Agrath, Chasing (Ta)	Leaves/Wood/ Seeds	Cough, Rheumatism	Decoction, meat put on leaves, Oil	Orally, Massage	Yes	Ne, Ta
159	<i>Sida acuta</i>	Balu (Nep)	Leaves	Boils	Paste	Dressing with Nepali paper	No	Ba, Ta

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
160	<i>Smilax ovalifoia</i>	Kukurdaino (Nep), Nakre (Ta)	Tender shoot	Eye sight	Cooked	Orally	No	Ta
161	<i>Solanum nigrum</i>	Kalobihi (Nep), Cheme (Ta)	Fruit	Fever	Raw	Orally	No	Ta
162	<i>Solanum aculeatissimum</i>	Kantakari (Nep)	Fruit	Headache	Paste	Rub	No	Ne
163	<i>Solena amplexicaulis</i>	Golkankri (Nep), Tansarkat (Ta), Talansi/Kothuse (Ne)	Root, Seed	Dysentery, Fever, Tonic, Indigestion, Typhoid, Urine inflammation	Decoction, Raw	Orally	No	Ba, Ne, Ta
164	<i>Sonchus oleraceus</i>	Dudhejhar (Nep), Khaeke (Ne)	Leaves	Fever	Decoction	Orally	No	Ne
165	<i>Sonchus wightianus</i>	Mulapate (Nep)	Leaves	Diabetes	Juice	Orally	No	Ba
166	<i>Spermadictyon suaveolens</i>	Petare (Ta)	Leaves	Cuts and wounds	Paste	Dressing	No	Ta
167	<i>Stellaria monosperma</i>	Jethimadhu (Nep), Banmran (Ta)	Root	Diarrhea	Juice	Orally	Yes	Ta
168	<i>Stephania glandulifera</i>	Gujargano (Nep)	Tuber	Gastric	Decoction	Orally	No	Ta
169	<i>Swertia angustifolia</i>	Sano chirayito (Nep), Bhalekhara (Ba), Kampman (Ta)	Entire plant	Fever	Decoction	Orally	Yes	Ba, Ta
170	<i>Swertia chirayita</i>	Chiriayito, Tite (Nep), Timda (Ta), Khalu (Ne)	Entire plant	Fever, Blood pressure	Decoction	Orally	Yes	Ba, Ne, Ta
171	<i>Syzygium cumini</i>	Jamun (Nep)	Seed	Diabetes	Powder	Orally	Yes	Ne

**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
172	<i>Terminalia alata</i>	Asna/Saj (Nep), Sad (Ba), Saj (Ta)	Bark/wood	Gastric, Scabies	Decoction	Orally, Bath	Yes	Ba, Ta
173	<i>Terminalia bellirica</i>	Barro (Nep), Barra (Ta), Bala (Ne)	Fruit/Bark	Bronchitis, Cough and cold, Constipation, Bronchitis, Tonic, Antihelmintic, Fever	Powder, Decoction, Raw, Powder	Orally	Yes	Ba, Ne, Ta
174	<i>Terminalia chebula</i>	Harro (Nep), Harra (Ba), Aurro (Ta), Hala (Ne)	Fruit	Cough and cold, Blood pressure, Sinusitis, Fever, Stomache, Appetite	Raw, Decoction	Chewing, Orally, Inhale	Yes	Ba, Ne, Ta
175	<i>Thalictrum foliolosum</i>	Dampate (Nep), Phalkichhe (Ta), Ganuwasa (Ne)	Root	Itching, Gastric	Paste, Juice	Rub, Orally	No	Ne, Ta
176	<i>Thespesia lampas</i>	Bankapas, Kapaseful (Nep)	Root	Fever, Stomache	Decoction, Paste	Orally	No	Ba, Ta
177	<i>Tinospora sinensis</i>	Gurjo (Nep)	Stem	Stomache, Diabetes, Fever	Decoction	Orally	Yes	Ba, Ne, Ta
178	<i>Tribulus terrestris</i>	Gokhur (Nep)	Fruits, Seed	Body inflammation, Kidney stones, Cough	Decoction	Washing, Orally	Yes	Ba, Ta
179	<i>Trichosanthes tricuspidata</i>	Indreni (Nep)	Seed	Fever, Liver swelling, Mouth ulcer	Decoction	Orally	Yes	Ba, Ne, Ta
180	<i>Trichosanthes wallichiana</i>	Jangalifarsi (Nep), Kokochasin (Ne)	Seed	Fever	Decoction	Orally	No	Ne
181	<i>Tupistra aurantiacea</i>	Chwalancha (Ne)	Rhizome	Wound with pus	Paste	Dressing	Yes	Ne, Ta

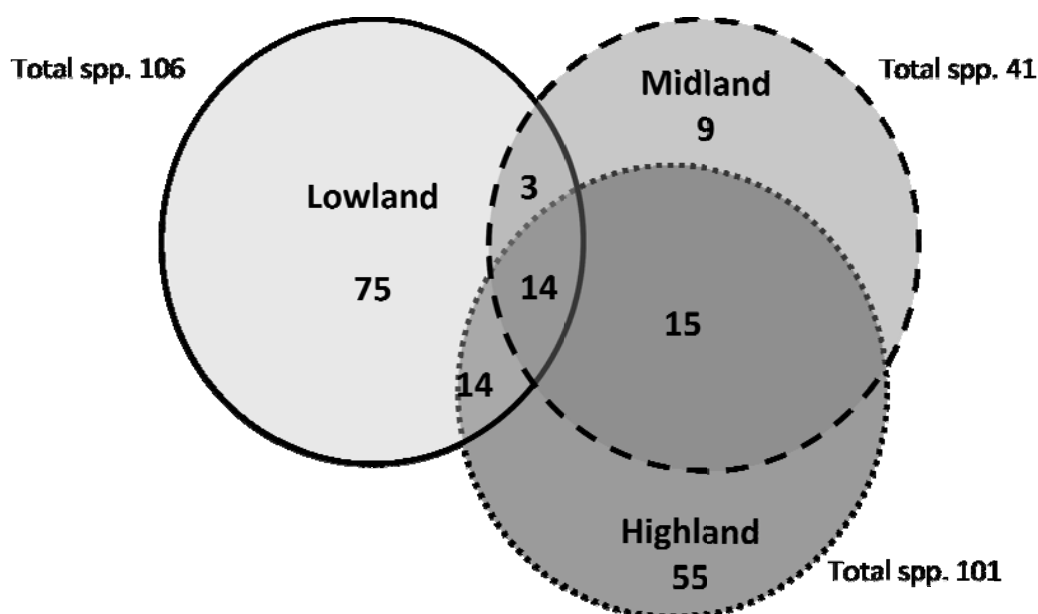
**Table 6: (Continued)**

S.N.	Scientific name	Local names	Medicinal part used	Medicinal uses	Method of preparation	Mode of administration	Market available	Ethnic groups
182	<i>Urtica dioica</i>	Sisnu (Nep), Polo (Ta), Nhake (Ne)	Entire plant, Leaves, Root	Blood pressure, Diabetes, Bone fracture, Kidney stones, Tonic	Decoction, Paste	Orally, Inhale, Plaster	Yes	Ba, Ne, Ta
183	<i>Viola pilosa</i>	Ghatteghans (Nep), Auloghar (Ta)	Entire plant	Fever	Decoction	Orally	No	Ta
184	<i>Viscum album</i>	Hadjoda (Nep), Gante ainjeru (Ta)	Leaves	Dislocate bone	Paste	Plaster	Yes	Ta
185	<i>Vitex negundo</i>	Simalai (Nep), Sinyal (Ta)	Leaves	Sinusitis, Cough and cold	Paste, Decoction	Inhale	No	Ba, Ta
186	<i>Woodfordia fruticosa</i>	Sanodhayaro/Dh aiyaro (Nep), Setho (Ba), Daring (Ta)	Flower	Cuts and wounds, Dysentery, Fever	Paste, Decoction	Dressing, Orally,	Yes	Ba, Ne, Ta
187	<i>Xanthium indicum</i> Roxb.	Boke kurro, Kuro (Nep)	Leaves, Roots	Cuts and wounds, Fracture	Paste	Dressing	No	Ba, Ta
188	<i>Zanthoxylum armatum</i>	Timur (Nep), Prumo (Ta), Tepura/Tebasi (Ne)	Fruit, Stem	Gastric, Cough and cold, Toothache	Decoction, Raw,	Orally, Chewing, Brush	Yes	Ne, Ta
189	<i>Zephyranthes carinata</i>	Hadelasun, Bhuinchampa (Nep), Mahariswan (Ne)	Bulb	Gastric	Decoction	Orally	No	Ne, Ta

Source: Field survey 2010; Note: Nepali=Nep, Bankaria=Ba, Newar=Ne, Tamang=Ta

The total number of medicinal plant species found in the three altitudinal zones (viz. lowland, midland and highland) was different (Figure 9). The highest number of species were identified in the lowlands (106 spp.) followed by highland (101 spp.) and the lowest in the midlands (41 spp.).

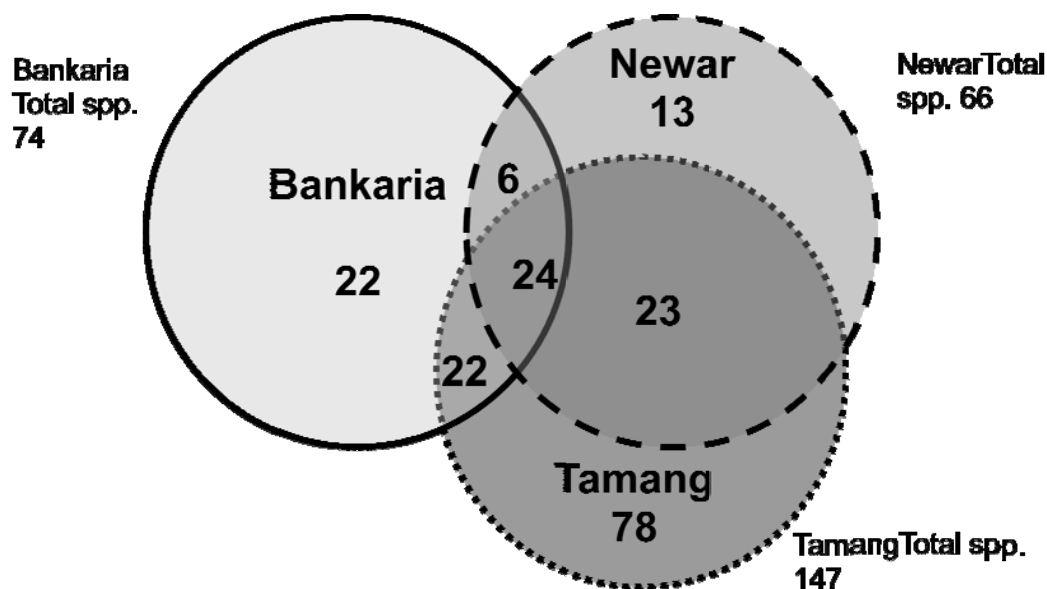
Among them, 75 species in lowland, 9 species in midland and 55 species in highland were distributed only in respective zones (Figure 9). The midland and highland shared 15 species, whereas midland and lowland shared only three and highland and lowland share 14 species. The common species for all three zones were 14 (Figure 9). The 14 medicinal plants which commonly used in three altitudinal zones are: *Acorus calamus*, *Artemisia indica*, *Astilbe rivularis*, *Bergenia ciliata*, *Centella asiatica*, *Lycopodium japonicum*, *Myrica esculenta*, *Oxalis corniculata*, *Phyllanthus emblica*, *Rubus ellipticus*, *Solena amplexicaulis*, *Swertia chirayita*, *Urtica dioica* and *Zanthoxylum armatum*.



**Figure 9:** Sharing of number of medicinal plant species in three altitudinal zones (lowland, midland, highland) in Makawanpur district, Central Nepal.

The three ethnic groups (Bankaria, Newar, and Tamang) utilized different number of medicinal plant species (Figure 10). It was observed that Tamangs utilized as many as 147 species of medicinal plants, whereas Bankarias utilized 74 spp. and Newars utilized only 66 spp. It showed that Tamangs were the ones who utilized the higher number of medicinal plants. The Bankaria ethnic group used as many as 22 species,

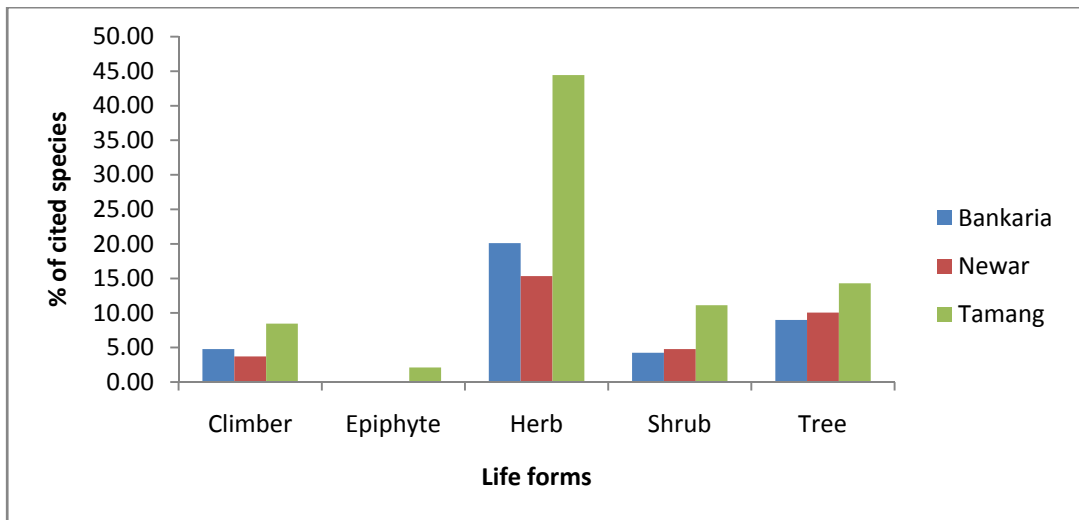
whereas the Newar and the Tamang used 13 and 78 species respectively. The Newar and Tamang communities shared 23 medicinal plant species, whereas Bankaria and Newar shared only 6 species. Similarly, Bankaria and Tamang shared 22 species, whereas Newar and Tamang ethnic groups shared 23 species shared with Newar and Tamang ethnic groups. But 24 medicinal plant species were common in all three ethnic groups.



**Figure 10:** Number of medicinal plants used by three ethnic groups (Bankaria, Newar and Tamang) in Makwanpur district, Central Nepal.

### Life forms

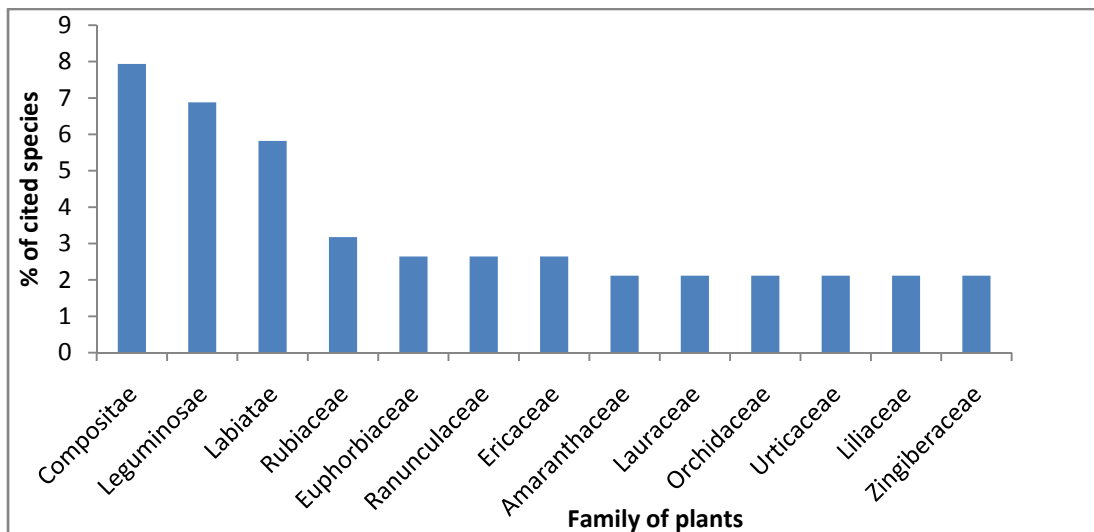
Regarding life forms, out of the 189 species, 106 species were herbs, 19 climbers, 26 shrubs, 34 trees and 4 epiphytes. On the basis of life form, the highest numbers of species used by three ethnic groups were herbs. The Bankaria used 38 species (20.11%) followed by Newar 29 species (15.34%) and Tamang used 84 species (44.44%). The used percentage of trees, shrubs and climber by the three ethnic groups are shown in Figure 11.



**Figure 11:** The proportions of life forms of medicinal plants used by Bankaria, Newar and Tamang ethnic groups.

### Plant families

On the basis of families, the Compositae with 15 species (8%), Leguminosae 13 species (7%), Labiatae 11 species (6%), Rubiaceae 6 species (3%) and Euphorbiaceae, Ranunculaceae, Ericaceae each with 5 species (3%) were the most used families by the three ethnic groups, followed by Amaranthaceae, Orchidaceae, Urticaceae, Liliaceae, and Zingiberaceae each with 4 species (2%) respectively (Figure 12).

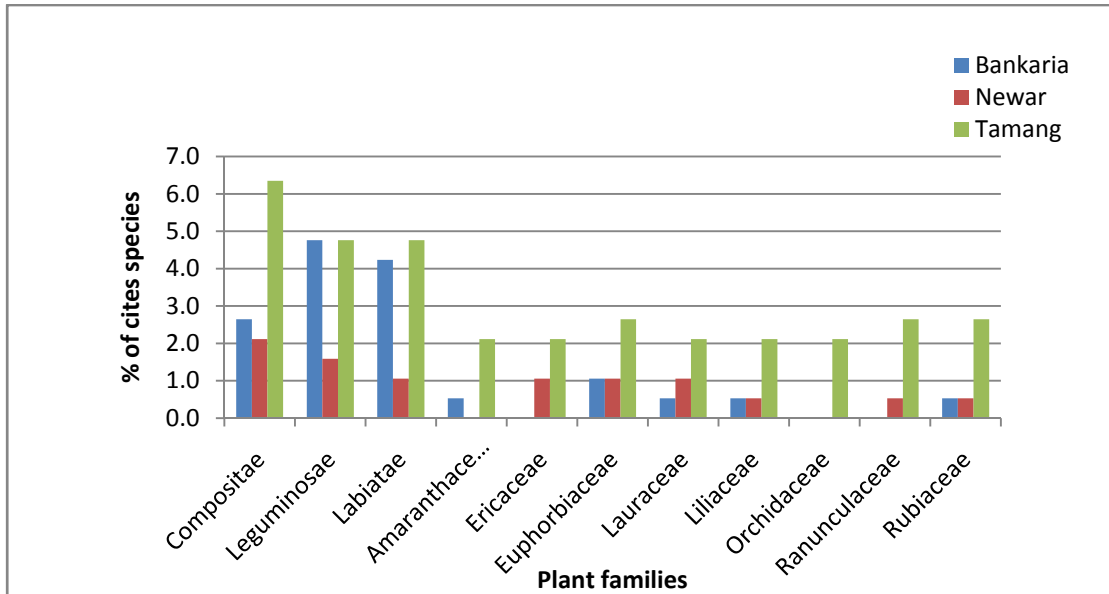


**Figure 12:** Plant families with highest number of species used by three ethnic groups.

The three most used families by Bankaria community having more than five species were Leguminosae (4.76%, 9 spp.), Labiatae (4.23%, 8 spp.), and Compositae (2.65%, 5 spp.). This proportion of utilization among Bankaria was higher than in Newar, who



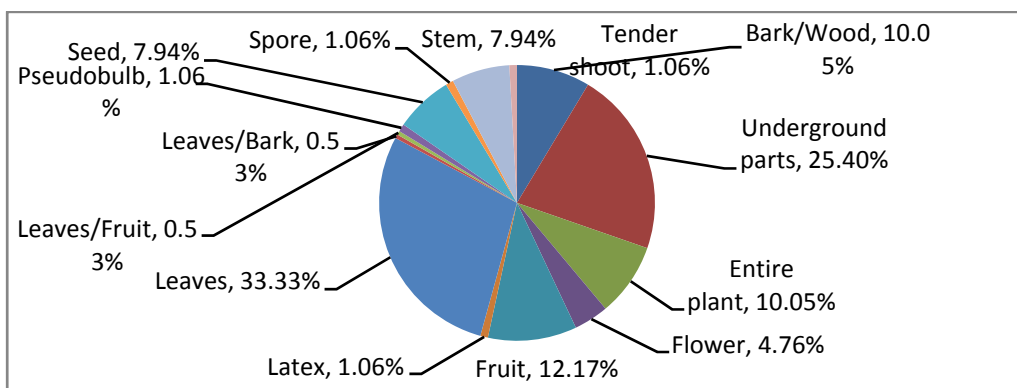
used Compositae (2.12%, 4 spp.), Leguminosae (1.59%, 3 spp.) and Labiatae (1.06%, 2 spp.), whereas Tamang community used Compositae (6.35%, 12 spp.), Leguminosae and Labiatae (4.76%, 9 spp. each) (Figure 11). Most of the other remaining families were represented by single or two species (Figure 13).



**Figure 13:** Dominant plant families showing percentage of species used by three ethnic groups.

### Plant Parts used

The three ethnic groups used different medicinal plant parts for curing various types of illness. The plant parts used to treat different diseases and other disorders were leaves, fruit, bark/wood, stem, seed, flower, tender shoot, pseudobulb, latex, spores, underground parts such as root/rhizome/tuber/bulb, and entire plants. The most common plant parts were leaves (33.33%, 63 spp.), underground plant parts, such as root/rhizome/tuber/bulb (25.40%, 48 spp.), fruits (12.17%, 23 spp.), bark/wood and entire plant (10.05%, 19 spp. each), stem and seed (7.94%, 15 spp. each), flower (4.76%, 9 spp.) and so on (Figure 14).



**Figure 14:** Medicinal plants part used.

## Habitat

The plant collection sites were divided into four habitats such as forest (primary and secondary forest), fallow land (open barren land, riverside, roadside), homegarden and farmers' field. Regarding the locations for collections, forests and fallow lands were most important habitats from where, 114 plant species (60.32%) were collected from forests, followed by fallow lands 67 species (35.45%), homegardens 8 species (4.23%) (Figure 15). About 7 species such as *Acorus calamus*, *Bauhinia variegata*, *Curcuma aromatica*, *Ficus lacor*, *Jasminum humile*, *Mentha spicata*, *Piper longum* were found in homegardens. Some species with high market demand such as *Asparagus racemosus*, *Swertia chirayita*, *Cinnamomum tamala* started to cultivate in farmers field, as they were rare in wild state.

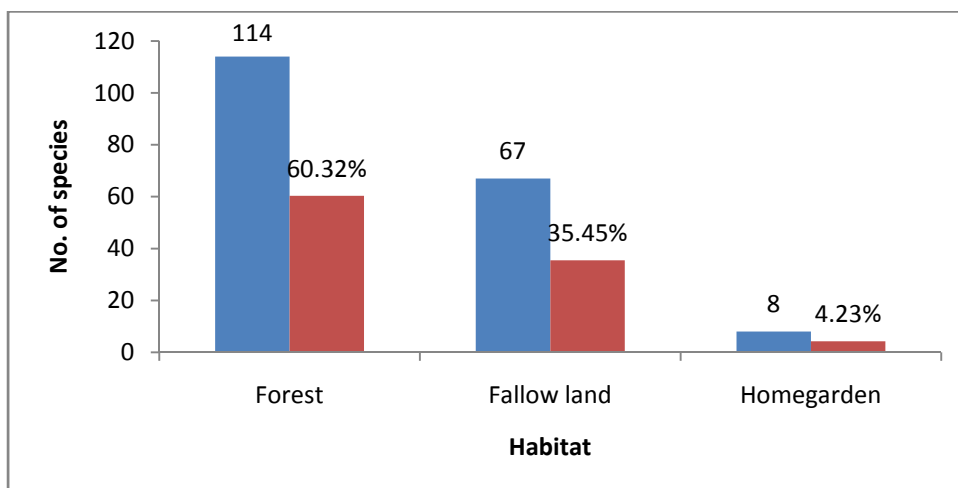


Figure 15: Ethnobotanical important plant species with their percentage in different habitats.

## Method of preparation

Most of the plants were prepared as decoction (41.80%, 79 spp.), paste (32.80%, 62 spp.), juice (6.88%, 13 spp.), powder, oil, ash, cooked with egg and mustard oil for medicinal uses (Figure 16). Some of the plants were also consumed in raw form.

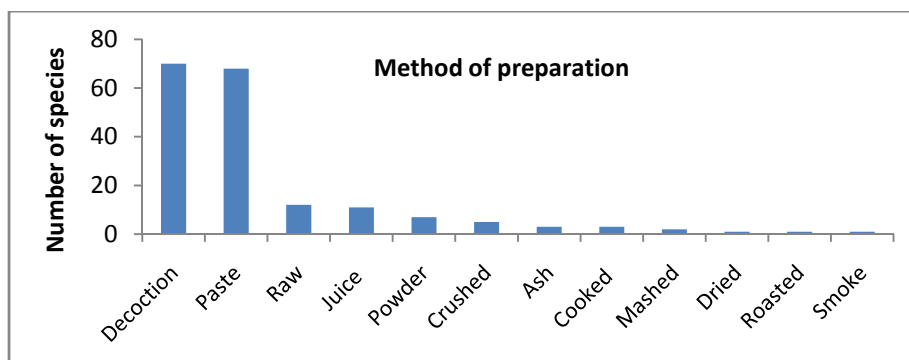


Figure 16: Methods of preparation of drugs.

The decoction was prepared by boiling the plant parts in water. In some plants, the decoction was obtained by soaking the plant parts in cold water overnight. The paste and juice were prepared by grinding fresh and dried material. The powder was prepared by grinding dried materials.

### Mode of administration

The most common administration method was oral (50%, 94 spp.) followed by dressing (24%, 45 spp.), chewing raw and dried material (3%, 6 spp.), plaster (4%, 8 spp.), massage and inhale (3%, 5 spp.) and rub on the body parts (5%, 10 spp.). The other mode of administration were used in drops (2%, 4 spp.), brush ((1%, 3 spp.), bath and wash (1%, 2 spp.) (Figure 17).

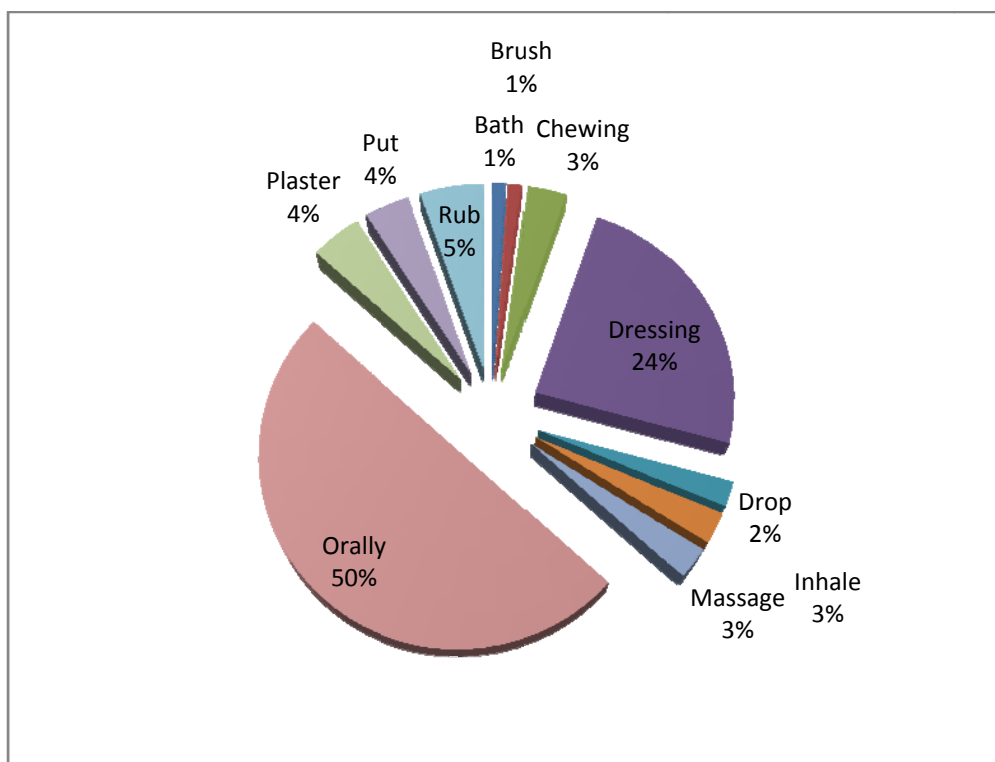
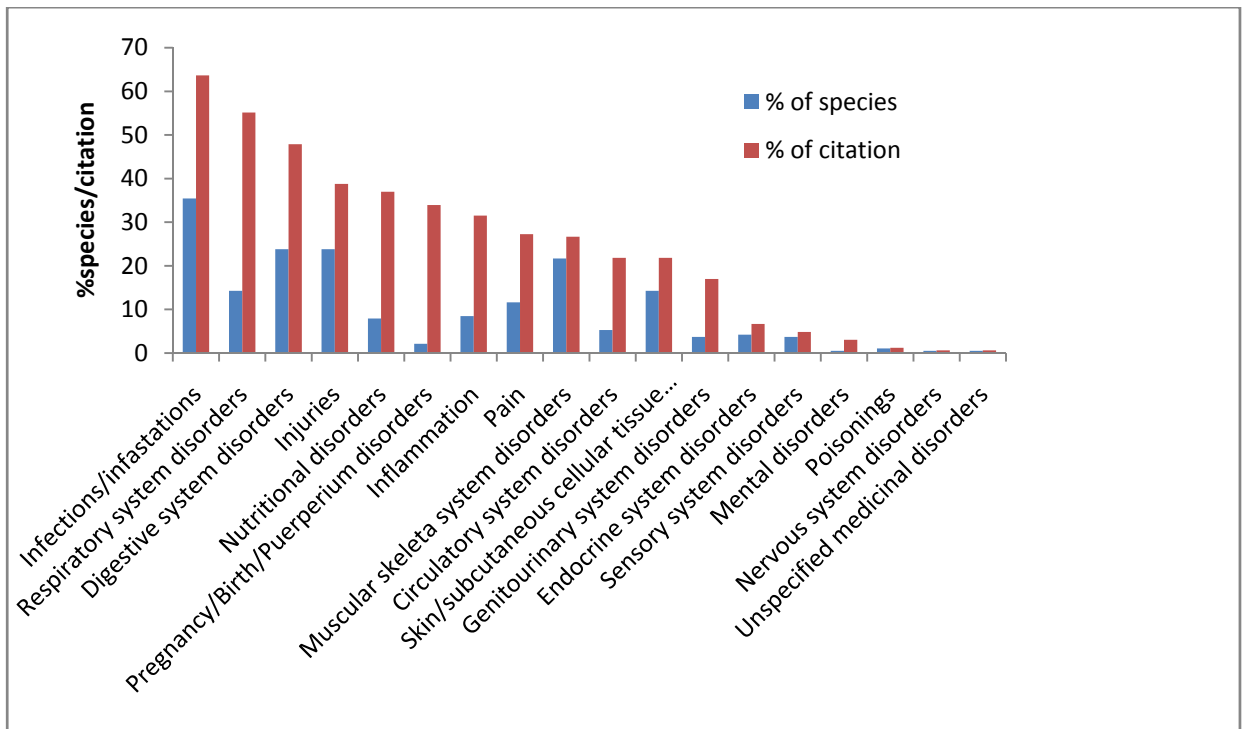


Figure 17: Mode of administration.

### Use categories

These use records were categorized in 18 different medicinal use categories following (Cook, 1995). The most treated use categories included infections/infestations 67 species (35 %), followed by respiratory system disorders 27 species (14 %), digestive system disorders and injuries 45 species (24%) each and muscular skeleton system disorders 41 species (22 %) (Figure 18).



**Figure 18:** Use categories of medicinal plants.

The Bankaria community reported that the most frequently uses of medicinal plants were for treating infections/infestation (30.99%) followed by digestive system disorders (29.58%), injuries (25.35%) and respiratory system disorders (22.54%), whereas in Newar community, the most frequently reported medicinal uses were for treating digestive system disorders (26.56%), skin/subcutaneous cellular tissue disorders (20.31%), infections/infestations (18.75%). Similarly in Tamang community, the frequently used medicinal uses were for treating infections/infestations (25.33%) followed by digestive systems disorders (21.33%), injuries and skin/subcutaneous cellular tissue disorders (16.67%) and respiratory system disorders (12%) (Table 7). The most common disease in Tamang community was infections/infestations, i.e. fever (115 citations) followed by diarrhea and dysentery (76 citations), cough and cold (81 citations), cuts and wounds (49 citations).

In Newar and Bankaria ethnics groups, the common diseases were diarrhea and dysentery (26 citations-Newar, 63 citations-Bankaria) followed by fever (23 citations-Newar, 54 citations-Bankaria), cough and cold (16 citations-Newar, 28 citations-Bankaria) (Table 7). The fever, diarrhea and dysentery, cough and cold were common diseases for all village people.

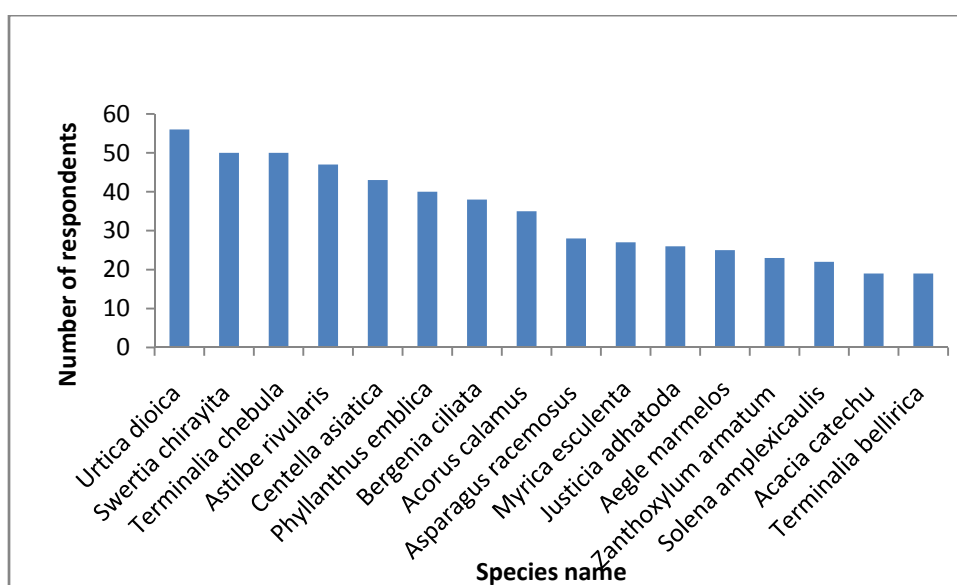
### **Cultural importance and consensus analysis**

The results of the informant agreement ratio (IAR) or informant consensus factor (ICF) showed that the value in this study ranges from 0 to 1 (Table 7). In Bankaria, the value of ICF was zero in the use categories like circulatory, mental disorders, nervous disorders, pregnancy/birth, sensory system disorders. The value of ICF was zero in Newar ethnic group in mental, nervous, sensory disorders and poisonings, whereas in Tamang ethnic group the highest ICF value was 1.0 for mental disorder. The pregnancy/birth/puerperium disorders showed the second highest ICF value 0.986 and 0.950 with 70 and 21 use reports in Tamang and Newar ethnic groups respectively whereas in Bankaria ethnic group showed the highest ICF value 0.778 with 28 use reports in inflammation disorder. This shows a more consistent use of the medicinal plants resources for these use categories. The women from both Newar and Tamang ethnic groups have their traditional knowledge in use of *Astilbe rivularis* and *Bergenia ciliata* plants after delivery. These plants are available in close vicinity.

They are used for pregnancy/birth. ICF is 0 for pregnancy/birth/puerperium illness in Bankaria indicating that there is a low consensus on the treatment of this illness problem. The genitourinary system disorders are reported common disease in Bankaria, Newar, and Tamang with ICF 0.750, 0.833, and 0.706 respectively. Similarly other most frequently observed common diseases in those ethnic groups were diarrhea and dysentery (digestive system disorder), fever (infections/infestations), cuts and wounds (injuries), cough and colds (respiratory system disorders). Figure 19 explained the most common medicinal plants used by majority of respondents and with their numbers. The highest number of respondents i.e. 56 respondents were used *Urtica dioica* for many types of diseases. Similarly, *Swertia chirayita*, *Terminalia chebula*, *Astilbe rivularis*, *Centella asiatica*, and *Phyllanthus emblica* were also the most commonly used plants by respondents. It means that these medicinal plants were the most recognized plant in this study area.

**Table 7:** Informant consensus factor (ICF) for different use categories medicinal plants among Bankaria, Newar, Tamang ethnic groups.

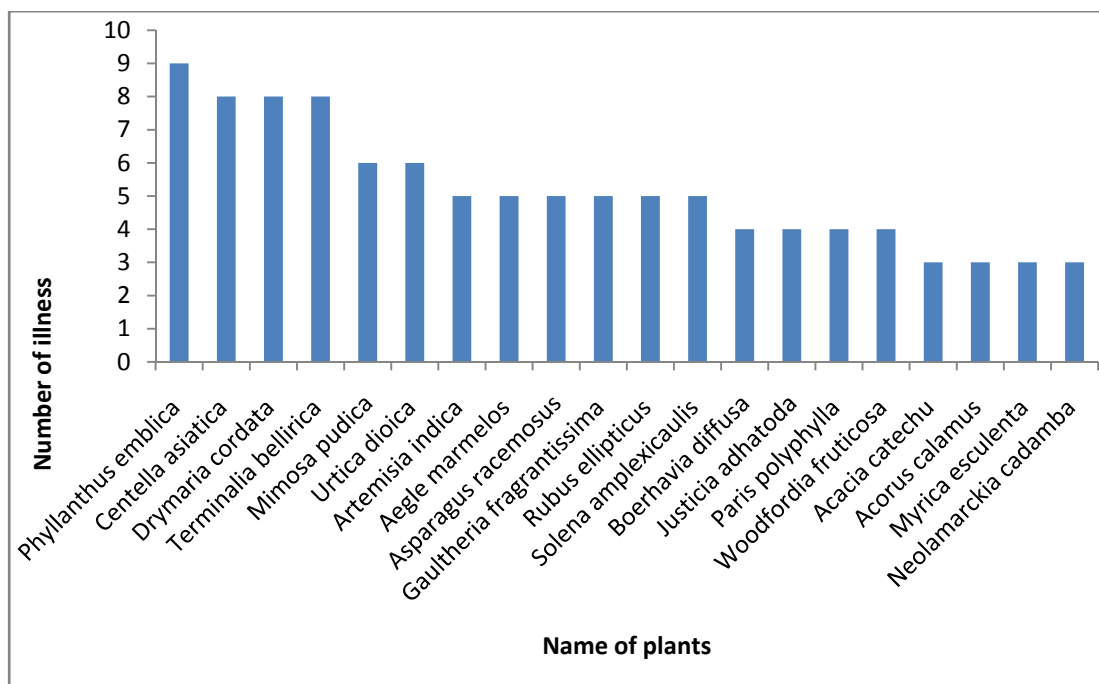
No.	Use category	Bankaria				Newar				Tamang			
		No. of sp.	%of sp.	No. of citation	ICF	No. of sp.	%of sp.	No. of citation	ICF	No. of sp.	%of sp.	No. of citation	ICF
1	Circulatory system disorders	4	5.63	4	0.000	5	7.81	14	0.692	7	4.67	18	0.647
2	Digestive system disorders	21	29.58	63	0.677	17	26.56	26	0.36	32	21.33	76	0.587
3	Endocrine system disorders	2	2.82	3	0.500	3	4.69	9	0.75	6	4.00	8	0.286
4	Genitourinary system disorders	4	5.63	13	0.750	3	4.69	13	0.833	6	4.00	18	0.706
5	Infections/infestations	22	30.99	54	0.604	12	18.75	23	0.5	38	25.33	115	0.675
6	Inflammation	7	9.86	28	0.778	5	7.81	12	0.636	8	5.33	26	0.720
7	Injuries	18	25.35	30	0.414	9	14.06	13	0.333	25	16.67	49	0.500
8	Mental disorders	0	0.00	0	0.000	0	0	0	0	1	0.67	5	1.000
9	Muscular skeletal system disorders	7	9.86	15	0.571	3	4.69	4	0.333	13	8.67	39	0.684
10	Nervous system disorders	0	0.00	0	0.000	0	0	0	0	1	0.67	1	0.000
11	Nutritional disorders	7	9.86	12	0.455	5	7.81	11	0.6	15	10.00	54	0.736
12	Pain	6	8.45	14	0.615	7	10.94	17	0.625	13	8.67	29	0.571
13	Pregnancy/Birth/Puerperium disorders	0	0.00	0	0.000	2	3.13	21	0.95	2	1.33	70	0.986
14	Poisonings	2	2.82	2	0.000	0	0	0	0	2	1.33	2	0.000
15	Respiratory system disorders	16	22.54	28	0.444	5	7.81	16	0.733	18	12.00	81	0.788
16	Sensory system disorders	0	0.00	0	0.000	2	3.13	2	0	5	3.33	7	0.333
17	Skin/subcutaneous cellular tissue disorders	6	8.45	9	0.375	13	20.31	22	0.429	25	16.67	39	0.368
18	Unspesified medical discorders	0	0.00	0	0.000	2	3.13	2	0	4	2.67	4	0.000



**Figure 19:** Species used by the number of respondents.

*Phyllanthus emblica* was used to treat the maximum number of illness (i.e. nine type of diseases) which was mentioned by 45 respondents (Figure 20). Some cultural analysis were calculated and plants with the highest value of relative frequency of citation (RFC) and cultural important index (CI) for three ethnic groups are shown in Table 7. When comparing with three ethnic groups, in the Bankaria ethnic group, the most commonly used medicinal plant species was *Swertia chirayita* (RFC=0.467) whereas in Newar and Tamang ethnic group, the RFC value was 0.172 and 0.469 respectively (Table 7).

The cultural importance index (CI) showed that Bankaria ethnic group used *Cleistocalyx operculatus* (0.67) in first position whereas in Newar and Tamang ethnic groups *Astilbe rivularis* were first rank in CI. Because the CI index measures was independent on the number of informants and considers the diversity of use (Table 8).



**Figure 20:** Species used to treat the number of illness.

### Species saliency

In cultural domains, species are held in a structured manner with some having more importance than others; some are more prominent in the minds of the people that constitute the culture and some less obvious. A salient species is one with high frequency of mention by informants, appearing early in their species listing (Martin, 1995) and corresponding to a higher Smith's saliency score to reflect the familiarity level of the species in the community. Analysis of free-list interviews showed that the score of medicinal plant domain of Bankaria consists of *Terminalia alata* (Smith's SI=0.399), *Cleistocalyx operculatus* (0.373), *Pogostemon benghalensis* (0.367), *Centella asiatica* (0.148); in Newar ethnic group consists of *Phyllanthus emblica* (0.472), *Urtica dioica* (0.346), *Bergenia ciliata* (0.319), *Centella asiatica* (0.319) and Tamang ethnic consists of *Astilbe rivularis* (0.359), *Bergenia ciliata* (0.405), *Urtica dioica* (0.194), *Swertia chirayita* (0.231) (Table 8). This result showed that, there was different knowledge distribution in between Bankaria, Newar and Tamang. This may be due to differences in availability of plants in study area or cultural difference.

Comparing the species list resulted from free-listing with the list from semi-structured interviews shows that some knowledge of medicinal plants was kept only by key informants (Table 8). There were also some plants mentioned in semi-structured



interviews but not reported in free-listing and might showed that knowledge concerning the use of these plants was lost.

**Table 8:** Comparison of medicinal plants used by three ethnic groups (Bankaria, Newar, Tamang) using three indices SI (Smith's salience index), RFC (Relative frequency of citation), CI (Cultural importance index).

<b>Ethnic group</b>				
<b><u>Bankaria</u></b>				
S.N.	Scientific name	SI	RFC	CI
1	<i>Terminalia alata</i>	0.399	0.167	0.033
2	<i>Cleistocalyx operculatus</i>	0.373	0.333	0.67
3	<i>Pogostemon benghalensis</i>	0.367	0.4	0.067
4	<i>Centella asiatica</i>	0.148	0.267	0.1
5	<i>Swertia chirayita</i>	0.163	0.467	0.033
6	<i>Solena amplexicaulis</i>	0.138	0.233	0.133
<b><u>Newar</u></b>				
1	<i>Phyllanthus emblica</i>	0.472	0.094	0.063
2	<i>Urtica dioica</i>	0.346	0.5	0.063
3	<i>Bergenia ciliata</i>	0.319	0.156	0.016
4	<i>Centella asiatica</i>	0.267	0.125	0.078
5	<i>Justicia adhatoda</i>	0.212	0.094	0.031
6	<i>Astilbe rivularis</i>	0.243	0.172	0.016
<b><u>Tamang</u></b>				
1	<i>Astilbe rivularis</i>	0.359	0.469	0.012
2	<i>Bergenia ciliata</i>	0.405	0.346	0.012
3	<i>Urtica dioica</i>	0.194	0.284	0.062
4	<i>Swertia chirayita</i>	0.231	0.296	0.012
5	<i>Myrica esculenta</i>	0.169	0.173	0.024
6	<i>Zanthoxylum armatum</i>	0.164	0.173	0.037

### **Market availability**

During the markets surveyed, 68 species of medicinal plants were traded on roadside market (Table 6). The most common species traded to international market mainly in India and China were *Swertia chirayita*, *Cinnamomum tamala*, *Berberis aristata*, *Persea duthiei*, *Bergenia ciliata*, *Didymocarpus pedicellatus*, *Myrica esculenta*, and *Paris polyphylla* etc. Bark of new medicinal use species such as *Litsea glutinosa*, *Persea duthiei*, and dried *Tribulus terrestris* fruit were found to be sold at urban markets.

### **Preference rank**

The results of preference ranking exercises are shown in Table 9. For the medicinal plants, the total scores of *Paris polyphylla* was found to be 49 scores based on high

market potential and utilization and ranked first. *Persea duthiei* ranked second, whereas *Satyrium nepalense* placed in 3<sup>rd</sup> rank and *Swertia chirayita* and *Asparagus racemosus* for 4<sup>th</sup> rank.

**Table 9:** Preference ranking (Martin, 1995) for traded and use of medicinal plants performed by the respondents in 5 study sites (Aghor, Chitlang, Churiamai, Handikhola, Hetauda), Makawanpur district.

Plant species	Respondents										Total score	Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10		
<i>Paris polyphylla</i>	5	5	5	5	4	5	5	5	5	5	49	1st
<i>Persea duthiei</i>	3	5	5	5	5	5	5	5	5	5	48	2nd
<i>Satyrium nepalense</i>	4	3	4	4	5	5	5	5	5	5	45	3rd
<i>Swertia chirayita</i>	5	4	4	4	4	5	5	5	3	4	43	4th
<i>Asparagus racemosus</i>	5	4	5	3	5	5	4	5	4	3	43	4th
<i>Chlorophytum nepalense</i>	3	2	3	5	5	5	4	5	5	5	42	5th
<i>Bergenia ciliata</i>	5	4	5	2	3	5	4	5	5	3	41	6th
<i>Terminalia chebula</i>	4	3	3	4	3	3	3	6	6	4	39	7th
<i>Selinum wallichianum</i>	2	3	2	4	4	2	4	5	5	6	37	8th
<i>Cucurliigo orchioides</i>	1	3	1	3	5	4	5	5	5	5	37	9th
<i>Astilbe rivularis</i>	5	2	5	2	2	5	3	5	3	2	34	10th
<i>Didymocarpus pedicellatus</i>	2	1	2	3	5	5	2	5	4	5	34	10th
<i>Urtica dioica</i>	2	1	1	2	5	5	5	5	5	3	34	10th
<i>Cinnamomum tamala</i>	2	4	3	4	3	3	4	5	5	1	34	10th
<i>Phyllanthus emblica</i>	1	3	4	3	2	3	3	4	5	3	31	11th
<i>Rubia manjith</i>	1	2	1	3	4	3	4	3	5	3	29	12nd
<i>Terminalia bellirica</i>	2	2	1	2	2	2	2	5	5	3	26	13rd
<i>Acacia catechu</i>	2	3	1	2	1	2	2	3	5	1	22	14th
<i>Rauwolfia serpentina</i>	1	2	3	1	4	1	1	3	4	1	21	15th
<i>Tinospora sinensis</i>	1	1	2	4	3	3	1	1	2	2	20	16th

Source: Field survey 2010 (Note: R1, R2...=Respondents)

### Priority setting approach for domestication

By summing up each of the values, 'priority index' of 20 most important species was calculated (Table 10). The following four species were rated as already domesticated in Makawanpur district or elsewhere and was thus excluded from the list despite their high 'priority index'. These species were *Cinnamomum tamala*, *Asparagus racemosus*, *Swertia chirayita*, *Phyllanthus emblica*. The remaining 16 species were ranked for future domestication programs, i.e. *Urtica dioica* was first rank. Similarly *Tinospora sinensis*, *Persea duthiei*, *Bergenia ciliata*, *Acacia catechu*, and *Cucurliigo orchioides* were second ranked (Table 10).

**Table 10:** Characteristics of the 20 most important potential priority wild medicinal plant species for future domestication in Makawanpur district, Central Nepal, and their rankings after calculating the priority index and excluding four species already domesticated elsewhere.

S.N.	Species name	Priority for sale (3=high)	Found in HGs (1=yes)	Ethnic groups (no.)	Altitude zones (no.)	Ease of cultivation (3=easy)	Vulnerable or endan-gered (1=yes)	Value adding storage (1=yes)	Priority index	Domesti-cated else-where (x=yes)	Rank for domesti-cation
1	<i>Urtica dioica</i>	3	0	3	3	NA	0	1	10		1
2	<i>Cinnamomum tamala</i>	3	1	3	3	3	0	1	10	x	
3	<i>Asparagus racemosus</i>	3	0	3	3	3	0	1	10	x	
4	<i>Terminalia chebula</i>	3	0	3	1	2	1	1	9		2
5	<i>Swertia chirayita</i>	3	0	3	3	3	0	0	9	x	
6	<i>Phyllanthus emblica</i>	3	0	3	1	2	1	1	9	x	
7	<i>Tinospora sinensis</i>	2	0	3	2	1	1	0	8		3
8	<i>Persea duthiei</i>	3	0	2	2	1	1	0	8		3
9	<i>Bergenia ciliata</i>	3	0	2	2	1	1	0	8		3
10	<i>Astilbe rivularis</i>	2	0	2	3	1	1	0	8		3
11	<i>Acacia catechu</i>	3	0	3	1	2	1	0	8		3
12	<i>Terminalia bellirica</i>	2	0	3	1	2	1	0	7		4
13	<i>Rauvolfia serpentina</i>	3	0	1	1	2	1	0	6		5
14	<i>Didymocarpus pedicellatus</i>	3	0	1	2	NA	1	0	7		4
15	<i>Paris polyphylla</i>	3	0	1	1	1	1	0	6		5
16	<i>Satyrrium nepalense</i>	3	0	1	1	NA	1	0	6		5
17	<i>Selinum wallichianum</i>	2	0	1	1	NA	0	0	4		6
18	<i>Rubia manjith</i>	2	0	1	1	3	0	0	4		6
19	<i>Chlorophytum nepalense</i>	3	0	1	1	NA	1	0	6		5
20	<i>Cucurliigo orchioides</i>	3	0	2	2	NA	1	0	8		3

### 3.1.4.2 DISCUSSION

The present study indicated that the local communities Bankaria, Newar and Tamang ethnic groups of Makawanpur district utilized 189 medicinal plants species for different illness. Similar study was done by Manandhar (1989), recorded 102 species used by Chepang tribes of Makawanpur district, and 161 species in Tamang community by Luitel *et al.* (2013).

When compared the method of uses and illness treated with published literatures from Makawanpur district (Manandhar, 1989; 1995b; Bhattarai *et al.* 2000; Uprety *et al.*, 2008; Hasan *et al.*, 2013; and Luitel *et al.*, 2013), 12 species (*Asparagus filicinus*, *Dendrobium longicornu*, *Litsea glutinosa*, *Paederia foetida*, *Persea duthiei*, *Prunus cerasoides*, *Scoparia dulcis*, *Scurrula parasitica*, *Solanum nigrum*, *Stellaria monosperma*, *Tribulus terrestris* and *Zephyranthes carinata*) of medicinal plants from the present study were revealed to be new uses for illness treated. In the present study, *Solanum nigrum* fruits were used for the fever. However, Luitel *et al.* (2013) reported that leaf of *Solanum nigrum* was consumed to treat malnutrition for children. Similarly, root paste of *Scoparia dulcis* is used to treat for fever (Manandhar, 1989), but in this root paste is used for sore throat. Fruits juice of *Paederia foetida* is applied in toothache (Uprety *et al.*, 2008), however flowers are chewed for toothache in the present study (Figure 8).

In the three ethnic groups (Bankaria, Newar, and Tamang) different numbers of medicinal plants species were used. The highest number of medicinal plant species used by the Tamang ethnic group (147 spp.), the lowest in the Newar ethnic group (66 spp.) whereas Bankaria ethnic group used 74 species. Tamang community showed better knowledge in utilization of medicinal plants. Similar observation was reported in Tamang community by Manandhar (1991) and Tamang (2003). Tamang and Bankaria ethnic groups have better knowledge of utilization of medicinal plants, because they lived close to the forest and have easy access to the plant resources.

The majority of the medicinal species used by all ethnic groups were herbs followed by trees, shrubs and climbers. The frequent use of herbaceous species among the Bankaria, Newar and Tamang communities could be a result of their abundance as compared to trees and shrubs. This result was also similar to the study on medicinal plants carried out in Nepal (Shrestha & Dhillon, 2003; Rokaya *et al.*, 2010; Uprety *et al.*, 2010). The common use of herbs as sources of medicine were also studied in Ethiopia (Giday *et al.*, 2003, 2007, Yineger *et al.*, 2007) and Uganda (Tabuti *et al.*, 2003) and in western Himalaya (Uniyal *et al.*, 2006). It is believed that herbs are found abundantly, so that it is easier to collect (Coe & Anderson, 1996; Shrestha & Dhillon, 2003). The plants which can easy to collect, store and transport, are also

factors that contribute to the preference for herbs (Shrestha & Dhillion, 2003). In study area, most of the herbs were collected easily from fallow land and the forest.

Among 189 medicinal plants species, Compositae 15 species (8%), Leguminosae 13 species (7%), Labiatae 11 species (6%), Rubiaceae 6 species (3%), Ericaceae, Euphorbiaceae and Ranunculaceae each with 5 species (3%) are the most used families followed by Amaranthaceae, Liliaceae, Orchidaceae and Zingiberaceae. The relatively higher contribution of medicinal plants by Compositae, Leguminosae and Labiatae as compared to other families could be attributed to their species richness. This results were similar to a previously published ethnobotany report of Nepal (Manandhar, 1989a; Bhattarai *et al.*, 2006) and are also reported outside the country by Giday *et al.* (2009) and Bradacs *et al.* (2011). Compositae, Leguminosae, Labiatae were among the largest dicotyledons families in the flora of Nepal (Press *et al.*, 2000).

The plant parts used for different illness were leaves, fruit, bark/wood, stem, seed, flower, tender shoot, pseudobulb, latex, spores, underground parts such as root/rhizome/tuber/bulb, and sometime entire plants. Inta *et al.* (2008) and Bradacs *et al.* (2011) also reported that leaves (54% and 43%) were the most commonly used part by Akha in Xishuangbanna and Thailand and in Vanuatu respectively. The common use of leaves in the preparation of medicine could be easily collection in any period of time as compared to other parts (Abera, 2003; Wassihun *et al.*, 2003; Kala, 2005; Tadesse *et al.*, 2005; Ignacimuthu *et al.*, 2006; Yineger & Yewhalaw, 2007; Yineger *et al.*, 2008; Giday *et al.*, 2010). Most of the ethnobotanical studies confirm that leaves are the major portion of the plant part used for the treatment of disease as they are active sites of photosynthesis and production of metabolites (Ghorbani, 2005; Bhattarai *et al.*, 2006). However, Rokaya *et al.* (2010), and Uprety *et al.* (2010) described that underground parts are the frequently used plant part and play an important role for the medicinal preparation. The similar results were also reported by Ghorbani *et al.* (2011) from the ethnobotanical studies of Hani Ethnic group of Yunnan, China. The preference of root to prepare traditional medicine is the reason that which contain high concentrations of bioactive compounds (Moore, 1994; Basualdo *et al.*, 1995). Therefore, leaves and underground parts were the most used plant parts, and agrees with most other ethnobotanical studies (Huai & Pei 2004; Chaudhary *et al.*, 2006; Yineger *et al.*, 2008). The collection of whole underground

plant part, collection of fruits before mature and excessive use of fruits or seeds for the medicine has a loss on regeneration of plants, which leads to decline of many medicinal plant populations in nature (Ghimire *et al.*, 2008). The harvesting of leaves for medicinal uses are much of sustainable compared to underground parts (Giday *et al.* 2003).

In the present study, most of the medicinal plants were collected from forest and fallow land. This report resembles with the work of Rokaya *et al.*, 2010; and Uprety *et al.*, 2010. This is common practice all over the world such in Uganda (Tabuti *et al.*, 2003), Peru (Bussmann & Sharon, 2006), Ethiopia (Fassil, 2005) and in Brazil (Gazzaneo *et al.*, 2005). Mostly weeds are abundantly growing in fallow land, easy to harvest and rich in bioactive compounds (Voeks, 2004).

For mode of administration, most of the plants were prepared as decoction (41.80%, 79 spp.), paste (32.80%, 62 spp.), juice (6.88%, 13 spp.), powder, oil, ash, cooked with egg and mustard oil for medicinal uses. This method of preparation was also reported by other studies from Nepal (Rokaya *et al.*, 2010; Uprety *et al.*, 2010) and outside Nepal (Andrade-Cetto, 2009; Giday *et al.*, 2010; Savikin *et al.*, 2013). However, the medicine were taken in juice or paste forms (Giday *et al.*, 2003; Giday & Ameni, 2003; Ignacimuthu *et al.*, 2006; Kunwar *et al.*, 2006 ). Some other reports, however, indicated the common use of concoction in Ethiopia (Yineger and Yewhalaw, 2007).

In Newar and Bankaria ethnics, the common diseases are diarrhea and dysentery, fever, cough and cold. The fever, diarrhea and dysentery, cough and cold are common disease, as this disease are more common in all of village people. Uprety *et al.* (2010) also observed the diarrhea and dysentery, cough and colds, cuts and wounds, fever and skin disease in Tamang community of Rasuwa district, Central Nepal. The genitourinary system disorders are reported common disease in Bankaria, Newar, and Tamang with ICF 0.750, 0.833, and 0.706 respectively. Uprety *et al.* (2010) also reported that treatment related to kidney problems with the highest ICF of 1.0. Tamang ethnic of Aghor at 2200 m altitude, the highest ICF (=1) were observed for used category related to mental disorder i.e. *Gaultheria fragrantissima* is used as antialcoholic. But plant in mental use category were cited by only one or three

respondents which showing that *Gaultheria fragrantissima*, when only few knows, making it vulnerable to extinction.

The plants which have low use values denotes that traditional knowledge about them is at risk of not being transmitted and that it may be gradually disappearing (Chaudhary *et al.*, 2006). The informant consensus factor (ICF) of local knowledge for illness treatment could be dependent on the availability of plant species and the illness in the study area.

The cultural importance index (CI) shows that Bankaria ethnic *Cleistocalyx operculatus* (CI=0.67) in first position whereas in Newar and Tamang ethnic *Astilbe rivularis* are first rank in CI. *Astilbe rivularis* were used against stomachache disorder after delivery. Because the CI index measures is independent on the number of informants and considers the diversity of use.

Analysis of free-list interviews showed that the score of medicinal plant domain of Bankaria consists of *Terminalia alata* (Smith's SI=0.399), *Cleistocalyx operculatus* (0.373), *Pogostemon benghalensis* (0.367), *Centella asiatica* (0.148); in Newar ethnic consists of *Phyllanthus emblica* (0.472), *Urtica dioica* L. (0.346), *Bergenia ciliata* (0.319), *Centella asiatica* (0.319) and Tamang ethnic consists of *Astilbe rivularis* (0.359), *Bergenia ciliata* (0.405), *Urtica dioica* (0.194), *Swertia chirayita* (0.231) (Table 7). This result showed that, there is different knowledge distribution in between Bankaria, Newar and Tamang. This may be due to differences in availability of plants in study area or cultural difference. The fact that medicinal plants are being used for the same purpose by more than one community might indicate their pharmacological effectiveness. Trotter and Logan (1986) stated that plants which are used in more than one illness are more likely to be biologically active. The plants which are used for more than one illness and more respondents could be their abundance in the study area. There are high market demand medicinal plants found in study area. The FAO estimated that worldwide between 4000 and 6000 species of medicinal plants are traded (Tuxill, 1999). In the surveyed markets, 68 species of medicinal plants were traded on roadside market and traded to international market such as in India and China, including *Swertia chirayita*, *Cinnamomum tamala*, *Berberis aristata*, *Myrica esculenta*, and *Paris polyphylla* etc.

## 3.2 WILD EDIBLE PLANTS

### 3.2.1 INTRODUCTION

Wild plants play very important role in the livelihoods of rural communities as an integral part of the subsistence strategy of people in many developing countries (Zemedu & Mesfin, 2001). Walters and Hamilton (1993) estimated about 75,000 species of wild edible plants in the world. Of which, nearly 3000 plant species have been used as human food and about 200 species have been domesticated as food crops (Simpson & Ogorzaly, 1995). Wild plant resources reduce the vulnerability of communities to food insecurity and become invaluable in times of hardships (Misra *et al.*, 2008; Belem *et al.*, 2009). Wild vegetables are traditionally important resource for ethnic groups subsistence (Xu *et al.*, 2004) as well as important sources of vitamins and minerals (Odhav *et al.*, 2007). The nutritional value of traditional wild vegetables is high (Sundriyal & Sundriyal, 2004; Orech *et al.*, 2007). Increased use of traditional wild edible plants can contribute to enhance people's health and standard of living as well as the economic and social status. Gathering of wild edible plants for both self-consumption and selling in markets are still very common practice in Nepal, particularly in rural areas. During food scarcity periods, a large number of people from urban and rural communities heavily depend on wild vegetables (DMP, 1982). However, many traditional wild vegetables are replaced by the introduction of exotic plants and improved varieties. Further, habitat degradation and poor marketing opportunities for traditional vegetables are responsible for losing their value (Joshi *et al.*, 2007). The wild vegetables are marginalized in current agricultural practice as well as poor utilization due to lack of awareness (Maikhuri *et al.*, 2004). There is an urgent need for conservation of wild plants, which can be useful in case of genetic erosion or for crop improvement (Kala, 2007). Most of the wild vegetables grown naturally are resistant to several biotic and abiotic stresses, they required fewer inputs and are comparatively nutritionally superior to cultivated crops (Bhardwaj *et al.*, 2007). Despite these advantages, most traditional wild edible plants are generally uncultivated and underutilized (Grivetti & Ogle, 2000). Abundance of many of these wild vegetables are decreasing which calls domestication and cultivation of priority species. Enhanced cultivation after domestication of these species may contribute to



their 'conservation through use' and to improve livelihoods of rural communities as reported for other regions of the world (Akinnifesi *et al.*, 2008).

Nepal's rich biodiversity is associated with the different vegetation types, ranging from tropical to alpine, results in the occurrence of about 6000 species of flowering plants (Press *et al.*, 2000). Out of these, about 1500 species are considered useful (Manandhar, 2002), of which about 400 plants are edible plants. Numerous publications provide a valuable knowledge of edible wild plants in various locations of Nepal (DMP, 1982; Regmi, 1979; Bajracharya, 1979; 1980, 1981a, 1981b; Bajracharya *et al.*, 1982; Manandhar, 1993; 1995c: 1997; Siwakoti *et al.*, 1997; Shrestha & Dhillion, 2006, Bhattarai *et al.*, 2009). Little is known about the nutritive values of wild fruits and nuts occurring in Nepal Himalaya (Bhandari, 1978; Bajracharya, 1980; Sundriyal & Sundriyal, 2004). In Nepal, however, there is so far neither a programme on domestication of indigenous wild edible plant species nor a plan for species priority setting as the first step for domestication. Makawanpur district of Central Nepal is considered one of the rich biodiversity hotspots of the country and harbours numerous indigenous underutilized wild edible plant species important for nutrition and income generation of rural households. The extensive traditional knowledge of the district's diverse ethnic groups related to uses and management of wild edible plants is not yet documented. The aim of this study was to document the diversity of wild edible plants and utilization pattern of wild edible plant in different ethnic groups and the preferences of local communities in Makawanpur district to develop a species priority setting approach for domestication.

### **3.2.2 LITERATURE REVIEW**

Banerji (1955) reported some edible and medicinal plants from east Nepal. Singh (1968) reported some wild food value plants of Nepal. Regmi (1979) published a book on Nepalese wild food plants. Bajracharya (1979, 1980) reported some Nepalese edible wild fruits and their nutritive values. Similarly, Bajracharya *et al.* (1982) studied on comparison of nutritive values of some edible ripe and unripe fruits of Nepal. Bajracharya (1981b; 1985) documented edible wild fruits Kathmandu Valley. DMP (1982) published wild edible plants of Nepal. Shrestha (1983) reported wild leafy and fruit vegetable from Dharan, Sunsari district. Shrestha (1987) reported

edible wild plants from Pokhara, Nepal. Budathoki *et al.* (1993) studied indigenous knowledge and technology on vegetable crops from western Nepal. Siwakoti *et al.* (1997) recorded some wild edible plants used by Satars tribe of Nepal. Amatya (1999) studied the cultivation practices of potential edible wild fruit trees in Nepal. Similarly Manandhar (1986a, 1989a, 1991a, 1993, 1995c, 1997) studied wild edible plants of Nepal. Maden and Dhakal (1998) have studied wild fruits from eastern Nepal. Bhandari *et al.* (2003) analysed nutritional evaluation in some wild yam tubers. Joshi and Siwakoti (2012) studied on wild leafy vegetable of Makawanpur district. Shrestha and Dhillion (2006) reported wild food plants from forest of Nepal. Shrestha and Shrestha (2004) documented wild edible plants from Langtang National Park, Rasuwa district. Bhattarai *et al.* (2009) studied wild edible plants from Manang district. Similarly Acharya and Acharya (2010) documented indigenous knowledge of wild edible plants in Central Nepal. Uprety *et al.* (2012) documented 81 species of wild edible plants and also assessed ethnoecological knowledge to identify the threats of them. Joshi *et al.* (2013) described some wild fruits and nuts from Makawanpur district.

### **3.2.3 MATERIALS AND METHODS**

#### **3.2.3.1 Ethnobotanical data collection**

The ethnobotanical study was conducted between 2010 and 2011. The ethnobotanical data collection was carried out in three ethnic groups Bankaria, Newar and Tamang ethnic groups living in Makawanpur district, Central Nepal. Wild edible plants was collected in the five study sites (Aghor, Chitlang, Churiamai, Handikhola, and Hetauda) from natural forests, farmers' field, fallow land, roadsides, homegardens and markets. A semi-structured interview questionnaire was developed (Appendix 4). Interviews were conducted with 145 respondents, who were randomly selected from three different ethnic groups. The respondents represented a wide range of age classes (8-78 years). Informants were asked independently the same question. Detailed information about local plant names, plant parts used, seasonal availability, mode of consumption, preference for consumption and sale for each of the species was gathered during individual interviews of the respondents using a semi-structured questionnaire.

A free-listing method was applied to get information about the frequently consumed edible plants from three Bankaria, Newar, and Tamang ethnic groups of five study sites such as Aghor, Chitlang, Churiamai, Handikhola and Hetauda (Figure 1).

Preference ranking was carried out with ten knowledgeable respondents from the local knowledgeable informants who already participated in the semi-structured interview. The list of edible wild vegetables and fruits were recorded from respondents, based on respondents perceived level of consumption and trade. In addition, market survey was undertaken to collect the number of edible wild plants for sale.

### **3.2.3.2 Priority setting approach for domestication**

Database of the wild vegetables and fruits was then used for the priority setting for domestication by using the following nine variables; priority for taste (range from 1 (low preference) to 3 (high preference)), priority for sale (range 1-3), species occurrence in homegardens (yes/no), number of ethnic groups using the species (range 1-3), number of altitude zones having the species (range 1-3), harvest in the winter months (yes/no), level of threat as perceived by respondents (threatened/not threatened), children's preference for consumption (yes/no) and possibility for processing and/or storage of the product (yes/no). The values of each of these variables were then summed to obtain a priority index (maximum value 17). Species domesticated elsewhere were excluded from the list. The remaining species were finally sorted by the priority index to identify the species with the highest priority for domestication.

### **3.2.3.3 Data analysis**

#### **Relative Frequency of Citation (RFC)**

Relative frequency of citation (RFC) was calculated from the data of semistructured interview. RFC is obtained by dividing frequency of citation (FC) (the number of respondents who mention the use of the edible species) by total number of respondents in the interview (N). This analysis varies from 0 to 1, when nobody refers to the plants as useful, to one in case that every respondents would mention it as useful (Tardio & Pardo-de Santayana, 2008).

$$RFC=FC/N$$

### **Smith's salience index (SI)**

Smith' salience index was used to examine species saliency or the most frequently used plant species by the ethnic groups in the study sites. The free-list data was analyzed in three ethnic groups (Bankaria, Newar and Tamang) separately. Freelists show the salience of items in the community and variation in knowledge of the ethnic groups (Puri & Vogl, 2005). Data obtained by free-listing method are analysed by using software ANTHROAPAC 4.08 (Boragatti, 1996). Salience index accounts for frequency of mentions and positions of items in freelists and ranges from 0 to 1, showing the highest salience at 1.

## **3.2.4 RESULTS AND DISCUSSION**

### **3.2.4.1 RESULTS**

#### **3.2.4.1a Wild vegetables**

##### **Diversity and use of wild vegetables**

A total of 97 wild vegetable species were recorded belonging to 74 genera and 45 families. The scientific names, local name (Nepali, Bankaria, Newar, Tamang), plant parts used, market available and habit are listed in Table 11.

**Table 11:** List of wild vegetables collected from Makawanpur district, Central Nepal. (Note: Nepali name=Nep; Newar=Ne, Bankaria=Ba, Tamang=Ta).

S.N.	Scientific name	Local name	Life form	Part used	Market availability	Ethnic groups
1	<i>Abelmoschus moschatus</i>	Latakasturi	Herb	Young fruit	No	Ba
2	<i>Aconogonum molle</i>	Thotne (Nep), Pathu, Pwathu (Ne)	Herb	Tender shoot	Yes	Ne
3	<i>Allium wallichii</i>	Dundu, Banlasun (Nep), Dundunge (Ne)	Herb	Leaves	No	Ne, Ta
4	<i>Alternanthera sessilis</i>	Saranchisag (Nep)	Herb	Leaves	No	Ba
5	<i>Amaranthus lividus</i>	Lattesag (Nep), Ghyebankan, Bankan (Ne)	Herb	Leaves	Yes	Ne
6	<i>Amaranthus spinosus</i>	Kande latte (Nep), Kan bankan (Ne)	Herb	Leaves	No	Ba
7	<i>Amaranthus viridis</i>	Latte (Nep), Nhagubanka (Ne)	Herb	Leaves	Yes	Ne
8	<i>Anagallis arvensis</i>	Armale (Nep)	Herb	Leaves	No	Ta
9	<i>Arisaema tortuosum</i>	Banko (Nep)	Herb	Leaves	No	Ta
10	<i>Ariveia viscosa</i>	Bantori (Nep), Swibhamo (Ne)	Herb	Leaves	No	Ba, Ne
11	<i>Artocarpus heterophyllus</i>	Kathahar (Nep), Fasin (Ne)	Tree	Young fruit	Yes	Ba, Ne, Ta
12	<i>Artocarpus lakoocha</i>	Badahar (Nep)	Tree	Young fruit	No	Ba
13	<i>Asparagus filicinus</i>	Kurilo (Nep)	Herb	Tender shoot	No	Ne
14	<i>Asparagus racemosus</i>	Kurilo (Nep)	Herb	Tender shoot	No	Ba, Ne, Ta
15	<i>Bambusa tulda</i>	Nigalotusa (Nep), Tichwaka (Ne)	Shrub	Tender shoot	Yes	Ba, Ne, Ta
16	<i>Basella alba</i>	Poisag (Nep)	Climber	Tender shoot	No	Ba
17	<i>Bauhinia purpurea</i>	Tanki (Nep)	Tree	Tender shoot	No	Ta
18	<i>Bauhinia vahlii</i>	Bhorla (Nep)	Climber	Young pod	No	Ne, Ta
19	<i>Bauhinia variegata</i>	Koiralo (Nep), Bharbo, Bhabro, Kunabu (Ne), Ambumendo (Ta)	Tree	Flower	Yes	Ba, Ne, Ta
20	<i>Bidens pilosa</i>	Kuro (Nep)	Herb	Leaves	No	Ba
21	<i>Blumea lacera</i>	Khichabhawatha (Ne)	Herb	Leaves	No	Ne

**Table 11: (Continued)**

S.N.	Scientific name	Local name	Life form	Part used	Market availability	Ethnic groups
22	<i>Boehmeria platyphylla</i>	Kamle (Nep), Kisinhyanika (Ne)	Herb	Leaves	No	Ta
23	<i>Boehmeria ternifolia</i>	Chalnisnisnu (Nep)	Herb	Leaves	No	Ta
24	<i>Boerhavia diffusa</i>	Punarva (Nep)	Herb	Tender shoot	No	Ne, Ta
25	<i>Bombax ceiba</i>	Simal (Nep), Simbasi (Ne)	Tree	Flower	Yes	Ba, Ne, Ta
26	<i>Cajanus scarabaeoides</i>	NA	Herb	Young pod	No	Ba
27	<i>Chenopodium album</i>	Bethe (Nep), Ikacha (Ne)	Herb	Leaves	Yes	Ba, Ne, Ta
28	<i>Chenopodium ambrosioides</i>	Rato latte (Nep)	Herb	Tender shoot	No	Ne, Ta
29	<i>Chlorophytum nepalense</i>	Chalidhap (Ta)	Herb	Leaves	No	Ta
30	<i>Cirsium wallichii</i>	Thakal (Nep), Chwakan (Ne)	Herb	Stem pith	No	Ta
31	<i>Clematis buchananiana</i>	Jungelahara (Nep)	Climber	Leaves	No	Ba, Ne
32	<i>Commelina benghalensis</i>	Kanesag (Nep)	Herb	Tender shoot	No	Ba, Ne
33	<i>Crateva unilocularis</i>	Sipligan (Nep), Khaeelcho (Ne)	Tree	Leaves	Yes	Ba, Ta
34	<i>Crotalaria alata</i>	Chhinchhine (Nep)	Herb	Young pod	No	Ba, Ta
35	<i>Crotalaria albida</i>	Bhediphul (Nep)	Herb	Young pod	No	Ba, Ta
36	<i>Crotalaria pallida</i>	Bakhrehans (Nep)	Herb	Young pod	No	Ba
37	<i>Crotalaria sessiliflora</i>	Keraughans (Nep)	Herb	Young pod	No	Ba, Ta
38	<i>Cycas pectinata</i>	Jagar (Nep)	Shrub	Tender shoot	No	Ba, Ta
39	<i>Dendrocalamus hamiltonii</i>	Tamabans (Nep), Chhyow (Ne)	Shrub	Tender shoot	Yes	Ba, Ne, Ta
40	<i>Dioscorea bulbifera</i>	Githa (Ba)	Climber	Tuber	No	Ba, Ne, Ta
41	<i>Dioscorea deltoidea</i>	Kukurtarul (Nep), Kuigo (Ba)	Climber	Tuber	Yes	Ba, Ta
42	<i>Dioscorea hamiltonii</i>	Bantarul (Nep), Githa (Ba, Nep), Dubucha (Ne)	Climber	Tuber	Yes	Ba, Ne, Ta
43	<i>Dioscorea hispida</i>	Bharlang (Ba)	Climber	Tuber	No	Ba, Ta

**Table 11: (Continued)**

S.N.	Scientific name	Local name	Life form	Part used	Market availability	Ethnic groups
44	<i>Dioscorea kaemmoonensis</i>	Tyaguna (Ba)	Climber	Tuber	No	Ba, Ne, Ta
45	<i>Dioscorea pentaphylla</i>	Bhakur (Ba)	Climber	Tuber	Yes	Ba, Ne, Ta
46	<i>Diplazium esculentum</i>	Neuro (Nep)	Herb	Tender shoot	Yes	Ba, Ne, Ta
47	<i>Dryopteris cochleata</i>	Neuro (Nep), Kuthruke, Thomaru Danke (Ne)	Herb	Tender shoot	Yes	Ba, Ne, Ta
48	<i>Eclipta prostrata</i>	Bhringiraj (Nep), Antalicha (Ne)	Herb	Leaves	Yes	Ba, Ta
49	<i>Emilia sonchifolia</i>	Dudhe (Nep)	Herb	Leaves	No	Ba
50	<i>Euphorbia hirta</i>	Dudhejhar (Nep)	Herb	Leaves	No	Ba, Ta
51	<i>Fagopyrum dibotrys</i>	Titefaper (Nep)	Herb	Leaves	Yes	Ba, Ne, Ta
52	<i>Fagopyrum esculentum</i>	Mithefaper (Nep), Kalanca (Ne)	Herb	Leaves	Yes	Ba, Ne, Ta
53	<i>Ficus hispida</i>	Khassreto (Nep)	Tree	Young fruit	No	Ba, Ta
54	<i>Ficus lacor</i>	Kavro (Nep)	Tree	Tender shoot	No	Ne
55	<i>Girardinia diversifolia</i>	Allosag (Nep), Panchepolo (Ta)	Herb	Leaves	No	Ta
56	<i>Herpetospermum pedunculatum</i>	Murmure (Nep)	Climber	Fruits	No	Ba
57	<i>Holarrhena pubescens</i>	Kurchi (Nep)	Shrub	Leaves	No	Ba, Ta
58	<i>Houttuynia cordata</i>	Gane (Nep)	Herb	Leaves	Yes	Ta
59	<i>Impatiens bicornuta</i>	Tiuri (Nep)	Herb	Leaves	No	Ba, Ta
60	<i>Indigofera cassioides</i>	Sagino (Nep)	Herb	Flower	No	Ba, Ta
61	<i>Ipomoea aquatica</i>	Karmisag (Nep)	Herb	Leaves	Yes	Ba, Ne, Ta
62	<i>Lathyrus aphaca</i>	Bankhesari (Nep)	Herb	Leaves	No	Ne, Ta
63	<i>Lilium nepalense</i>	Khiraula (Nep)	Herb	Leaves	No	Ta
64	<i>Lygodium japonicum</i>	Parewavuri (Ba)	Climber	Tender shoot	No	Ba
65	<i>Macropanax dispermus</i>	Chinia (Nep), Kharchuli, Hampaha (Ne)	Tree	Tender shoot/leaves	Yes	Ne
66	<i>Malva verticillata</i>	Lafesag (Nep)	Herb	Tender shoot	Yes	Ne, Ta
67	<i>Moringa oleifera</i>	Sajiwan (Nep)	Tree	Young fruit	Yes	Ne, Ta

**Table 11: (Continued)**

S.N.	Scientific name	Local name	Life form	Part used	Market availability	Ethnic groups
68	<i>Mucuna pruriens</i>	Kauso (Nep), Chhyakisime (Ne)	Climber	Young fruit	No	Ba
69	<i>Natsiatum herpeticum</i>	Kalilahara (Nep)	Climber	Tender shoot	No	Ba
70	<i>Oenanthe javanica</i>	Chanati (Ne)	Herb	Leaves	No	Ba, Ne, Ta
71	<i>Ophioglossum nudicaule</i>	Jibresag (Nep)	Herb	Leaves	Yes	Ba, Ta
72	<i>Persicaria runcinata</i>	Amilobethe (Nep)	Herb	Leaves	No	Ba, Ta
73	<i>Phoenix loureiri</i>	Thakal (Nep)	Shrub	Tender shoot	No	Ba, Ta
74	<i>Phytolacca acinosa</i>	Jaringosag (Nep), Thusake, Thusa (Ne)	Herb	Tender shoot/leaves	Yes	Ba, Ne, Ta
75	<i>Plantago erosa</i>	Churnajhar (Nep), Nyamnyung (Ta)	Herb	Leaves	No	Ba, Ta
76	<i>Portulaca oleracea</i>	Kulfasag (Nep)	Herb	Tender shoot	No	Ba
77	<i>Pouzolzia zeylanica</i>	Nichasag (Nep)	Herb	Leaves	No	Ba, Ne, Ta
78	<i>Pteris biaurita</i>	Dantheneuro (Nep), Daunthi (New)	Herb	Leaves	No	Ba, Ne, Ta
79	<i>Rorripa indica</i>	Pafelejhar (Nep), Bunke (Ne)	Herb	Leaves	No	Ba
80	<i>Rorripa nasturtium aquaticum</i>	Kholesag (Nep), Khusike, Poriken (Ne)	Herb	Leaves	Yes	Ba, Ne, Ta
81	<i>Rumex nepalensis</i>	Halhale (Nep), Haleto (Ta)	Herb	Leaves	No	Ba, Ne, Ta
82	<i>Senna tora</i>	Tapre (Nep)	Herb	Young pod	No	Ba
83	<i>Smilax lanceifolia</i>	Kukurdaino (Nep)	Climber	Tender shoot	No	Ta
84	<i>Smilax ovalifolia</i>	Kukurdaino (Nep), Nagrikhe (Ta)	Climber	Tender shoot	No	Ta
85	<i>Solanum nigrum</i>	Kalobihi (Nep)	Herb	Leaves	No	Ba
86	<i>Sonchus oleraceus</i>	Dudhejhar (Nep)	Herb	Leaves	No	Ne, Ta
87	<i>Sonchus asper</i>	Dudhejhar (Nep), Khaeke (Ne)	Herb	Leaves	No	Ba, Ne, Ta
88	<i>Stellaria media</i>	Armalejhar (Nep)	Herb	Leaves	No	Ne, Ta
89	<i>Stellaria monosperma</i>	Jethimadhu (Nep), Banmran (Ta)	Herb	Leaves	No	Ba, Ta



**Table 11: (Continued)**

S.N.	Scientific name	Local name	Life form	Part used	Market availability	Ethnic groups
90	<i>Talinum cuneifolium</i>	Chiniasag (Nep)	Herb	Leaves	Yes	Ba, Ne
91	<i>Tectaria coadunata</i>	Danthe/Kalineuro (Nep)	Herb	Tender shoot	Yes	Ba, Ne, Ta
92	<i>Tragopogon gracilis</i>	Dowacha (Ne)	Herb	Leaves	No	Ne
93	<i>Tupistra aurantiaca</i>	Chwolacha (Ne)	Herb	Leaves	No	Ne, Ta
94	<i>Urtica dioica</i>	Sisnu (Nep), Nhyaka (Ne), Polo (Ta)	Herb	Leaves	Yes	Ba, Ne, Ta
95	<i>Vicia angustifolia</i>	Kutalikosa (Nep)	Herb	Tender shoot	No	Ba
96	<i>Vicia hirsuta</i>	Kutalikosa (Nep)	Herb	Tender shoot	No	Ba
97	<i>Youngia japonica</i>	NA	Herb	Leaves	No	Ba, Ne

Source: Field survey 2010

When compared with lists of wild vegetables published by Manandhar (2002), Bhattarai *et al.* (2009) and Uprety *et al.* (2012), most of the species documented in the present study were similar except *Talinum cuneifolium* Willd. and *Tragopogon gracilis* D. Don. These two species are new additions to the available wild vegetable species for Nepal (Figure 21).

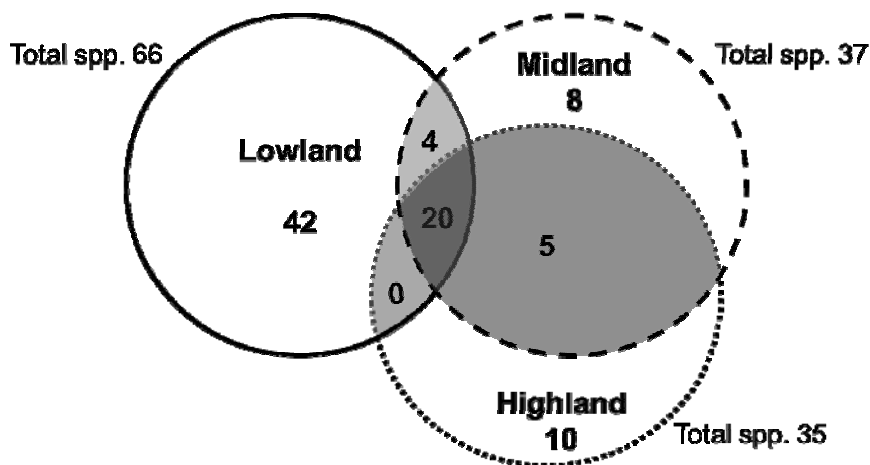


a. Leaves of *Talinum cuneifolium*

b. *Tragopogon gracilis*

**Figure 21:** New wild vegetable species reported from Makawanpur district, Central Nepal

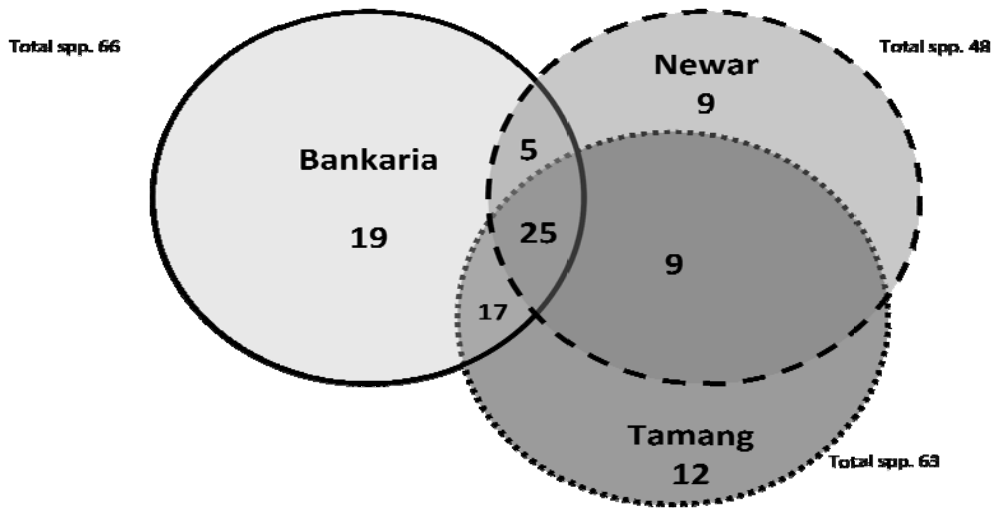
The three altitude zones surveyed (lowland, midland and highland) have different numbers of wild vegetable species. The highest numbers of species were identified in the lowland (66 spp.) and the lowest in the highlands (35 spp.). Species similarity was different among the three altitudinal zones.



**Figure 22:** Number of wild vegetable species distributed in different altitudinal zones of study areas.

As many as 42 species in the lowlands, eight species in midland and 10 species at highland were not common with other zones. The midland and highland shared five species, whereas the midland and the lowland shared only four species. Similarly, there were no common species in the highland and lowland. However, 20 species were found common in all three zones (Figure 22).

The three ethnic groups (Bankaria, Newar, and Tamang) have also used different number of wild vegetable plant species. The highest number of vegetable species was consumed in the Bankaria ethnic group (66 spp.) followed by Tamang (63 spp.), and Newar ethnic group (48 spp.). Species similarity was different among the three ethnic groups, in the Bankaria ethnic group 19 species were reported, whereas the Newar and the Tamang had reported nine and 12 species respectively. The Newar and Tamang communities shared nine vegetable plant species, whereas Bankaria and Newar shared five species. Similarly Bankaria and Tamang shared 17 species, and nine species were shared among Newar and Tamang ethnic groups (Figure 23). There were 25 vegetable species common in all three ethnic groups. Figure 23 also showed that Bankaria and Tamang used more wild vegetables than Newar.

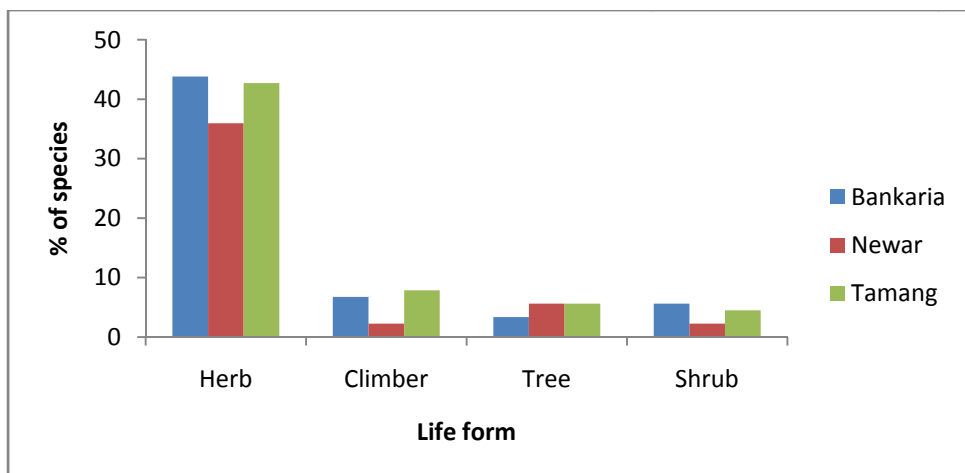


**Figure 23:** Vegetable species used by three ethnic groups

One reason for this result could be the Bankaria and Tamang ethnic group lived close to forests, and have more knowledge and easy access to these wild plant resources, whereas the Newar ethnic group mostly lived in urban areas and has less traditional knowledge on wild vegetables.

### Life forms

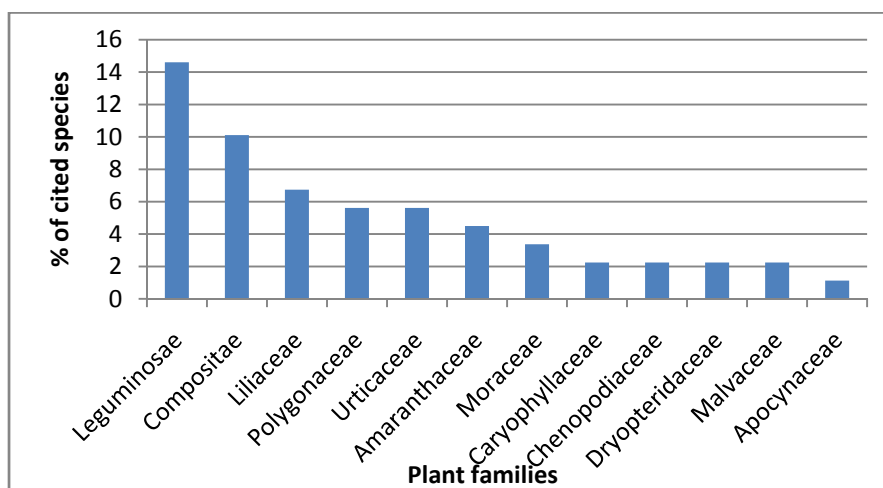
Out of the 97 wild vegetable species, 67 species were herbs, 15 climbers, nine shrubs and 10 trees. The majority of the species used by all ethnic groups were herbs. Bankaria, Newar and Tamang were used 44 %, 36%, 43% of herbs respectively followed by climbers, trees and shrubs (Figure 24).



**Figure 24:** Life forms of vegetables used by three ethnic groups.

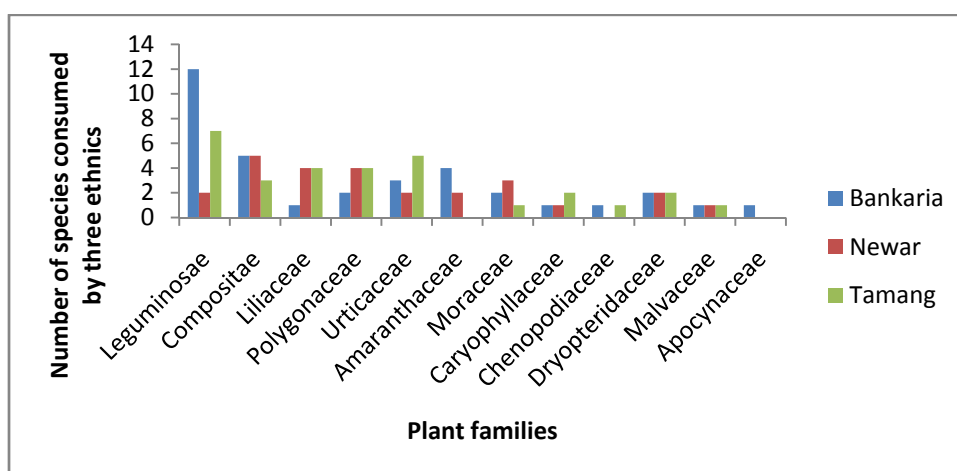
### Plant families

Among the total vegetable species, 13 species belong to family Leguminosae (15%), followed by Compositae with nine species (10%), Liliaceae six species (7%), Polygonaceae and Urticaceae each with five species (6%), Amaranthaceae four species ((4%), Moraceae three species (3%) and Caryophyllaceae two species (2%) (Figure 25).



**Figure 25:** Plant families with the highest number of cited species.

While comparing the three ethnic groups of the study sites, the top three families used by Bankaria ethnic group were Leguminosae (12 spp.), Compositae (5 spp.) and Amranthaceae (4 spp.). This proportion of utilization was higher as compared to Newar, who used Compositae (3 spp.), Leguminosae (2 spp.) and Amaranthaceae (2 spp.), Labiatae (1.06%, 2 spp.) and Tamang ethnic group used Leguminosae (7 spp.), Compositae (3 spp.), and Urticaceae (Figure 26).



**Figure 26:** Plant families with number of vegetable species consumed by three ethnic groups.

### Plant parts used

Out of the 97 documented wild vegetable species the most commonly used parts were leaves (47 spp., 48%) followed by their tender shoots (26 spp.), while only 14 species used for their fruits or pods, 3 for their flowers, and one for its stem pith (Figure 27).

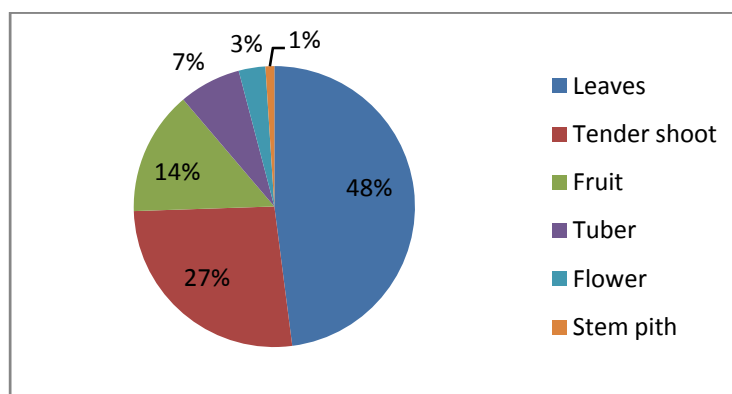


Figure 27: Plant parts used for vegetable

### Habitat

Regarding the locations for collecting wild vegetables in the present study, forests and fallow lands were most important habitats from where 50 and 48 species were collected respectively (Figure 28). Similarly, 7 species (*Bauhinia purpurea*, *B. variegata*, *Crateva unilocularis*, *Dendrocalamus hamiltonii*, *Ficus hispida*, *F. lacor* and *Moringa oleifera*) were collected from homegardens. Some species of plants as *Asparagus racemosus*, *Amaranthus lividus*, *Chenopodium album*, *Fagopyrum dibotrys*, *F. esculentum* were cultivated in the farmers' field. These plants were also found in the wild.

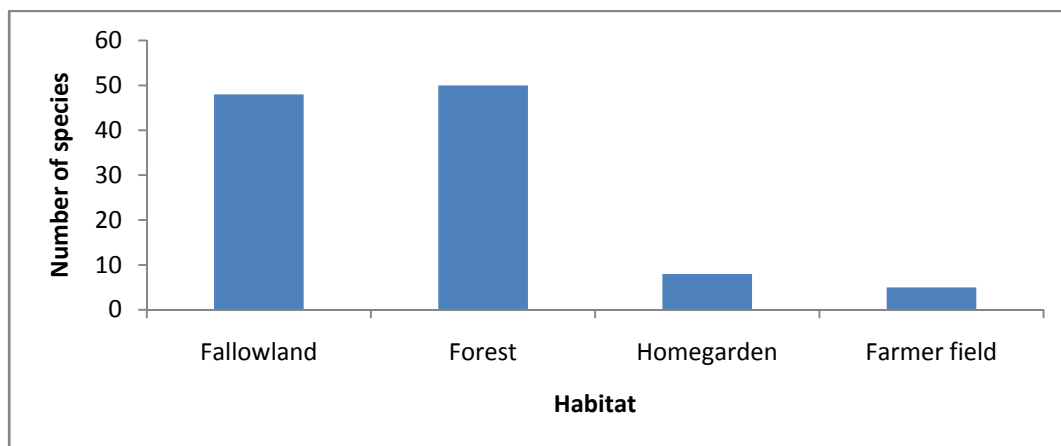
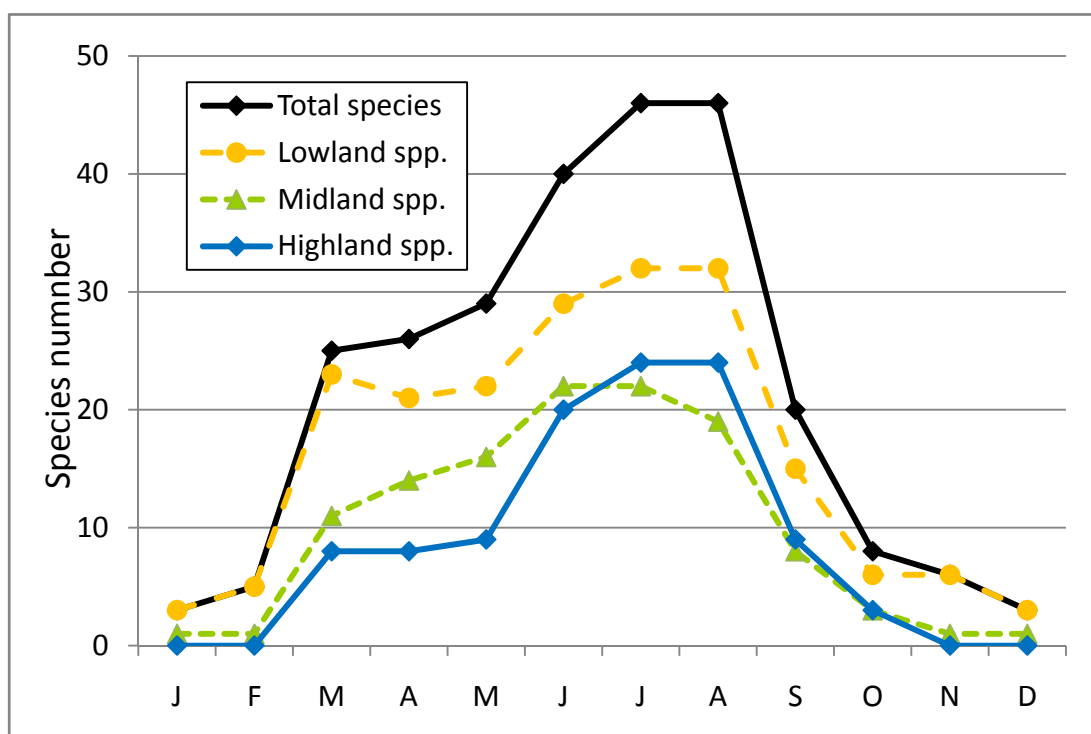


Figure 28: Number of vegetable species collected from various habitats

Some of the documented vegetables such as *Ficus hispida* was rarely consumed as vegetable but rather used as livestock fodder.

### Seasonal availability

Attempt was also made to report the availability of wild vegetable species in various seasons of the year. According to respondents 3-5 species were harvested in the winter season from December to February (Figure 29), whereas, 40-46 species were collected during rainy season (June to August), in winter season 2 species and in summer season 18 species. However, some differences in harvesting seasons were observed among the different altitude zones. In the highlands and midlands, only one species were collected during the months of November to February (Figure 29). The peak season was June to August in the highland which was slightly later than in the midlands. More than 20 species were available in the lowlands during six months of the year (March to August), but two months in both the midlands (June and July) and the highlands (July and August).



**Figure 29:** Seasonal availability of wild vegetable species in different altitude of Makawanpur district

### Mode of consumption

Based on the interviews with respondents 7 species were top ranked with regard to taste and consumption frequency by both children and adults of all the study sites.

These were *Bambusa tulda*, *Chenopodium album*, *Dendrocalamus hamiltonii*, *Diplazium esculentum*, *Dryopteris cochleata*, *Ipomoea aquatica*, and *Tectaria coduanata*. The second ranked preferred species were *Amaranthus viridis*, *Macropanax dispermus*, *Pteris biaurita*, and *Urtica dioica* (Table 12). These wild vegetables did not require any special processing for cooking or consumption, except the removal of stings and some other microstructures of nettles in some species. Most of the wild vegetables were boiled and cooked with cooking oil, salt and spices. However, some of wild vegetables such as *Chenopodium album*, *Amaranthus lividus*, *A. viridis* were boiled and prepared by mixing with fried seed powder of *Glycine max*, *Sesamum indicum* or *Perilla frutescens* (Table 12). The *Phytolacca acinosa* leaves required special treatment in order to reduce the bitterness, such as boiling and washing several times before the final preparation of vegetable.

**Table 12:** Traditional knowledge on mode of consumption of prioritized wild vegetables.

Species name	Occurrence	Part used	Mode of consumption
<i>Bambusa tulda</i>	Grows in forest edge, also cultivated in home garden.	Tender shoots	Outer covering is removed. Soft inner shoots are smashed and fried with cooking oil or cooked with potato.
<i>Chenopodium album</i>	Occurs in fallow land. Women cultivated in potato and wheat crops.	Tender shoots	Tender shoots are fried with egg. Tender shoots are also mixed with <i>Glycine max</i> , <i>Perilla frutescens</i> , <i>Sesamum indicum</i> fried flour and spices.
<i>Dendrocalamus hamiltonii</i>	Commonly occurs in forest area and roadside. This plant is collected from wild, also found domesticated in home garden.	Tender shoot	Cooked with potato. Also cut into small pieces and covered with Banana leaves to make fermented shoot, which can be preserved for longer period.
<i>Diplazium esculentum</i>	Frequently occurs in moist forest.	Tender fronds	Fried with cooking oil
<i>Dryopteris cochleata</i>	Frequently occurs in moist forest.	Tender fronds	Fried with cooking oil
<i>Ipomoea aquatica</i>	Grows in slow running water and pond.	Tender shoot and leaves	Fried with cooking oil

Source: Field study 2009-2011

## Cultural importance

Table 13 showed the most commonly used vegetables among three ethnic groups (Bankaria, Newar, Tamang). In Bankaria the frequently used vegetables are *Amaranthus lividus* (RFC=0.70), *Dioscorea bulbifera*, *D. kaemoonensis*, *Crateva unilocularis*, *D. hispida*, whereas in Newar ethnic group *Dryopteris cochleata* (RFC=0.95); *Bambusa tulda*, *Diplazium esculentum*, *Dendrocalamus hamiltonii*, *Tectaria coadunata*, and in Tamang ethnic group used *Dendrocalamus hamiltonii*

**Table 13:** Comparison of relative frequency of citation (RFC) for wild vegetables use in Banakria, Newar and Tamang ethnic groups.

Bankaria		Newar		Tamang	
	RFC		RFC		RFC
<i>Amaranthus lividus</i>	0.66	<i>Dryopteris cochleata</i>	0.95	<i>Dendrocalamus hamiltonii</i>	0.93
<i>Dioscorea bulbifera</i>	0.66	<i>Bambusa tulda</i>	0.93	<i>Diplazium esculentum</i>	0.93
<i>Dioscorea kaemoonensis</i>	0.66	<i>Diplazium esculentum</i>	0.93	<i>Bambusa tulda</i>	0.91
<i>Crateva unilocularis</i>	0.63	<i>Dendrocalamus hamiltonii</i>	0.91	<i>Dioscorea hamiltonii</i>	0.91
<i>Dioscorea hispida</i>	0.63	<i>Tectaria coadunata</i>	0.87	<i>Dryopteris cochleata</i>	0.91
<i>Dioscorea pentaphylla</i>	0.6	<i>Chenopodium album</i>	0.8	<i>Dioscorea bulbifera</i>	0.89
<i>Bambusa tulda</i>	0.57	<i>Rorripa nasturtium aquaticum</i>	0.53	<i>Pteris biaurita</i>	0.89
<i>Diplazium esculentum</i>	0.57	<i>Urtica dioica</i>	0.49	<i>Tectaria coadunata</i>	0.89
<i>Rorripa nasturtium aquaticum</i>	0.57	<i>Amaranthus lividus</i>	0.47	<i>Urtica dioica</i>	0.82
<i>Smilax ovalifolia</i>	0.57	<i>Ipomoea aquatica</i>	0.47	<i>Smilax ovalifolia</i>	0.78

Source: Field survey 2009-2011

(RFC=0.93), *Diplazium esculentum*, *Bambusa tulda*, *Dioscorea hamiltonii*, and *Dryopteris cochleata*. It means that the use of vegetable species differ within the ethnic groups.



### **Species saliency**

In Bankaria ethnic group, *Dioscorea hamiltonii* with the highest frequency reported by 18 (respondents) followed by species that recorded moderate frequency 17 are *D. hispida*, *D. kaemoonensis*. Similarly, in Newar and Tamang ethnic group, it was *Diplazium esculentum* with the highest use frequency was recorded (61) and (44) respectively. Such a correlation between high frequency of these species signifies that they are the most significant to local communities. Species with high frequency recorded a higher Smith' saliency index while less frequency recorded low saliency index. Such saliency of species helps to understand how the cultural domain is perceived across in different ethnic groups (Table 14). It means, the highest saliency index (0.42) for the most saliency species was recorded in Bankaria ethnic group for *Dioscorea hamiltonii*, while the Newar and Tamang ethnic group, the saliency index (0.65) and (0.48) were recorded for *Diplazium esculentum*.

### **Market availability**

Among the total, 28 wild vegetable species were found to be sold in the urban markets (Table 11). The common marketable wild vegetables were *Aconogonum molle*, *Amaranthus lividus*, *Amaranthus viridis*, *Bambusa tulda*, *Bauhinia variegata*, *Dendrocalamus hamiltonii*, *Diplazium esculentum*, *Dryopteris cochleata*, *Ipomoea aquatica*, *Macropanax dispermus*, *Malva verticillata*, *Rorripa nasturtium aquaticum*, *Talinum cuneifolium*, *Tectaria coadunata*, and *Urtica dioica*. Some species such as *Fagopyrum esculentum*, *Amaranthus viridis*, *Chenopodium album*, were cultivated mainly for selling in the markets. The market price of leafy vegetables ranged from 20-40 rupees per one small bundle (about 400-500 g). It is found that one vegetable seller can earned up to Rs.100 per day, it means by marketing the vegetables could be contributed to income generation and poverty reduction of the local communities.

**Table 14:** Wild vegetables with comparison of Smith's salience index (SI) in Bankaria, Newar and Tamang ethnic groups.

Species name	Bankaria		Species name	Newar		Species name	Tamang	
	Frequency	SI		Frequency	SI		Frequency	SI
<i>Diplazium esculentum</i>	28	0.704	<i>Diplazium esculentum</i>	61	0.653	<i>Diplazium esculentum</i>	44	0.481
<i>Tectaria coduanata</i>	20	0.403	<i>Bauhinia variegata</i>	55	0.634	<i>Bauhinia variegata</i>	32	0.46
<i>Dioscorea hamiltonii</i>	18	0.425	<i>Dendrocalamus hamiltonii</i>	46	0.421	<i>Dryopteris cochleata</i>	29	0.189
<i>Dioscorea hispida</i>	17	0.438	<i>Dryopteris cochleata</i>	45	0.404	<i>Tectaria coduanata</i>	24	0.14
<i>Dioscorea kaemooensis</i>	17	0.426	<i>Chenopodium album</i>	33	0.288	<i>Dendrocalamus hamiltonii</i>	23	0.247
<i>Amaranthus lividus</i>	13	0.259	<i>Urtica dioica</i>	32	0.14	<i>Bambusa tulda</i>	21	0.291
<i>Bambusa tulda</i>	12	0.271	<i>Macropanax dispermus</i>	30	0.199	<i>Urtica dioica</i>	20	0.12
<i>Dioscorea pentaphylla</i>	10	0.2	<i>Bombax ceiba</i>	21	0.202	<i>Phytolacca acinosa</i>	18	0.163
<i>Bauhinia vahlii</i>	10	0.104	<i>Aconogonum molle</i>	19	0.218	<i>Amaranthus lividus</i>	16	0.127
<i>Dryopteris cochleata</i>	8	0.166	<i>Ecliptia prostrata</i>	16	0.117	<i>Chenopodium album</i>	16	0.187

**Table 15:** Preference ranking (Martin, 1995) of wild vegetables in 5 study sites (Aghor, Chitlang, Churiamai, Handikhola, Hetauda), Makawanpur district.

Plant species	Respondents										Total score	Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10		
<i>Diplazium esculentum</i>	5	5	4	4	4	5	5	5	5	4	46	1st
<i>Bauhinia variegata</i>	3	5	3	5	4	5	4	4	5	5	43	2nd
<i>Dendrocalamus hamiltonii</i>	5	5	4	2	5	1	4	3	5	5	39	3rd
<i>Malva verticillata</i>	1	3	1	3	5	4	5	5	5	5	37	4th
<i>Dryopteris cochleata</i>	4	3	3	3	2	4	5	5	4	3	36	5th
<i>Aconogonum molle</i>	5	2	1	5	2	4	3	4	5	4	35	6th
<i>Dioscorea hamiltonii</i>	5	5	3	1	4	3	2	4	5	3	35	6th
<i>Phytolacca acinosa</i>	3	2	3	5	4	5	3	2	4	3	34	7th
<i>Macropanax dispernum</i>	5	4	3	5	3	1	3	2	4	4	34	7th
<i>Chenopodium album</i>	4	3	3	4	3	3	3	4	3	3	33	8th
<i>Artocarpus heterophyllus</i>	1	2	5	4	3	4	5	2	3	4	33	8th
<i>Tectaria coadunata</i>	5	5	1	2	3	4	4	2	3	4	33	8th
<i>Ipomoea aquatica</i>	2	3	2	4	4	2	4	3	3	4	31	9th
<i>Bambusa tulda</i>	2	1	5	3	1	3	3	2	5	4	29	10th
<i>Urtica dioica</i>	2	4	2	2	3	5	4	2	2	3	29	10th
<i>Moringa oleifera</i>	1	1	3	2	4	3	3	5	5	2	29	10th
<i>Amaranthus lividus</i>	2	1	4	1	3	4	4	1	2	3	25	12nd
<i>Rorripa naturtium aquaticum</i>	4	2	3	2	2	3	3	2	1	1	23	13rd
<i>Amaranthus viridis</i>	3	3	2	3	2	3	2	2	2	1	23	13rd
<i>Talinum cuneifolium</i>	1	1	1	2	1	2	2	4	2	1	17	14th

Source: Field survey 2010

### Preference ranking

The results of preference ranking exercises are shown in Table 15. *Diplazium esculentum* ranked first with 46 scores, whereas *Bauhinia variegata* 2<sup>nd</sup> with 43 scores and *Dendrocalamus hamiltonii* 3<sup>rd</sup> with 39 scores based on high market potential and consumption.

### Priority setting approach for domestication

An approach for identifying priority wild vegetable species for domestication was used to calculate a 'priority index'. A total of 20 species with high preference ranking were used to calculate the priority index. Among them, the following species with high priority index were already domesticated and they are not ranked in the list. The species were *Ipomoea aquatica*, *Rorripa nasturtium aquaticum*, *Moringa oleifera*, *Fagopyrum esculentum*, *Asparagus racemosus*, *Solanum nigrum*, *Amaranthus lividus*, *Amaranthus viridis* and *Chenopodium album*. The remaining species were ranked for future domestication programs. Out of them *Bauhinia variegata*, *Dendrocalamus hamiltonii*, *Bambusa tulda*, *Diplazium esculentum*, *Dryopteris cochleata* and *Tectaria coadunata* have the highest priorities (Table 16).

**Table 16:** Characteristics of the 20 most important potential priority wild vegetable species for domestication in Makawanpur district, Central Nepal, and their rankings after calculating the priority index and excluding species already domesticated elsewhere.

Species name	Priority for taste(3=high)	Priority for sale (3=high)	Found in HGs (1=yes)	Ethnic groups (no.)	Altitude zones(no.)	Avail. Oct-Feb.(1=yes)	Vulnerable or endan-gered (1=yes)	Eaten by children+adults (1=yes)	Value adding /storage(1=yes)	Priority index	Domesti-cated else-where (x=yes)	Rank for domesti-cation
<i>Bauhinia variegata</i>	3	3	1	3	3	0	1	1	1	16		1
<i>Dendrocalamus hamiltonii</i>	3	3	1	3	3	0	NA	1	1	15		2
<i>Bambusa tulda</i>	3	3	1	3	3	0	0	1	0	14	x	3
<i>Diplazium esculentum</i>	3	3	0	3	3	0	1	1	0	14		3
<i>Dryopteris cochleata</i>	3	3	0	3	3	0	1	1	0	14		3
<i>Tectaria coadunata</i>	3	3	0	3	3	0	1	1	0	14		3
<i>Urtica dioica</i>	3	3	0	3	3	0	1	0	0	13		3
<i>Amaranthus lividus</i>	2	3	0	3	3	0	0	1	0	12	x	NA
<i>Amaranthus viridis</i>	3	2	0	3	3	0	0	1	0	12	x	NA

**Table 16: (Continued)**

<i>Macropanax dispermus</i>	3	3	0	2	3	0	0	1	0	<b>12</b>		<b>4</b>
<i>Moringa oleifera</i>	3	3	1	2	1	0	1	1	0	<b>12</b>	x	<b>NA</b>
<i>Dioscorea hamiltonii</i>	2	2	0	3	3	1	0	0	0	<b>11</b>		<b>5</b>
<i>Chenopodium album</i>	3	3	0	1	3	0	0	1	0	<b>11</b>	x	<b>NA</b>
<i>Ipomoea aquatica</i>	3	3	0	3	1	0	0	1	0	<b>11</b>	x	<b>NA</b>
<i>Malva verticillata</i>	3	3	0	2	1	0	1	1	0	<b>11</b>	x	<b>NA</b>
<i>Rorripa nasturtium aquaticum</i>	3	3	0	3	2	0	0	0	0	<b>11</b>	x	<b>NA</b>
<i>Artocarpus heterophyllus</i>	3	3	1	2	1	0	0	1	0	<b>11</b>	x	<b>NA</b>
<i>Aconogonum molle</i>	1	2	0	3	3	0	0	1	0	<b>10</b>		<b>6</b>
<i>Phytolacca acinosa</i>	1	1	0	2	2	0	0	0	0	<b>6</b>		<b>7</b>
<i>Talinum cuneifolium</i>	1	1	0	2	1	0	0	0	0	<b>5</b>		

Source: Field survey 2010

### 3.2.4.1b Wild fruits and nuts

#### Diversity and use of fruit and nut species

In total, 65 fruit and nut species belonging to 33 families and 50 genera were recorded. The scientific names, plant families, life forms, local names, fruiting time, value addition and market available were listed in Table 17.

The species were also recorded on altitudinal basis (Figure 30). The lowland houses 32 species, among them 4 species were common with midland and 7 species with highland. Similarly, the midland houses 33 species, among them 4 species shared with lowland, whereas the highland zone did not shared a single species with the lowlands and 7 species shared in all three altitudinal zones.

**Table 17:** List of fruits and nuts reported from Makawanpur district, Central Nepal (Note: Nepali =Nep; Newar=Ne, Bankaria=Ba, Tamang=Ta).

S.N.	Scientific name	Local names	Lifeform	Market available	Value addition	Ethnic groups
1	<i>Aegle marmelos</i>	Bel (Nep), Bya (Ne)	Tree	Yes	Juice	Ba, Ne, Ta
2	<i>Ampelocissus divaricata</i>	Pureni	Climber	No	No	Ba, Ta
3	<i>Antidesma acidum</i>	Archal (Nep), Sipringkyumba (Ta)	Tree	No	No	Ba, Ta
4	<i>Artocarpus heterophyllus</i>	Katahar (Nep), Fansi (Ne)	Tree	Yes	No	Ba, Ne
5	<i>Berberis aristata</i>	Chutro (Nep), Chhurasin (Ne)	Shrub	No	No	Ne, Ta
6	<i>Berberis asiatica</i>	Chutro (Nep), Nyakpusi, Chhurasin (Ne)	Shrub	No	No	Ne, Ta
7	<i>Buchanania latifolia</i>	Piyari (Nep)	Tree	No	No	Ta
8	<i>Callicarpa macrophylla</i>	Goldar (Nep)	Shrub	No	No	Ne
9	<i>Careya arborea</i>	Kumbhi (Nep)	Tree	No	No	Ta
10	<i>Castanopsis indica</i>	Katus (Nep), Singalise, Syanguli, Makusingare, Singalise (Ne), Singaro (Ta)	Tree	Yes	No	Ba, Ne, Ta
11	<i>Castanopsis tribuloides</i>	Musurekatus (Nep), Chasin (Ne)	Tree	No	No	Ne, Ta
12	<i>Celtis australis</i>	Khari (Nep), Dhisin, Kusin (Ne)	Tree	No	No	Ne
13	<i>Choerospondias axillaris</i>	Lapsi (Nep), Amlī, Amri (Ne)	Tree	Yes	Dried pulp, pickle	Ne, Ta
14	<i>Cissus javana</i>	Jangali angur, Purani (Nep)	Climber	No	No	Ba
15	<i>Cleistocalyx operculatus</i>	Kyamuna (Ba, Ta)	Tree	No	No	Ba, Ne, Ta
16	<i>Coriaria nalaensis</i>	Machhaino (Nep.), Hakufakusi, Khyapasi, Khabasi (Ne)	Shrub	No	No	Ne, Ta

**Table 17: (Continued)**

S.N.	Scientific name	Local names	Lifeform	Market available	Value addition	Ethnic groups
17	<i>Diploknema butyracea</i>	Chyuri (Nep), Lhusi (Ne), Singamar(Ta)	Tree	Yes	Churioil	Ba, Ne, Ta
18	<i>Potentilla indica</i>	Bhuikafal (Nep), Bwakapasi, Dyapasi (Ne)	Trailing herb	No	No	Ne, Ta
19	<i>Elaeagnus infundibularis</i>	Guyenli (Nep), Chhulansi, Musaler, Maltasin (Ne)	Shrub	No	No	Ne, Ta
20	<i>Elaeagnus parviflora</i>	Madilo (Nep)	Shrub	No	No	Ne, Ta
21	<i>Ficus racemosa</i>	Dumri (Nep), Durgalisin, Pyarasin (Ne)	Tree	No	No	Ba, Ne
22	<i>Ficus sarmentosa</i>	Pakhure (Nep), Durukusin (Ne)	Climber	No	No	Ne
23	<i>Ficus oligodon</i>	Nimaro (Nep), Mako (Ta)	Tree	No	No	Ba, Ta
24	<i>Fragaria nubicola</i>	Bhuiainselu (Nep)	Trailing herb	No	No	Ne
25	<i>Gaultheria fragrantissima</i>	Dhansingare (Nep), Charasin (Ne)	Shrub	No	No	Ne, Ta
26	<i>Gaultheria nummularioides</i>	Ratigedi (Nep)	Shrub	No	No	Ta
27	<i>Grewia optiva</i>	Jalme (Nep)	Tree	No	No	Ba, Ta
28	<i>Holboellia latifolia</i>	Gufala (Nep.), Bunsu, Bhosin, Bhause, Gulpakuse (Ne)	Climber	No	No	Ne
29	<i>Juglans regia</i> var. <i>kamaonia</i> .	Okhar (Nep), Khosi, Khwase, Khawasyuka (Ne)	Tree	Yes	Juglans oil	Ne, Ta
30	<i>Leea asiatica</i>	Galeni (Nep)	Shrub	No	No	Ba, Ta
31	<i>Maclura cochichinensis</i>	Dimar (Nep), Lupasi, Rupasi, Lapasi (Ne)	Scrambling shrub	No	No	Ne
32	<i>Mahonia napaulensis</i>	Jamanemandro (Nep), Jantarmentar, Mikapusi, , Markapasi, Mitasi (Ne)	Shrub	No	No	Ne, Ta

**Table 17: (Continued)**

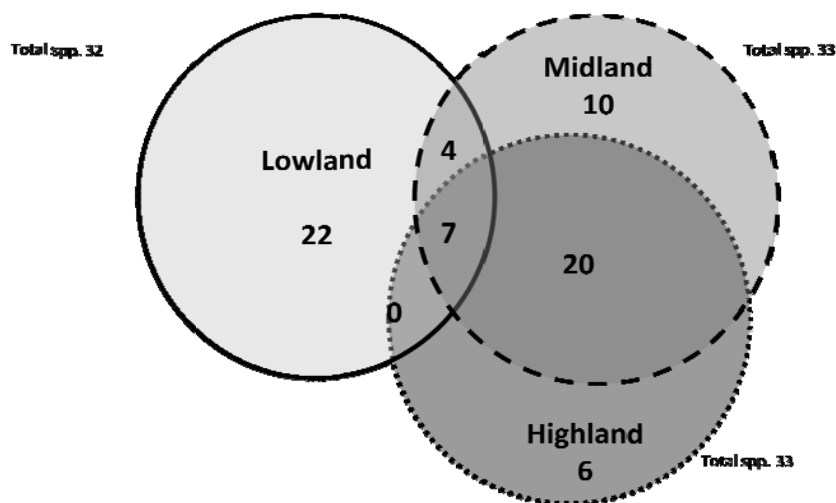
S.N.	Scientific name	Local names	Lifeform	Market available	Value addition	Ethnic groups
33	<i>Melastoma malabathricum</i>	Angeri (Nep)	Herb	No	No	Ta
34	<i>Morrus serrata</i>	Kimbu (Nep), Sasipasi (Ne)	Tree	No	No	Ne, Ta
35	<i>Myrica esculenta</i>	Kafal (Nep), Kabasi (Ne), Kharpassi (Ta)	Tree	Yes	No	Ba, Ne, Ta
36	<i>Myrsine capitellata</i>	Baklepatfal (Nep)	Tree	No	No	Ta
37	<i>Ophiopogon intermedius</i>	Bansupari (Nep)	Herb	No	No	Ta
38	<i>Oxyspora paniculata</i>	Angeri (Nep)	Herb	No	No	Ne, Ta
39	<i>Phoenix loureiroi</i>	Thakal, Khajurki (Nep)	Shrub	No	No	Ba, Ta
40	<i>Phyllanthus emblica</i>	Amla (Nep), Ambae, Amba (Ne)	Tree	Yes	Dried fruit, Pickle	Ba, Ne, Ta
41	<i>Prunus cerasoides</i>	Painyu (Nep), Fasipa (Ne)	Tree	No	No	Ne, Ta
42	<i>Pyracantha crenulata</i>	Ghangharu (Nep), Jyosi (Ne)	Shrub	No	No	Ne, Ta
43	<i>Pyrus pashia</i>	Mayal (Nep), Hakupasi, Daupasi (Ne)	Tree	Yes	No	Ne, Ta
44	<i>Rhus chinensis</i>	Bhakiamilo (Nep), Chhasin, Supasi, Subase (Ne)	Tree	No	No	Ne
45	<i>Ribes himalense</i>		Shrub	No	No	Ta
46	<i>Rubus acuminatus</i>	Ratoainselu (Nep), Kansipa (Ne)	Scandent shrub	No	No	Ne, Ta
47	<i>Rubus ellipticus</i>	Ainselu (Nep), Ersi, Yansin (Ne), Polung (Ta)	Shrub	Yes	No	Ba, Ne, Ta
48	<i>Rubus fockeanus</i>	Jangali ainselu, Kaloainselu (Nep), Kaikalase (Ne)	Shrub	No	No	Ta
49	<i>Rubus niveus</i>	Gwayansi (Ne)	Shrub	No	No	Ne, Ta
50	<i>Rubus paniculatus</i>	Kandaainselu, Setoainselu (Nep), Ketafasin, Kapasi (Ne)	Scrambling shrub	No	No	Ne, Ta



**Table 17: (Continued)**

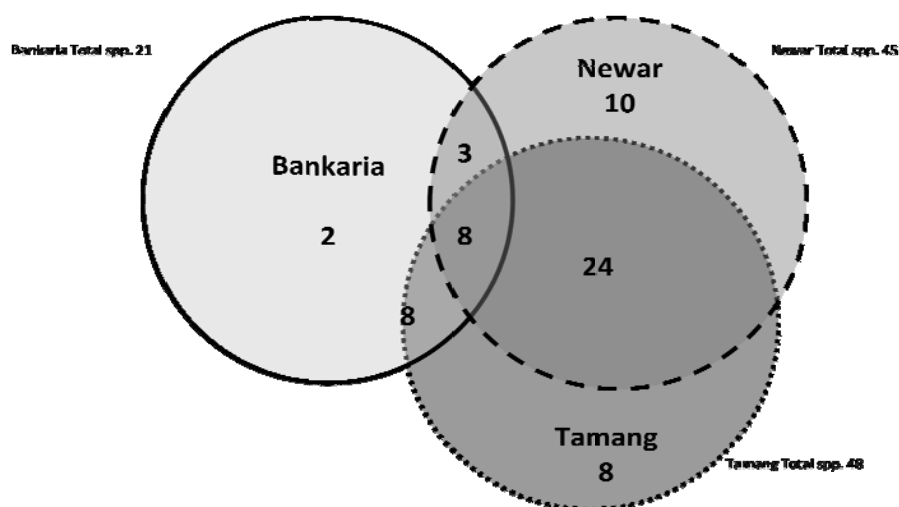
S.N.	Scientific name	Local names	Lifeform	Market available	Value addition	Ethnic groups
51	<i>Rubus penduculosus</i>	NA	Scrambling shrub	No	No	Ta
52	<i>Rubus reticulatus</i>	Ratoainselu	Scrambling shrub	No	No	Ne, Ta
53	<i>Saurauia napaulensis</i>	Gogan (Nep), Bajalapte (Ne)	Tree	No	No	Ne
54	<i>Schleichera oleosa</i>	Kusumfal (Nep)	Tree	Yes	No	Ba
55	<i>Scurrula parasitica</i>	Ainjeru(Nep), Yar asin (Ne)	Epiphyte shrub	No	No	Ne, Ta
56	<i>Semecarpus anacardium</i>	Bhalayo, Amaro (Nep)	Tree	No	No	Ba, Ta
57	<i>Solena amplexicaulis</i>	Golkankri (Nep), Talasi Guntusi, Kothuse (Ne)	Climber	N	No	Ba, Ne, Ta
58	<i>Syzygium cumini</i>	Jamun (Nep)	Tree	Yes	No	Ba, Ne, Ta
59	<i>Tamarindus indica</i>	Imali (Nep), Titipaun (Ne)	Tree	Yes	Yes	Ne
60	<i>Terminalia bellirica</i>	Barro (Nep), Bala (Ne)	Tree	Yes	No	Ne, Ta
61	<i>Viburnum cylindricum</i>	Palamin (Nep)	Shrub	No	No	Ne
62	<i>Viburnum mullaha</i>	Mahelo (Nep), Yansi, Chhwasin (Ne)	Shrub	No	No	Ne, Ta
63	<i>Ziziphus incurva</i>	Hadebayer (Nep), Kukusin, Hargulase, Harbir (Ne)	Tree	No	No	Ne
64	<i>Ziziphus mauritiana</i>	Bayer (Nep)	Tree	Yes	Yes	Ne, Ta
65	<i>Ziziphus rugosa</i>	Asarefal (Nep)	Shrub	No	No	Ta

Source: Field survey 2010



**Figure 30:** Number of fruit species reported from different altitudinal zones of Makawanpur district, Central Nepal.

The three ethnic groups (Bankaria, Newar, and Tamang) have used different number of wild fruits (Figure 31). The highest number of wild fruits was eaten by the Tamang ethnic group (48 spp.) and Newar (45 spp.), and the lowest by the Bankaria ethnic group (21 spp.).

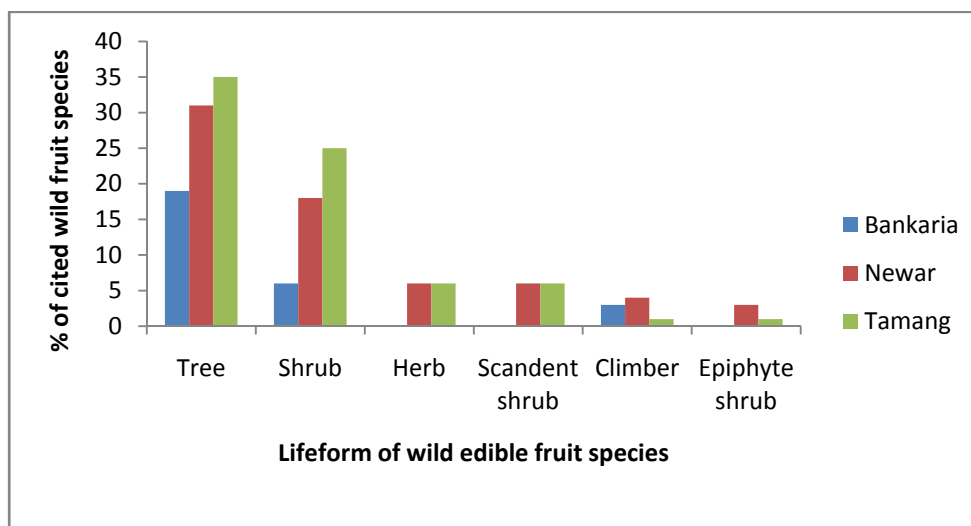


**Figure 31:** Wild fruits used by three ethnic groups.

Species similarity was different among the three ethnic groups. In the Newar ethnic group it was reported 10 species, whereas in Bankaria and Tamang had reported two and eight wild fruit species respectively. The Newar and Tamang communities shared 24 fruit species, whereas Bankaria and Newar shared 3 species. Similarly Bankaria and Tamang shared eight species. There were 8 wild fruit species common in all three ethnic groups.

## Life forms

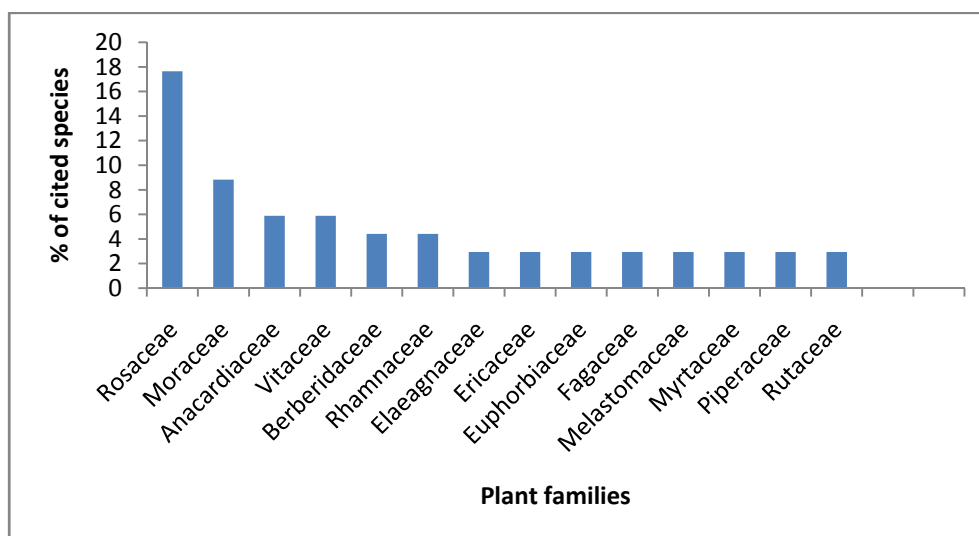
Out of the 65 wild fruit and nut species, 30 species were tree, 25 species shrub, 4 species herb and scandent shrub, 4 species climber and one species were epiphyte shrub. The highest numbers of species used by all ethnic groups were trees. The highest number of wild fruit species consumed by Tamang (24%), followed by Newar (21%) and Bankaria (13%) (Figure 32).



**Figure 32:** Life forms of wild edible fruit and nut species consumed by Bankaria, Newar and Tamang ethnic groups.

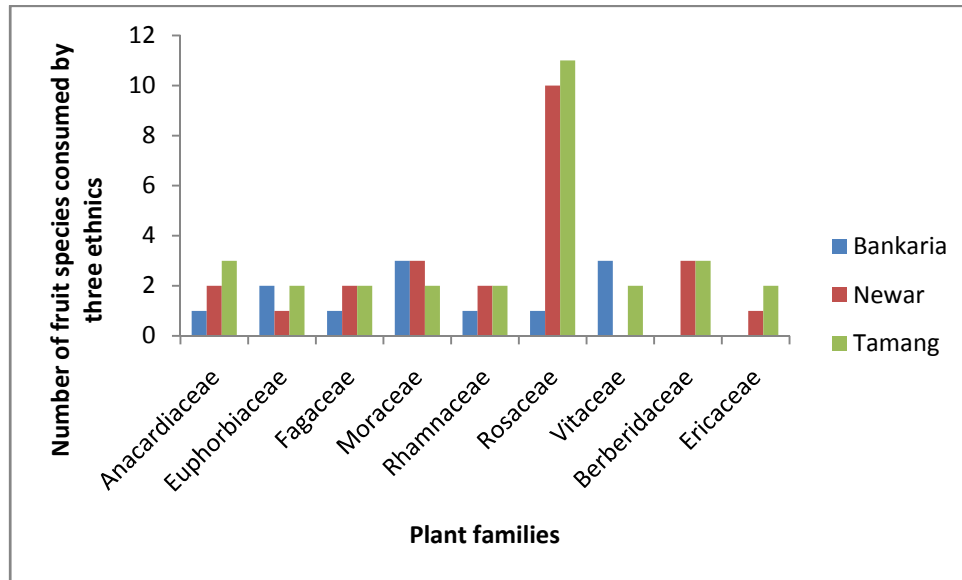
## Plant families

Majority of wild fruits and nuts species belonged to Rosaceae with 12 species (18%), followed by Moraceae 6 species (9%), Anacardiaceae and Vitaceae 4 species (6%) each, Berberidaceae and Rhamnaceae 3 species (4%) each (Figure 33).



**Figure 33:** Major plant families with the percentage of species consumed as wild fruits and nuts.

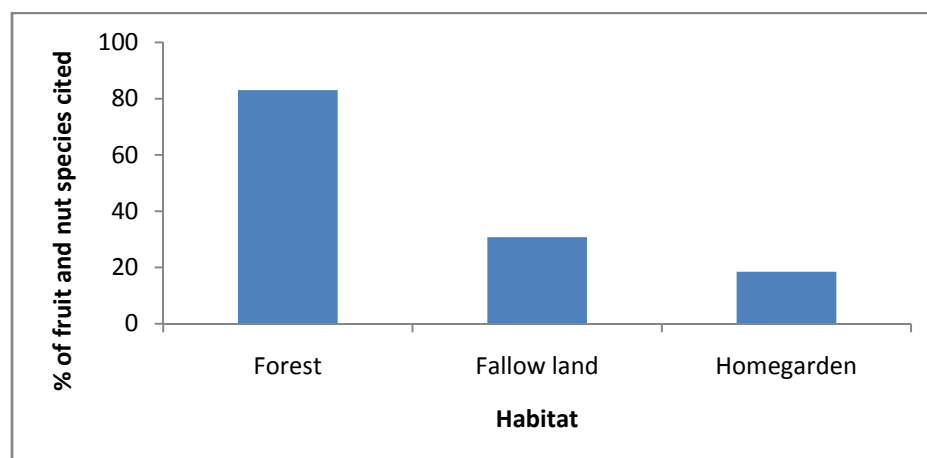
Bankaria community used major wild fruits belonging to Moraceae and Vitaceae (3 spp. each). Whereas in Newar ethnic group the species of fruits consumed from Rosaceae (10 spp.), Moraceae and Berberidaceae (3 spp. each). Similarly, Tamang community also used from Rosaceae (11 spp.), Anacardiaceae and Berberidaceae (3 spp. each) (Figure 34).



**Figure 34:** Top families consumed by three ethnic groups.

### Habitat

Out of the 65 fruit and nut species, 54 (83%) species were reported from forests, 20 species (31%) from fallow lands and 12 species (18 %) such as *Aegle marmelos*, *Artocarpus heterophyllus*, *Choerospondias axillaris*, *Juglans regia* var. *kamaonia*, *Morus serrata*, *Phyllanthus emblica*, *Pyrus pashia*, *Syzygium cumini*,

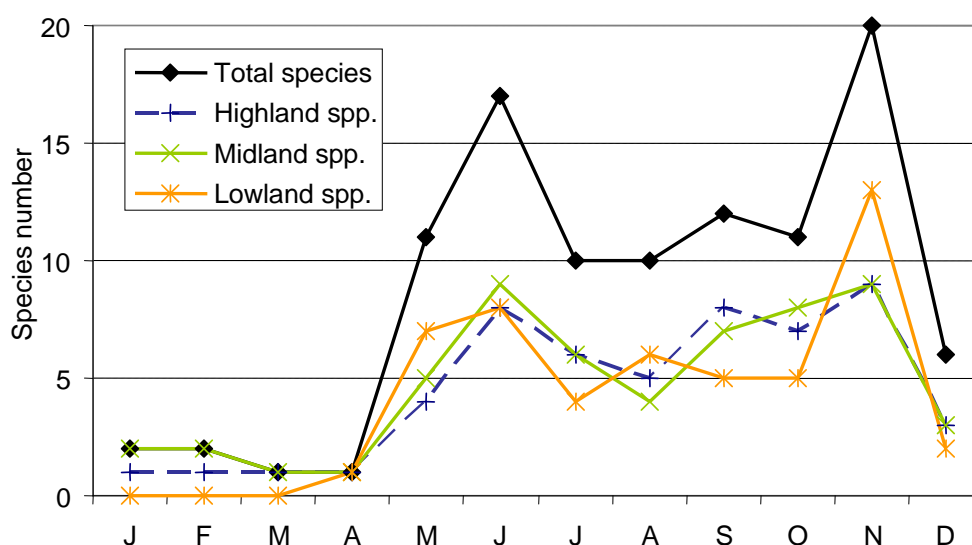


**Figure 35:** Fruit and nut species found in various habitats.

*Tamarindus indica*, *Ziziphus mauritiana* etc. were common in homegardens (Figure 35).

### Seasonal availability

Availability of fruit and nut species varied in seasons of the year. Respondents mentioned only few species (1-2 species) to be harvested in the months January to April leading to very low fruit consumption during winter time. During the months of May to November 10-20 species of fruits collected (with the peak in November), whereas in December only six species were collected (Figure 36). The availability was differences among the altitude zones. In the lowlands, no species were collected during the months January to March, but many species were collected in the months of May to June, in November in the midlands and highlands. The peak months were June, and September to November in all zones. A few two species were available even during the winter time from January to March (Figure 35).



**Figure 36:** Seasonal availability of fruit and nut species in different altitudinal zones of the Makawanpur district.

### Consumption of fruit species

A few fruit species such as *Phyllanthus emblica*, *Tamarindus indica* and *Ziziphus mauritiana* etc. species were consumed fresh. They also preserved in dry form for home consumption and sale. Fruits of *Choerospondias axillaris* and *Aegle marmelos* were also processed to prepare candies, juice, jam and fruit powder for income generation.

## Cultural importance

Table 18 showed the most commonly used wild fruits and nuts by three ethnic groups. In Bankaria ethnic group, most of respondents consumed *Phoenix loureiroi*, *Cleistocalyx operculatus*, *Syzygium cumini* whereas in Newar and Tamang community, the frequently consumed wild fruits and nuts were *Rubus ellipticus*, *Myrica esculenta*.

**Table 18:** RFC (Relative frequency of citation) in Bankaria, Newar and Tamang ethnic group.

Species name	RFC Bankaria	Species name	RFC Newar	Species name	RFC Tamang
<i>Phoenix loureiroi</i>	0.83	<i>Rubus ellipticus</i>	0.69	<i>Rubus ellipticus</i>	0.77
<i>Cleistocalyx operculatus</i>	0.66	<i>Myrica esculenta</i>	0.67	<i>Myrica esculenta</i>	0.58
<i>Syzygium cumini</i>	0.66	<i>Phyllanthus emblica</i>	0.39	<i>Phoenix loureiroi</i>	0.51
<i>Rubus ellipticus</i>	0.62	<i>Pyrus pashia</i>	0.39	<i>Juglans regia</i> var. <i>kamaonia</i>	0.21
<i>Semecarpus anacardium</i>	0.48	<i>Maclura cochichinensis</i>	0.36	<i>Berberis asiatica</i>	0.19
<i>Diploknema butyracea</i>	0.31	<i>Mahonia napaulensis</i>	0.33	<i>Phyllanthus emblica</i>	0.19
<i>Schleichera oleosa</i>	0.31	<i>Cleistocalyx operculatus</i>	0.28	<i>Choerospondias axillaris</i>	0.16
<i>Phyllanthus emblica</i>	0.21	<i>Berberis aristata</i>	0.22	<i>Castanopsis indica</i>	0.14
<i>Cissus javana</i>	0.17	<i>Elaeagnus infundibularis</i>	0.22	<i>Cleistocalyx operculatus</i>	0.14
<i>Ficus racemosa</i>	0.17	<i>Rhus chinensis</i>	0.19	<i>Castanopsis tribuloides</i>	0.12

## Species saliency

A salient species is one with high frequency mentioned by respondents, appearing early in their species listing and corresponding to a higher Smith's salience scores to reflect the familiarity level of the species in the community. In Bankaria and Newar ethnic groups *Myrica esculenta* was the most salience fruit, whereas in Tamang ethnic group, *Rubus ellipticus* showed the first rank, i.e. most of the Tamang local people consumed *Rubus ellipticus*. The correlation between high frequency of these species

signifies that they are the most significant to the ethnic groups. Hence, the species *Leea aspera*, *Castanopsis* in Bankaria ethnic group, *Terminalia bellirica* in Newar and *Ziziphus rugosa* in Tamang ethnic group with less respondents frequency suggesting that they are less significant to respondents.

**Table 19:** Wild fruits with comparison of Smith's salience index in Bankaria, Newar and Tamang ethnic groups.

Bankaria		Newar		Tamang	
Species name	Smith's S	Species name	Smith's S	Species name	Smith's S
<i>Myrica esculenta</i>	0.82	<i>Myrica esculenta</i>	0.89	<i>Rubus ellipticus</i>	0.67
<i>Syzygium cumini</i>	0.57	<i>Rubus ellipticus</i>	0.54	<i>Myrica esculenta</i>	0.39
<i>Cleistocalyx operculatus</i>	0.54	<i>Elaeagnus infundibularis</i>	0.18	<i>Cleistocalyx operculatus</i>	0.28
<i>Rubus ellipticus</i>	0.65	<i>Berberis aristata</i>	0.15	<i>Syzygium cumini</i>	0.25
<i>Aegle marmelos</i>	0.27	<i>Pyrus pashia</i>	0.12	<i>Berberis asiatica</i>	0.16
<i>Semecarpus anacardium</i>	0.08	<i>Choerospondias axillaris</i>	0.09	<i>Phoenix loureiroi</i>	0.13
<i>Ziziphus mauritiana</i>	0.14	<i>Mahonia napaulensis</i>	0.08	<i>Diploknema butyracea</i>	0.13
<i>Diploknema butyracea</i>	0.13	<i>Maclura cochinchinensis</i>	0.10	<i>Phyllanthus emblica</i>	0.09
<i>Terminalia bellirica</i>	0.05	<i>Juglans regia</i>	0.07	<i>Aegle marmelos</i>	0.12
<i>Schleichera oleosa</i>	0.09	<i>Phyllanthus emblica</i>	0.07	<i>Berberis aristata</i>	0.06
<i>Phoenix loureiroi</i>	0.05	<i>Coriaria napalensis</i>	0.02	<i>Terminalia bellirica</i>	0.05
<i>Phyllanthus emblica</i>	0.07	<i>Castanopsis indica</i>	0.05	<i>Ziziphus mauritiana</i>	0.08
<i>Leea aspera</i>	0.02	<i>Rubus fockeanus</i>	0.01	<i>Castanopsis indica</i>	0.04
<i>Castanopsis indica</i>	0.02	<i>Terminalia bellirica</i>	0.01	<i>Ziziphus rugosa</i>	0.03

### Market availability

Wild fruits and nuts are often a significant means of income generating opportunity for the rural people because wild fruits production can be done with little capital investment and land. A total of 15 wild fruits and nuts species were sold in the nearby markets. Some fruits such as *Choerospondias axillaris*, *Tamarindus indica*, *Phyllanthus emblica*, *Ziziphus mauritiana* were sold in markets after preparing marmalades and dried pulp candy. Many indigenous wild fruits such as *Myrica esculenta*, *Aegle marmelos*, *Rubus ellipticus*, *Diploknema butyracea*, *Castanopsis indica*, *Phyllanthus emblica*, *Juglans regia* var. *kamaonia*, *Pyrus pashia* etc. were more expensive in local markets than the cultivated exotic species (Table 17).

### Preference ranking

Respondents in the preference ranking exercise were asked to cite the 12 most important wild fruits and nuts. The results of preference ranking exercises are shown in Table 18. For consumption and high potential trade and taste of wild fruits and nuts, *Myrica esculenta* ranked first, whereas *Rubus ellipticus* 2<sup>nd</sup>, *Aegle marmelos* 3<sup>rd</sup> rank.

**Table 20:** Preference ranking (Martin, 1995) of wild vegetables in 5 study sites (Aghor, Chitlang, Churiamai, Handikhola, Hetauda), Makawanpur district.

Plant species	Respondents											Total score	Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10			
<i>Myrica esculenta</i>	5	3	2	4	4	5	4	5	5	5		42	1st
<i>Rubus ellipticus</i>	5	5	5	2	2	4	2	5	5	3		38	2nd
<i>Aegle marmelos</i>	3	5	4	4	3	1	5	4	5	3		37	3rd
<i>Choerospondias axillaris</i>	5	5	4	5	1	2	2	4	4	3		35	4th
<i>Diploknema butyracea</i>	3	2	2	4	3	5	4	3	3	5		34	5th
<i>Ziziphus mauritiana</i>	3	2	5	4	3	4	4	4	3	1		33	6th
<i>Pyrus pashia</i>	3	5	1	3	4	3	2	3	4	5		33	6th
<i>Berberis aristata</i>	5	5	1	2	2	4	2	4	4	3		32	7th
<i>Phyllanthus emblica</i>	2	3	1	2	5	4	3	2	4	5		31	8th
<i>Syzygium cumini</i>	1	1	5	4	3	4	1	5	3	4		31	8th



**Table 20 : (Continued)**

Plant species	Respondents											Total score	Rank
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10			
<i>Castanopsis indica</i>	2	2	3	2	3	2	3	4	3	4	28	10th	
<i>Cleistocalyx operculatus</i>	0	0	5	3	3	3	2	4	4	3	27	11st	
<i>Morus serrata</i>	2	2	1	3	4	3	2	4	4	2	27	11st	
<i>Tamarindus indica</i>	0	0	2	2	4	3	4	3	2	4	24	12nd	
<i>Juglans regia</i> var. <i>kamaonia</i>	1	1	2	3	5	4	3	2	1	1	23	13th	
<i>Ziziphus rugosa</i>	0	0	4	5	1	2	2	3	4	1	22	14th	
<i>Elaeagnus infundibularis</i>	4	3	1	2	1	2	3	3	1	1	21	15th	
<i>Schleichera oleosa</i>	0	0	3	1	4	5	1	3	2	1	20	16th	
<i>Mahonia napaulensis</i>	3	2	2	1	3	1	1	1	1	2	17	17th	

Source: Field survey 2010

### Priority setting approach for domestication

Based on the interviews with respondents during field visits, 13 species were high ranked with regard to taste, eight species out of these 13 species were preferred by all three ethnic groups. Most of the respondents preferred the sweet or sweet-sour taste of fruits. These species were *Morus serrata*, *Rubus acuminatus* and *Ziziphus mauritiana*. Some species like *Aegle marmelos*, *Diploknema butyracea* and *Syzygium cumini* were cultivated in homegardens. The fruits of *Myrica esculenta*, *Rubus ellipticus*, *Terminalia bellirica* and *Ziziphus rugosa* were heavily collected from the forest, but they are classified as ‘vulnerable’ by the respondents. With regard to market value, 15 fruit and nut species were rated as high market potential. Nine of these species were rated as ranked with regard to their taste and 12 were cultivated in homegardens (Table 19). The highest market ranking species were *Castanopsis indica*, *Myrica esculenta*, *Terminalia bellirica* and *Terminalia chebula*. They were collected only from forests and classified as ‘vulnerable’ with regard to their decreasing abundance in the forest habitat.

The criteria for selection of species as a priority species for domestication were named as taste, market value, possibility of domestication in homegarden, availability and preference by all three ethnic groups, distribution in three altitudinal zones,

availability of fruits and nuts during the lean season from December to April, level of threats (i.e. vulnerable or endangered), fruits and nuts consumed by both children and adults and species' and value adding. By summing up each of the values, a "priority index was calculated (Table 19). For that 20 most preference species were selected. The species which are already domesticated in Nepal or other countries were not ranked. These species were *Choerospondias axillaris*, *Phyllanthus emblica*. From this priority approach, *Castanopsis indica*, *Juglans regia*, *Myrica esculenta*, *Schleichera oleosa* and *Rubus ellipticus* were identified the most priority species for domestication in Makawanpur district.

### **Other uses of wild edible plants in Makawanpur district**

#### **Snacks**

*Dendrobium longicornu* flower, *Nephrolepis auriculata* tuber, *Satyrium nepalense* tuber, and *Pleione praecox* are used as snacks.

#### **Pickles**

Fruits of some plants *Antidesma acidum*, *Choerospondias axillaris* ripe and unripe fruits, *Lindera neesiana* young fruit, *Rhus chinensis*, *Antidesma acidum* young leaves and fruits, *Bauhinia purpurea* flower and tender leaves, *Bauhinia variegata* flower, *Begonia picta* petiole, *Mentha spicata* leaves, *Oxalis corniculata* leaves are used to make pickles.

#### **Beverage**

Most of the plants used for making beverage are plants species belonging to family Asteraceae, Rosaceae and Lythraceae. Flowers of *Duhaldea cappa*, *Elephantopus scaber*, and *Pyracantha crenulata* fruits are used to make starter material for beverage, while flowers of *Woodfordia fruticosa* are used to make alcohol.

#### **Bread making**

*Persea duthiei* dried and fresh bark and leaves of *Pouzolzia zeylanica* flour are mixed with wheat flour to make bread which make bread soft and delicious.

## Spices/Juice

Some parts of plant species such as dried and fresh leaves of *Cinnamomum tamala*, dried fruits of *Piper longum*, fresh and dried fruits *Zanthoxylum armatum*, *Lindera neesiana* are used as spices in study area. Pulp of *Aegle marmelos*, petals of *Rhododendron arboreum* are used to prepare juice.

**Table 21:** Characteristics of potential priority fruit and nut species for domestication and their rankings after calculating the priority index and excluding species already domesticated elsewhere.

Species name	Priority for taste(3=high)	Priority for sale (3=high)	Found in HG (1=yes)	Ethnic groups collecting it(no.)	Altitude zones(no.)	Avail. Dec-Apr(1=yes)	Vulnerable or endangered (1=yes)	Eaten by children+adults (1=yes)	Value adding /storagepossible(1=yes)	Priority index	Domesticated elsewhere	Rank for domestication
<i>Aegle marmelos</i>	3	3	1	4	1		1	1	1	<b>14</b>	x	
<i>Artocarpus heterophyllus</i>	3	3	1	2	1			1		<b>11</b>	x	
<i>Castanopsis indica</i>	2	3		3	3		1	1		<b>13</b>		3
<i>Choerospondias axillaris</i>	2	3	1	3	2	1	1		1	<b>14</b>	x	
<i>Cleistocalyx operculatus</i>	3	0	1	4	1		1	1		<b>11</b>		5
<i>Diploknema butyracea</i>	3	3	1	3	1		1	1		<b>13</b>	x	
<i>Juglans regia</i> var. <i>kamaonia</i>	3	3	1	3	2			1	1	<b>14</b>		2
<i>Morus serrata</i>	3	0	1	1	1		1	1		<b>8</b>		
<i>Myrica esculenta</i>	3	3		3	2		1	1		<b>13</b>		3
<i>Phyllanthus emblica</i>	2	3	1	3	1	1	1		1	<b>13</b>	x	
<i>Rubus ellipticus</i>	3	3		3	3	1	1	1		<b>15</b>		1
<i>Syzygium cumini</i>	3	3	1	4	1		1	1		<b>14</b>	x	
<i>Tamarindus indica</i>	2	3	1	2	1			1	1	<b>11</b>	x	
<i>Schleichera oleosa</i>	3	3		4	1		1		1	<b>13</b>		3
<i>Elaeagnus infundibularis</i>	1	3		4	1		1		1	<b>11</b>		5
<i>Mahonia napaulensis</i>	1	3	1	3	2		1		1	<b>12</b>		4
<i>Ziziphus mauritiana</i>	3	3	1	2	1	1	1	1	1	<b>14</b>	x	
<i>Ziziphus rugosa</i>	3	0		1	1		1			<b>6</b>		7
<i>Pyrus pashia</i>	2	2	1	2	2	0	0	1	0	<b>10</b>		6
<i>Berberis aristata</i>	1	0	0	2	2	0	0	1	0	<b>6</b>		7

Source: Field survey 2010 (Note: x=already domesticated species.)

### 3.2.4.2 DISCUSSION

All ethnobotanical studies cited above were carried out among three ethnic groups Bankaria, Newar and Tamang. A total of 97 wild vegetables were recorded from Makawanpur district. Compared to the inventory results of Manandhar (2002), Bhattarai *et al.* (2009), 2 species *Talinum cuneifolium* and *Tragopogon gracilis* were cited for the first time as wild vegetable in this study area. The present study is able to make the largest documentation of Nepalese wild edible vegetables so far that of other work of Bhattarai *et al.* (2009), who reported 14 wild vegetable species collected from the Gurung communities in Manang district, Central Nepal. Possible reasons for that low number of wild vegetables are found in the high altitude in Manang (above 3000 m asl.) and the rather low diversity of the natural vegetation in that region, which is dominated by grasslands. Similarly, 36 wild vegetable species were recorded by Uptery *et al.* (2012) from Makawanpur, Tanahun, Dang, Bardiya and Kailali district of Nepal. It also found the highest diversity of wild edible plants in Makawanpur district, which may be due to the fact that the Bankaria ethnic group lives close to forests of Makawanpur district and depends more on wild plant resources while other ethnic groups are less dependable on wild edible plants.

The three altitude zones surveyed (lowland, midland and highland) differed in their total richness of wild vegetable species. The highest number of species was identified in the lowlands (66 spp.) and the lowest in the highlands (35 spp.). It is probable that more species would have been recorded for the highlands and midlands if more respondents had been interviewed. Most probably in the lowlands more wild vegetable species occur than in the higher altitudes. This result was similar with that of Sundriyal and Sundriyal (2004), who also reported that a higher diversity of wild edible plants from low to intermediate altitudes (<2000 m) as compared to higher altitudes (>2000 m).

With respect to indigenous knowledge on wild vegetable uses, Bankaria ethnic groups can be considered as quite interesting. They know far more wild edible plants (59 spp.) than Tamang (56 spp.) and Newar (44 spp.). This showed that they both have longer experiences with the use of forest resources in comparison to Newars. This may be due to Newars live urban area and mostly consume plants from market.

In the lowlands, as many as 22 fruits and nut species were reported, but midlands and the highlands had low number of fruits. Similar results were also observed by Chen *et al.* (1999) in Dai ethnic living in lower elevation consume less fruits than Hani ethnic living in mountainous region. *Myrica esculenta* (0.578), *Diplazium esculentum* (0.572), *Rubus ellipticus*. (0.45), *Bauhinia variegata* (0.379), and *Syzygium cumini* (0.263) are salient species in Makawanpur district. Uprety *et al.* (2012) also mentioned that *Asparagus racemosus* and *Diplazium esculentum* are important species of vegetables. The result of the present study showed that the three ethnic groups had different knowledge of wild edible plants. This may be due to differences in availability of plants in study area or might be due to differences of cultural preference. In the study area, most of the salient species have wide distribution and are easily accessible. Saliency of species helps to understand how the cultural domain is perceived across a group of people. Hence, the species such as *Myrica esculenta*, *Diplazium esculentum*, *Rubus ellipticus* can be regarded as the most significant species to respondents. In contrast, less respondents frequency suggesting that they are less significant to respondents. Pardo-de-Santayana *et al.* (2007) compared the wild edible plants knowledge in Iberian Peninsula and concluded that the patterns of wild edible plant usage depend on socio-cultural factors rather than biological factors such as diversity of wild edible plants, flora and climate. However, Ghorbani *et al.* (2012) explained that this might be the cultural preference of ethnic group for use of wild edible plants in Dai, Hani ethnic groups in Naban River Watershed national Nature Reserve, Yunnan, SW China. Different ethnic groups in southern Yunnan consume wild fruits differently from each other due to difference accessibility Chen *et al.* (1999). Termote *et al.* (2011) found that the use and knowledge of wild edible plants is culturally with high diversity between ethnic groups in Tshopo district of Congo.

## CHAPTER 4

### 4. CONSERVATION STATUS OF USEFUL PLANTS

#### 4.1 INTRODUCTION

The useful plant resources are necessary for the livelihood for nutrition, health care and income generation. These plants resources are harvested from different region of Nepal. Market demand and unsustainable collection of non-timber forest products in most part of world has led to erosion of the availability in natural condition. In Nepal, about 20% of the medicinal and aromatic plants have market potential (Edwards, 1996). The non-timber forest products, mainly medicinal and aromatic plants are gathered for trade in most part of the Nepal Himalaya (Ghimire, 2008). Non-timber forest products are harvested from wild for trade (Aumeeruddy-Thomas & Karki, 2005). Mostly traded plants are harvested from forest and greatly threatened by commercial collection and habitat destruction (Shrestha & Joshi, 1996); lack of conservation awareness and over exploitation (Malla *et al.*, 1995; Edwards, 1996; Subedi 1997; Chaudhary 1998; Ghimire *et al.* 2001, 2004, 2005). There is no threat status of non-timber forest products in Nepal. But Shrestha and Joshi (1996) assessed threat status of Nepalese flora. CAMP (2001) assessed threat status of medicinal plants based on IUCN threat categories. On the basis of these work on threat status of Nepalese plants, a total of 138 native vascular plants taxa are threatened in Nepal (Ghimire, 2008). Biodiversity is the process of being lost (Balmford *et al.*, 2003; Jenkins *et al.*, 2003), and are increasing threats in the world (Pimm *et al.*, 1995). Nowadays, climate change is one of the major issues in threatening of biodiversity in global context (Sommer *et al.*, 2010). Habitat loss and invasive alien species are also another cause of threatening the plant diversity (Hilton-Taylor *et al.*, 2009). The IUCN Red List system for categorizing extinction risk to species (IUCN, 2001) is widely used and is the most comprehensive quantitative method for determining threat on a global scale (Rodrigues *et al.*, 2006). Plant conservation for Target 2 of the Global Strategy is preliminary assessment of the conservation status of all known plant species, at national, regional and international levels (UNEP, 2002). Since the "Earth Summit" in Rio de Janeiro in 1992, the loss of biodiversity is a global target (Baillie *et al.*, 2008). The national and international biodiversity conservation

organizations developed several strategies for the estimation of the conservation status of species. In certain parts of the world, conservation of natural resources is part of the traditions of the local communities living in that area e.g. the tribal communities in Gwangxi Karst Region of China (Li & Su, 1995), in Mayamba district of Sierra Leone (Lebbie & Raymond, 1995). Southeast Asia is considered a biodiversity hotspot because it harbours high number of endemic species that are threatened by the loss of greater than 70% of original habitats (Myers *et al.*, 2000). Southeast Asia is highlighted as an area where past and present human driven land use changes are expected to cause extinctions across a wide range of taxa (Lee & Jetz, 2008) and has the highest proportion of threatened species across all taxonomic (IUCN, 2006). Makawanpur district is habitat of larger number of plant species and unsustainable harvesting by local people on the plant resources has increased the vulnerability of the species in this area.

#### **4.2 LITERATURE REVIEW**

The threat status of commercially important indigenous species was determined by Red Data (IUCN, 1970) using some parameters such as availability, collection, part used and growth. Using these parameters the relative importance of specific medicinal plants can be classified into: endangered, vulnerable, rare, infrequent and dominant. IUCN (1994) adopted criteria to assess risks of extinction at a global scale: global/international recognition of the species, rapid destruction of its limited habitat, extensive hunting pressure for food and trade, representation of each major group, economic importance of the species, distribution of the species. Shrestha and Joshi (1996) described the threats to the flora of Nepal come from natural as well as anthropogenic factors. They listed 60 species of non-endemic threatened flowering plants from Nepal. Chaudhary (1998) reported that major threats of the wild plant resources are due to over harvesting, unsustainable and habitat destruction, e.g. the encroachment of agriculture, deforestation, fires, and overgrazing and in the lower altitudinal range, threats are due to dense population, migration, urbanization, slash and burn and expansion of agricultural land. Karki and Williams (1999) documented priority species of medicinal plants in South Asia and highlighted the background and rationale for selecting and prioritizing medicinal plant species for enhanced research attention. Rai *et al.* (2000) studied conservation threats of some important medicinal plants of the Sikkim Himalaya. CAMP (2001) assessed 51 medicinal plant species, of

which 3 species critically endangered, 14 species endangered, 23 species vulnerable, 3 species threatened, 1 species least concerned, 7 species data deficient. Larsen (2002) studied about commercial medicinal plant extraction in the hills of Nepal, its local management system and ecological sustainability. Olsen and Larsen (2003) documented the alpine medicinal plant trade and Himalayan mountain livelihood strategies. The study indicated that the annual trade amounts to thousands of tons of roots, rhizomes, tubers, leaves etc. Joshi and Joshi (2005) noted about the trend of ethnobotanical research and conservation of useful species. Ghimire and Aumeeruddy-Thomas (2005a) conducted the assessment of potential endangerment of the documented species adapting the method of Rapid Vulnerability Approach (RVA) in Shey-Phosundo National Park in Dolpa and in Dovan Village Development Committee, Palpa district by Aryal *et al.* (2008). Sherchan *et al.* (2005) studied the distribution, conservation practices and trade of Yarsagumba in Manang district of Annapurna Conservation Area. Salik *et al.* (2006) hypothesized that a high potential endangerment of medicinal plants goes hand in hand with a high commercial use, while traditional uses do not affect the sustainability of the populations. IUCN provides internationally accepted and successfully established categories and criteria for the assessment of the global and regional extinction risk of species (Rodrigues *et al.*, 2006; IUCN, 2010). Wagner *et al.* (2008) assessed endangerment of medicinal plants from Muktinath Valley and Kali Gandaki in Central Nepal. Shrestha and Shrestha (2012) studied vulnerability assessment of high-valued medicinal plants in Langtang National Park, Central Nepal.

### **4.3 MATERIALS AND METHODS**

#### **4.3.1 Preparation of traded plants checklist**

The lists of traded plants were collected from Department of Forest, Makawanpur district, survey of local markets, local people information and traders. This list was considered as a priority list of high valued useful plant resources in Makawanpur district.

#### **4.3.2 Semi-structured interview**

In Makawanpur district, most of the threatened plants were of ethnobotanical importance. Local knowledgeable people had valuable information about plants



abundance, distribution and localities of their availability. It is also important that local knowledge of plant abundances and distributions that prove essential to a national and ultimately to global, implementation of plant conservation. The key informants, traders, plant collectors of the study sites were interviewed based on the semi-structured questionnaires (Appendix 5) to obtain information from local people about the status of traded useful plants, such as method of harvesting, quantity of harvested, causes of threats, trade status, knowledge on conservation, method of propagation, use value, amount of traded, need for conservation of useful natural plant resources.

#### **4.3.3 Rapid Vulnerability Assessment (RVA)**

To assess the traded, vulnerable and threatened useful plants, a rapid vulnerability assessment (RVA) was conducted. This method was assessed by interviewing with indigenous local people, field observations, and published literatures (Aryal & Pelz, 2008; Ghimire *et al.*, 2001). There were 10 vulnerability criteria used for the species (Table 22). For each of the 10 criteria of vulnerability score ranging from 1 to 4 (1 is low and 4 for high vulnerability) were assigned for each species.

Data for the criteria such as plant parts used, growth status, user group, harvesting techniques, were recorded by interviews with knowledgeable local people, plant collectors, traders and field observation.

Data for the criteria such as market demand, amount traded was collected from Department of Forest, Makawanpur district trade bulletin, traders and local market surveys. Data of "life forms, habitat was collected by field observation. Data of geographical distribution was obtained from Press *et al.* (2000), while official conservation/threat status was recorded from published literatures such as Shrestha and Joshi (1996), National Register Medicinal Plants (IUCN, 2000); NBS (2002); CAMP (2001).

In criteria 1, plant species whose underground parts used, are more vulnerable as the entire plants has to be uprooted by digging to collect such parts. So, this criterion was given the highest value 4. Criteria 2 is life forms: herb, shrubs, tree. Tree (long lived perennial) was more vulnerable because they have to rely entirely on their

underground parts and destruction of these parts can seriously affect their number and density. Plant species which grows on gravel and rocky habitats are very fragile habitats were more vulnerable than species grows on grasslands, pastures and meadows. The species which occurs in small geographical area, are at high extinction risk. On the other hand species found all over the world have well adapted to a wide geographical region and therefore less vulnerable. The species whose growth status is very slow is more vulnerable than fast growth. The species which are listed threatened in IUCN, CAMP, and multiple organizations indicated that the species was threatened on global basis, denoting high vulnerability.

After completing the list, all values for each species were summed and scored for each criterion. Based on this information, the useful plants were divided into different categories of vulnerability. Table 22 shows the 10 categories and their scores. Finally the total score of each species was summed up to obtain the threat value of individual useful species. The species that scored value equal to or greater than 25 were placed in threat category I, representing the most vulnerable species in that area. Similarly, the other categories were given below:

Threat category I > 25

Threat category III 15-19

Threat category II 20-24

Threat category IV < 14

**Table 22:** Criteria of vulnerability and scores for useful plants of Makawanpur district

S.N.	Criteria	Categories	Score
1.	Plant parts used	Rhizomes, root, whole plant	4
		Bark, Stem	3
		Inflorescence, flower, fruit, seed	2
		Leaves	1
2.	Life forms	Tree	4
		Shrub	3
		Climbers	2
		Herb	1
3.	Habitat	Gravel/soil, rocky/stony slopes	4
		Epiphyte	3
		Forest, shrubberies, agricultural land	2
		Grassland, pasture, meadows	1
4.	Geographical distribution	Nepal endemic	4
		Himalaya endemic	3
		Himalaya +surroundings	2
		Cosmopolitan	1
5.	Growth status	Very slow growth	4
		Slow growth	3
		Moderate growth	2
		Very fast growth	1
6.	User group	Trade+local people+local exchange	4
		Trade+local people	3
		Trade+ local exchange	2
		Trade	1

**Table 22: (Continued)**

S.N.	Criteria	Categories	Score
7.	Market demand	High demand	4
		Moderate	3
		Low demand	2
		No demand	1
8.	Amount traded	>5000kg	4
		3000-5000kg	3
		1000-3000kg	2
		<1000kg	1
9.	Harvesting techniques	Digging/Uprooted	4
		Cutting/Scratching	3
		Debarking	2
		Picking/Plucking	1
10.	Official conservation/threat status	Status in three categories and more	4
		Status in two categories	3
		Status in one category	2
		Not assigned	1

Adopted from Ghimire *et al.*, 2001; field survey 2010

## 4.4 RESULTS AND DISCUSSION

### 4.4.1 RESULTS

#### High value medicinal plants and other useful plants of Makawanpur district

Based on their high market demand, local utilization and their rarity, 48 species belonging to 44 genera and 38 families were identified as highly valuable medicinal, wild vegetables and wild fruits in Makawanpur district (Table 23). These plants were collected from Churiamai, Chitlang, Aghor, Simbhanjyang area. Altogether 68 medicinal plants were sold in Makawanpur district along roadside, local and whole sale market (Table 6), 28 tradable wild vegetable of which 5 species high marketable (Table 11), and 18 wild fruits and nuts species, (Table 17) of which 4 species have high market demand according to key informants information. Among 68 tradable medicinal plants, 48 medicinal species was recorded as high market demand for outside country. Out of 48 species, *Rauvolfia serpentina* is threat categories of IUCN, Government of Nepal protected, CITES appendix II and CAMP. Two species are in threat category of IUCN. Similarly, seven species were threat category of CAMP, whereas, two species were threat category of IUCN, CITES, CAMP and four species were threat category of IUCN and CAMP, *Rauvolfia serpentina* is banned for trade outside the country without processing, whereas two orchid species such as *Pleione praecox* and *Satyrrium nepalense* are included in the CITES Appendix II (Table 23).

**Table 23:** High valued medicinal, vegetable and fruits species found in Makawanpur district, Central Nepal.

S.N.	Scientific name	Local name	Locality	IUC N	GoN	CIT ES	CAMP
1	<i>Aconitum laciniatum</i>	Bikh	Daman	T	-	-	-
2	<i>Aconitum spicatum</i>	Bikh	Daman	T	-	-	V
3	<i>Aconogonum molle</i>	Thotne	Aghor	-	-	-	-
4	<i>Allium wallichii</i>	Banlasun	Aghor	-	-	-	-
5	<i>Alstonia scholaris</i>	Chhatiwan ko bokra	Churiamai	R	-	-	V
6	<i>Asparagus racemosus</i>	Satawari/kurilo	Handikhola/Churiamai	-	-	-	V
7	<i>Astilbe rivularis</i>	Thuloaushadhi	Chitlang	-	-	-	-
8	<i>Bauhinia vahlii</i>	Bhorlapat	Churiamai	-	-	-	-
9	<i>Berberis aristata</i>	Daruhaldi	Chitlang/Aghor	-	-	-	-
10	<i>Bergenia ciliata</i>	Pashanved	Daman	T	-	-	-
11	<i>Boehmeria rugulosa</i>	Dar ko bokra	Aghor	-	-	-	-
12	<i>Castanopsis indica</i>	Dhalekatus	Chitlang	-	-	-	-
13	<i>Cinnamomum tamala</i>	Nepali dalchini, Sinkauli	Aghor	-	-	-	-
14	<i>Cucurliigo orchioidea</i>	Kalo Museli	Aghor	-	-	-	V
15	<i>Daphne papyracea</i>	Lokta	Chitlang	-	-	-	-
16	<i>Didymocarpus pedicellatus</i>	Kumkum ko pat	Aghor	-	-	-	-
17	<i>Dioscorea deltoidea</i>	Kukurtarul	Churiamai	T	-	II	E
18	<i>Diplazium esculentum</i>	Niuro	Aghor	-	-	-	-
19	<i>Dipsacus inermis</i>	Halik/Banmula	Aghor	-	-	-	-
20	<i>Dryopteris cochleata</i>	Niuro	Aghor	-	-	-	-
21	<i>Juglans regia var. kamaonia</i>	Okhar	Chitlang	-	-	-	-
22	<i>Lilium nepalense</i>	Ban Lasun	Aghor	-	-	-	DD
23	<i>Macropanax dispermus</i>	Chinia	Chitlang	-	-	-	-
24	<i>Myrica esculenta</i>	Kafal	Chitlang	-	-	-	-
25	<i>Paris polyphylla</i>	Satuwa	Simbhanjyang	V	-	-	V
26	<i>Persea duthiei</i>	Pawanbokra	Aghor	-	-	-	-
27	<i>Phyllanthus emblica</i>	Amala	Churiamai	-	-	-	-
28	<i>Phytolacca acinosa</i>	Jaringosag	Aghor	-	-	-	-
29	<i>Piper longum</i>	Pipla	Hetauda	-	-	-	V
30	<i>Pleione praecox</i>	Bhuichampa	Simbhanjyang	-	-	II	-
31	<i>Podophyllum hexandrum</i>	Laghupatra	Simbhanjyang	V	-	II	V
32	<i>Polypodioides amoena</i>	Bisfej	Aghor	-	-	-	-
33	<i>Rauvolfia serpentina</i>	Sarpagandha	Hetauda	EN	GoN	II	CR
34	<i>Rhododendron lepidotum</i>	Sunpati	Daman	-	-	-	-
35	<i>Rubia manjith</i>	Majitho	Aghor	-	-	-	V
36	<i>Satyrium nepalense</i>	Gamdol	Aghor	-	-	II	-
37	<i>Selinum wallichianum</i>	Bhutkesh	Aghor	-	-	-	-
38	<i>Swertia angustifolia</i>	Sanodhaiyaro	Aghor	-	-	-	EN
39	<i>Swertia chirayita</i>	Chirayito	Chitlang/Aghor	V	-	-	V

**Table 23: (Continued)**

S.N.	Scientific name	Local name	Locality	IUC N	GoN	CIT ES	CAMP
40	<i>Syzygium cumini</i>	Jamun	Hetauda	-	-	-	-
41	<i>Terminalia bellirica</i>	Barro	Churiamai	-	-	-	-
42	<i>Terminalia chebula</i>	Harro	Churiamai	-	-	-	-
43	<i>Tinospora sinensis</i>	Gurjolahara	Hetauda	-	-	-	V
44	<i>Trichosanthes tricuspidata</i>	Indreni	Aghor	-	-	-	-
45	<i>Urtica dioica</i>	Sisnu	Chitlang	-	-	-	-
46	<i>Viscum album</i>	Hadjor	Chitlang	-	-	-	-
47	<i>Woodfordia fruticosa</i>	Sanodhaiyaro	Churiamai	-	-	-	-
48	<i>Zanthoxylum armatum</i>	Timur	Aghor	-	-	-	-

Source: CAMP (2001); NBS (2002); Field survey 2010.

### Market demand useful plants

Out of 48 species of traded plants from Makawanpur district, *Asparagus racemosus*, *Dioscorea deltoidea*, *Podophyllum hexandrum*, *Tinospora sinensis*, *Polypodioides amoena* were the most highly traded. For the trade, tubers of *Asparagus racemosus* was harvested about 21950 kg per year in fiscal year 066/67 (2009/2010) from this district. District Forest Office records showed an average collection of *Dioscorea deltoidea* 10000 kg, *Podophyllum hexandrum* 5000 kg (Table 24). If no data is available for traded useful plant species, marked with NA (Table 24). Most of the traded plants were harvested from wild and community forest, but *Asparagus racemosus* tuber were harvested from the cultivated land. Amount of trade data was obtained from Department of Forest, Makawanpur district and traders. Of 48 species high demand market plant species, 18 species were harvested by digging and then uprooted entire plants, 16 species picking, 9 cutting, 3 debarking and 2 species were collected by scratching whole plant parts from their habitat (Table 24).

**Table 24:** High value traded plants and their method of harvesting.

S.N.	Scientific name	Local name	Life form	Parts traded	Amount traded/kg	Harvesting technique
1	<i>Aconitum laciniatum</i>	Bikh	Herb	Dry tuber	NA	Digging/Uprooted
2	<i>Aconitum spicatum</i>	Bikh	Herb	Dry tuber	NA	Digging/Uprooted
3	<i>Aconogonum molle</i>	Thotne	Herb	Fress leaves	50	Picking
4	<i>Allium wallichii</i>	Banlasun	Herb	Dry tuber	350	Digging
5	<i>Alstonia scholaris</i>	Chhatiwan ko bokra	Tree	Dry bark	500	Debarking
6	<i>Asparagus racemosus</i>	Satawari/kurilo	Herb	Dry tuber	21950	Digging

**Table 24: (Continued)**

S.N.	Scientific name	Local name	Life form	Parts traded	Amount traded/kg	Harvesting technique
7	<i>Astilbe rivularis</i>	Thuloaushadhi	Herb	Dry rhizome	1000	Digging
8	<i>Bauhinia vahlii</i>	Bhorlapat	Climber	Dry leaves	2500	Picking
9	<i>Berberis aristata</i>	Daruhaldi	Shrub	Dry wood	2000	Cutting
10	<i>Bergenia ciliata</i>	Pashaved	Herb/Rock	Dry rhizome	250	Digging
11	<i>Boehmeria rugulosa</i>	Dar ko bokra	Herb	Dry stem	1000	Cutting
12	<i>Castanopsis indica</i>	Dhalekatus	Tree	Fruit	20	Picking
13	<i>Cinnamomum tamala</i>	Nepali dalchini, Sinkauli	Tree	Dry bark	2000	Debarking
14	<i>Cucurligo orchioides</i>	Kalo Museli	Herb	Dry rhizome	NA	Digging
15	<i>Daphne papyracea</i>	Lokta	Shrub	Dry stem	NA	Cutting
16	<i>Didymocarpus pedicellatus</i>	Kumkum ko pat	Herb/Rock	Young leaves	NA	Scratching
17	<i>Dioscorea deltoidea</i>	Kukurtarul	Climber	Tuber	10,000	Digging
18	<i>Diplazium esculentum</i>	Niuro	Herb	Fresh tender shoot	500	Picking
19	<i>Dipsacus inermis</i>	Halik/Banmula/Halhale	Herb	Dry root	2600	Digging
20	<i>Dryopteris cochleata</i>	Niuro	Herb	Fresh tender shoot	600	Picking
21	<i>Juglans regia var. kamaonia</i>	Okhar	Tree	Nuts	900	Picking
22	<i>Lilium nepalense</i>	Ban Lasun	Herb	Dry tuber	200	Digging
23	<i>Macropanax dispermus</i>	Chinia	Tree	Fresh tender shoot	800	Picking
24	<i>Myrica esculenta</i>	Kafal	Tree	Fresh fruit	1000	Picking
25	<i>Paris polyphylla</i>	Satuwa	Herb	Dry tuber	NA	Digging
26	<i>Persea duthiei</i>	Pawanbokra	Tree	Dry bark	800	Debarking
27	<i>Phyllanthus emblica</i>	Amala	Tree	Dry fruit	2000	Picking
28	<i>Phytolacca acinosa</i>	Jaringosag	Herb	Fresh leaves	600	Picking
29	<i>Piper longum</i>	Pipla	Climber	Dry fruit	1000	Picking
30	<i>Pleione praecox</i>	Bhuichampa	Herb	Tuber	NA	Digging
31	<i>Podophyllum hexandrum</i>	Laghupatra	Herb	Dry rhizome	NA	Digging
32	<i>Polypodioides amoena</i>	Bisfej	Herb	Dry rhizome	NA	Scratching
33	<i>Rauwolfia serpentina</i>	Sarpagandha	Herb	Dry root	3500	Digging
34	<i>Rhododendron lepidotum</i>	Sunpa ti	Shrub	Dry leaves	NA	Cutting
35	<i>Rubia manjith</i>	Majitho	Climber	Dry stem	300	Cutting
36	<i>Satyrium nepalense</i>	Gamdol	Herb	Dry rhizome	1115	Digging
37	<i>Selinum wallichianum</i>	Bhutkesh	Herb	Dry rhizome	NA	Digging
38	<i>Swertia angustifolia</i>	Sanochirato	Herb	Dry entire plant	4080	Digging
39	<i>Swertia chirayita</i>	Chirayito	Herb	Dry entire plant	NA	Digging

**Table 24: (Continued)**

S.N.	Scientific name	Local name	Life form	Parts traded	Amount traded/kg	Harvesting technique
40	<i>Syzygium cumini</i>	Jamun	Tree	Fresh fruit	1275	Picking
41	<i>Terminalia bellirica</i>	Barro	Tree	Dry fruit shell	100	Picking
42	<i>Terminalia chebula</i>	Harro	Tree	Dry fruit	1000	Picking
43	<i>Tinospora sinensis</i>	Gurjolahara	Climber	Dry stem	1000	Cutting
44	<i>Trichosanthes tricuspidata</i>	Indreni	Climber	Dry seeds	5200	Cutting
45	<i>Urtica dioica</i>	Sisnu	Herb	Fresh leaves	NA	Picking
46	<i>Viscum album</i>	Hadjor	Shrub/P arasite	Dry entire plant	400	Cutting
47	<i>Woodfordia fruticosa</i>	Sanodhaiyaro	Shrub	Dry flower	300	Cutting
48	<i>Zanthoxylum armatum</i>	Timur	Shrub	Dry/Fresh fruit	NA	Picking

Source: Respondents interviews in study sites 2011; market source; Department of Forest, Makawanpur

### Rapid vulnerability assessment (RVA)

Rapid vulnerability assessment (RVA) was conducted among the high market demand and frequently harvested species. Results from RVA are provided in Table 25. Based on RVA analysis 12 species such as *Bergenia ciliata*, *Dioscorea deltoidea*, *Asparagus racemosus*, *Paris polyphylla*, *Podophyllum hexandrum*, *Aconitum spicatum*, *Didymocarpus pedicellatus*, *Aconitum laciniatum*, *Astilbe rivularis*, *Cucurliigo orchioides*, *Rauwolfia serpentina* and *Swertia chirayita* were found to be in the high vulnerable with the threat scores greater than 25 (Figure 37). 19 species in moderate vulnerable with threat scores 20-24 and placed in threat category II. 12 species ranked in III threat category with 16-19 scores. The least vulnerable species were *Aconogonum molle*, *Diplazium esculentum*, *Dryopteris cochleata*, *Urtica dioica* and *Phytolacca acinosa* with less than 18 threat scores and placed in threat category IV (Table 25). It is clear from the data that the four categories such as part used, life form, market demand and harvesting techniques are increased the high threat scores in comparison to other categories. Vulnerability of species due to trade was low for most of the species except high in *Dioscorea deltoidea*, *Asparagus racemosus*, *Tinospora sinensis*, *Polypodioides amoena* and *Selinum wallichianum* (Table 25).

Most of the species in high vulnerable category are mainly medicinal species used in traditional medicine and high market demand. Less vulnerable species are mainly food species which are used very frequently by local people.

**Table 25:** Rapid vulnerability assessment (RVA) categories and scores of high trade valued useful plants of Makawanpur district.

S.N.	Scientific name	Plant part used	Life form	Habitat	Distribution	Growth status	User group	Market demand	Amount traded/kg/yr	Harvesting technique	Official threat status	Total score	Threat category
1	<i>Bergenia ciliata</i>	4	1	4	3	4	3	4	1	4	2	30	I
2	<i>Dioscorea deltoidea</i>	4	2	2	2	2	3	3	4	4	4	30	I
3	<i>Asparagus racemosus</i>	4	1	2	2	1	4	3	4	4	2	27	I
4	<i>Paris polyphylla</i>	4	1	2	2	4	4	3	NA	4	3	27	I
5	<i>Podophyllum hexandrum</i>	4	1	2	2	4	3	3	NA	4	4	27	I
6	<i>Aconitum spicatum</i>	4	1	2	2	3	4	3	NA	4	3	26	I
7	<i>Didymocarpus pedicellatus</i>	4	1	4	3	4	3	3	NA	3	1	26	I
8	<i>Aconitum laciniatum</i>	4	1	2	2	3	4	3	NA	4	2	25	I
9	<i>Astilbe rivularis</i>	4	1	2	2	4	2	3	2	4	1	25	I
10	<i>Cucurliigo orchioides</i>	4	1	2	2	4	3	3	NA	4	2	25	I
11	<i>Rauwolfia serpentina</i>	4	1	2	2	2	3	3	NA	4	4	25	I
12	<i>Swertia chirayita</i>	4	1	2	2	1	4	3	1	4	3	25	I
13	<i>Persea duthiei</i>	3	4	2	2	3	3	3	1	2	1	24	II
14	<i>Tinospora sinensis</i>	3	2	2	2	2	2	2	4	3	2	24	II
15	<i>Alstonia scholaris</i>	3	4	2	1	4	1	2	1	2	3	23	II



**Table 25: (Contiued)**

S.N	Scientific name	Plant part used	Life form	Habitat	Distribution	Growt h status	User group	Market demand	Amount traded/kg/yr	Harvesting technique	Official threat status	Total score	Threat category
16	<i>Dipsacus inermis</i>	4	1	2	3	2	2	2	2	4	1	23	II
17	<i>Lilium nepalense</i>	4	1	2	3	2	2	2	1	4	2	23	II
18	<i>Pleione praecox</i>	4	1	3	2	4	1	2	NA	4	2	23	II
19	<i>Polypodioides amoena</i>	4	1	3	NA	3	1	3	3	4	1	23	II
20	<i>Viscum album</i>	4	3	3	2	4	1	1	1	3	1	23	II
21	<i>Allium wallichii</i>	4	1	2	2	4	1	2	1	4	1	22	II
22	<i>Cinnamomum tamala</i>	2	4	2	2	2	2	3	2	2	1	22	II
23	<i>Berberis aristata</i>	3	3	2	3	1	1	2	2	3	1	21	II
24	<i>Daphne papyracea</i>	2	3	2	3	2	2	3	NA	3	1	21	II
25	** <i>Myrica esculenta</i>	2	4	2	2	4	1	3	1	1	1	21	II
26	<i>Phyllanthus emblica</i>	2	4	2	2	4	1	2	2	1	1	21	II
27	<i>Rubia manjith</i>	3	2	2	2	3	1	2	1	3	2	21	II
28	<i>Satyrium nepalense</i>	4	1	2	2	2	1	3	NA	4	2	21	II
29	<i>Selinum wallichianum</i>	4	1	2	2	1	1	1	3	4	1	20	II
30	<i>Terminalia bellirica</i>	2	4	2	2	3	2	2	1	1	1	20	II
31	<i>Terminalia chebula</i>	2	4	2	2	3	2	2	1	1	1	20	II
32	* <i>Macropanax</i>	1	4	2	2	4	1	2	1	1	1	19	III

	<i>dispermus</i>												
33	<i>Rhododendron lepidotum</i>	1	3	2	2	3	1	2	1	3	1	19	III
34	*** <i>Boehmeria rugulosa</i>	3	1	2	3	1	1	1	2	3	1	18	III
35	** <i>Castanopsis indica</i>	2	4	2	2	3	1	1	1	1	1	18	III
36	<i>Swertia angustifolia</i>	4	1	2	2	1	1	1		4	2	18	III
37	** <i>Juglans regia</i> var. <i>kamaonia</i>	2	4	2	2	2	1	1	1	1	1	17	III
38	<i>Piper longum</i>	2	2	2	2	2	1	2	1	1	2	17	III
39	** <i>Syzygium cumini</i>	2	4	2	2	2	1	1	1	1	1	17	III
40	<i>Woodfordia fruticosa</i>	2	3	2	2	2	1	1	NA	3	1	17	III
41	<i>Zanthoxylum armatum</i>	2	3	2	2	1	3	2	NA	1	1	17	III
42	*** <i>Bauhinia vahlii</i>	1	2	2	2	2	2	2	1	1	1	16	III
43	<i>Trichosanthes tricuspidata</i>	2	2	2	2	1	1	2	NA	3	1	16	III
44	* <i>Aconogonum molle</i>	1	1	2	2	2	1	1	1	1	1	13	IV
45	* <i>Diplazium esculentum</i>	1	1	2	NA	2	1	3	1	1	1	13	IV
46	* <i>Dryopteris cochleata</i>	1	1	2	NA	2	1	3	1	1	1	13	IV
47	<i>Urtica dioica</i>	1	1	2	1	1	1	3	1	1	1	13	IV
48	* <i>Phytolacca acinosa</i>	1	1	2	2	1	1	1	1	1	1	12	IV

Source: Ghimire *et al.*, 2001; Field survey, 2009-2011, Note:\* vegetable; \*\* fruit and nuts; \*\*\*others



**Figure 37:** Vulnerable plants of Makawanpur district. a. *Aconitum spicatum*; b. *Aconitum laciniatum*; c. *Astilbe rivularis*; d. *Asparagus racemosus*; e. *Bergenia ciliata*; f. *Cucurliigo orchioides*; g. *Didymocarpus pedicellatus* ; h. *Dioscorea deltoidea*; i. *Paris polyphylla*; j. *Podophyllum hexandrum*; k. *Rauwolfia serpentina*; and l. *Swertia chirayita*.

#### 4.4.2 DISCUSSION

In the present study, 31 species of medicinal plants have been identified as high vulnerability with threat category I and II, whereas the plants used as vegetables, fruits and other uses had low vulnerability. Due to their common occurrence, distribution, wide habitats, and harvesting techniques etc. makes them less vulnerable for food and other uses. However most of the medicinal plants mentioned are vulnerable because of unsustainable harvesting (by digging/uprooted, cutting, debarking and scratching). Similarly, Wagner *et al.* (2008) described that most of the

Himalayan medicinal plants are vulnerable due to deforestation, burning and grazing. Conservation Assessment and Management of Medicinal Plant (CAMP) categorized 51 species of medicinal plants as high valued and potentially threatened species in Nepal (CAMP, 2001). Among the species documented in the present Rapid Vulnerability Assessment (RVA) study, 14 species are found to be the threat categories assigned by CAMP, that means Makawanpur district is one of the home of 27.45% of the vulnerable medicinal plants of national concern (Table 24). Similarly, *Rauvolfia serpentina* is protected by Government of Nepal (NBS, 2002), nine species are under IUCN threat categories (IUCN, 2001) and five species are included in CITES Appendix II (CITES, 2011). Therefore, several useful plants of Makawanpur district are not only high potential for trade and utilization, but they are also of global concern for conservation. The harvesting technique for the most of these vulnerable plants was unsustainable. Plants were entirely uprooted and no part was left for next regeneration. The useful plants, which underground plant parts were used, highly vulnerable due to unsustainable harvesting (Table 23). Similar results were observed by Ghimire *et al.* (2001) in Shey-Phoksundo National Park and its Buffer zone, Dolpa. A study on the trade of medicinal plants by Amatya (2003) revealed that 100 tons of lichens, 45 tons of *Pinus* spp. resin, 6 tons of *Swertia chirayita*, 3 tons of *Bergenia ciliata*, 2 tons of *Rubia manjith* and 1 ton of *Asparagus racemosus* were treaded from Makawanpur district.

The high market demanded species such as *Asparagus racemosus*, *Swertia chirayita*, *Cinnamomum tamala*, *Phyllanthus emblica*, *Piper longum* have been started to cultivate in Makawanpur district.

## CHAPTER 5

### 5. CONCLUSION AND RECOMMENDATIONS

#### 5.1 CONCLUSION

Makawanpur district has various altitudinal ranges from tropical to temperate climate which favors the growth of diversity of flora. In present study, 695 angiospermic flora belonging to 542 dicots and 153 monocots were collected from this district. There are different life forms such as herbs, shrubs, trees, climbers. Some interesting insectivorous plant such as *Drosera peltata*, parasitic plants *Cuscuta reflexa*, *Aeginetia indica*, *Orobanche aegytiaca*, lithophytes plants *Bergenia ciliata*, *Didymocarpus pedicellatus* and one new plant species (*Merremia hirta*) for flora of Nepal were also reported. It is believed that there may be many unrecorded plant species, hence there is a long-term comprehensive study of the flora to document total species of the Makawanpur district. Further, the flora of Makawanpur district is declining because the forest destroyed and cleared for making agricultural field, road and building construction. The useful forest resources are also illegally exploited for economic benefits. It is concluded that the study of flora of Makawanpur district is important for assessing the plant biodiversity and conservation and sustainable development of this region.

In this present study, 189 medicinal plants species belonging to 84 families were documented by free-listing and semi-structured interviews with Bankaria, Newar and Tamang ethnic groups based on utilization. Compositae, Leguminosae, Labiatae were the most cited families while leaves and underground parts were the most used plant parts. Preference ranking exercises in high market demand of useful plant resources, revealed that medicinal plants such *Paris polyphylla*, *Persea duthiei*, *Satyrion nepalense*, *Swertia chirayita*, *Asparagus racemosus* were most appreciated by three ethnic groups of Makawanpur district. The common diseases among three communities were digestive disorder, fever, cough and cold, cuts and wounds. *Urtica dioica*, *Swertia chirayita*, *Terminalia chebula*, *Astilbe rivularis*, *Centella asiatica*, *Cleistocalyx operculatus* were the most used species. So detail pharmacological assessment is necessary in these plant species. The Bankaria and Tamang people

possess rich ethnomedicinal knowledge comparison to Newar people. Although they were culturally different, they had rich knowledge about the use of medicinal plants.

Wild vegetable, fruits and nut species still play a significant role in the livelihoods of rural communities in Makawanpur district, Central Nepal, and are important for nutrition and income generation. However, traditional knowledge about the use of wild vegetables was not equally distributed among the ethnic groups of respondents. The preference ranking in taste and market value, revealed that the wild vegetables *Diplazium esculentum*, *Dryopteris cochleata*, *Bauhinia variegata*, and wild fruits and nuts such as *Myrica esculenta*, *Rubus ellipticus*, *Aegle marmelos*, *Choerospondias axillaris*, and *Diploknema butyracea* are most preferred by the Bankaria, Newar and Tamang ethnic groups.

Present approach was regarded as useful to prioritize wild vegetable and fruits species for future domestication efforts by integrating ethno-botanical, socio-economic and bio-physical information into the decision making process. However, more research is needed to improve the approach, for example studies on nutritional values of the documented wild vegetable and fruit species.

All the plant parts used as medicinal, vegetables, fruits in Makawanpur district, are gathered from wild, while only few are grown in homegarden and farmer field. The strength of the priority setting approach for domestication not only in view of their existing state of threat but improve sustainable conservation. Therefore, the data compiled in this study can assist in selection and domestication of medicinal, wild vegetables, fruits which are available throughout the year, to be grown in homegarden and field. Based on RVA analysis 12 species such as *Bergenia ciliata*, *Dioscorea deltoidea*, *Asparagus racemosus*, *Paris polyphylla*, *Podophyllum hexandrum*, *Aconitum spicatum*, *Didymocarpus pedicellatus*, *Aconitum laciniatum*, *Astilbe rivularis*, *Cucurliigo orchioides*, *Rauvolfia serpentina* and *Swertia chirayita* were found to be in the high vulnerable due to high market demand and unsustainable harvesting. Sustainable harvesting and management strategies should be implemented to prevent overexploitation which may result in the local extinction of important and vulnerable non-timber forest species. Documenting the ethnobotanical species within any particular area does not meet the basic needs of the indigenous people. Therefore, prioritization should be given on vulnerable plants for domestication. Ethnobotanical

plants of Makawanpur district are highly valued, so detailed research on these selected plant species would be beneficial for Nepal as well as Makawanpur district. There available barren and abandoned lands in these district should be used to cultivate these prioritized species. These data are intended for establishment of *ex situ* conservation culture of endangered plants in the community forests of Makawanpur district. The research on utilization pattern and conservation status of plant resources of Makawanpur district, provides baseline data for future investigations on the utilization of plant species for medicinal, vegetable and fruits purposes.

## 5.2 RECOMMENDATIONS

Based on the results of present research, following recommendations are assigned for sustainable development and conservation of the plant resource of Makawanpur district:

- Further collection of flora should be undertaken in unexplored areas to prepare complete inventory of plants in Makawanpur district.
- Proper identification of neglected and under exploited plants used by local people should be carried out.
- Distribution maps of economically important plant species should be prepared before the plants become rare or vulnerable.
- Database of useful plants including herbarium and photograph should be developed and upgraded regularly. Such information should be made available in local languages.
- Ethnobotanical knowledge is disappearing rapidly, so interaction program with traditional healers, plant traders and collectors should be organized frequently to encourage and respect their knowledge.
- Marketing experts and traders should be included in species priority setting to better assess the economic potential of the documented species.
- Preferred species of medicinal plants such as *Paris polyphylla*, *Persea duthiei*, *Satyrium nepalense*, *Swertia chirayita*, *Tinospora sinensis*, wild vegetables, *Dioscorea hamiltonii*, *Diplazium esculentum*, *Dryopteris cochleata*, *Tectaria coduanata* and wild fruits *Myrica esculenta*, *Rubus ellipticus*, *Ziziphus mauritiana* should be included for *in situ* and *ex situ* conservation.

- Local communities should be encouraged to cultivate the medicinal plants of high market demand, delicious wild vegetables and fruits in their own land for sustainable conservation. Provision for technical as well as financial assistance should be made to local communities from Government to promote such plants.
- Pharmacological screening of valuable medicinal plants should be done to prove validity of traditional health care practices.
- Nutritional value of less known edible plants should be done for value addition and economical potential for future.
- Rare, vulnerable and endangered useful plants should be cultivated outside natural habitats, nurseries, homegardens for long term conservation.
- Seed germplasm should be established for wild useful plants.
- Recording of rare and threatened species for conservation purposes and species specific survey should be carried out to relocate the critically endangered plants.
- Sustainable harvest and management strategies should be implemented to prevent over exploitation which may result in the local extinction of important and vulnerable NTFP species.
- Awareness program, food fair, cooking and indigenous processing methods of wild useful plant resource demonstration should be promoted in each ethnic community.



## CHAPTER 6

### 6. SUMMARY

Globalization, deforestation and environmental degradation cause the disappearance of biodiversity together with loss their ethnobotanical traditional knowledge. The cultural domain studies are important for promoting wise use and conservation of medicinal plants and wild edible plants. Regarding this, a study was undertaken in Makawanpur district to estimate the consequence of loss on the plant resources and also to make conservation and management plans. It is necessary to identify conservation status of plant resources and priorities these plants for domestication and *ex situ* conservation.

The Makawanpur district lies in Central Nepal, covers an area of 2426 square kilometer, located between latitude 27<sup>0</sup>10' N to 27<sup>0</sup> 40' N and longitude 84<sup>0</sup>41'E to 85<sup>0</sup> 31'E. Based on altitudinal zones, accessibility of plant resources, Hetauda Municipality (500 m), Chitlang Village Development Committee (1800 m), Handikhola VDC (500 m), Churiamai VDC (600 m), Aghor Namtar VDC (2300m) was selected as study sites. Three ethnic groups such as Bankaria, Newar and Tamang were selected to conduct the present study.

The specific objectives are to explore angiospermic flora from different altitudinal zones of Makawanpur district, document ethnobotanical knowledge on utilization pattern of plant resources (medicinal and edible plants) by three indigenous community (Bankaria, Newar, Tamang) with respect to develop preferences of plant species for local communities, to assess *in situ* conservation status of selected useful (medicinal, edible) plant resources (threats and vulnerability) of the study area.

The floristic list of angiosperms in Makawanpur district comprises of 695 species belonging to 472 genera and 124 families. Among them one insectivorous plant, 9 parasitic, 5 aquatic, 38 epiphytes and 3 lithophytes were also recorded. Out of 695 species, 542 species with 375 genera under 110 families belong to dicots, 153 species with 97 genera under 14 families to monocots. In the floristic study, Leguminosae (Fabaceae) was the dominant family with 60 species (8.63%) and 33 genera.

Similarly, Compositae (Asteraceae) with 52 species (7.48%), was the second largest family, whereas Graminae (Poaceae) and Orchidaceae 45 species (6.47%) were found to the third largest families. Majority of the 695 documented species were herbs 456 species (65.61%) followed by trees 96 species (13.81%), shrubs 78 species (11.22%), climbers 51 species (7.34%) and creeping herbs 14 species (2.01%). Most of the plants were collected in the forest (59.42%) and fallow land (37.55%) followed by homegarden (1.58%) and wetland (1.155%). *Merremia hirta* (Linn.) Merr. belonging to family Convolvulaceae was reported a new species for Nepal.

A total of 189 medicinal plant species, 97 wild vegetables and 65 wild fruits and nut species were recorded by semi-structured interviews with Bankaria, Newar and Tamang ethnic groups of Makawanpur district. The three altitudinal zones (lowland, midland and highland) have differed in the utilization of medicinal plants. The highest number of species were collected in the lowlands (106 spp.) followed by highland (101 spp.) and the lowest in the midlands (41 spp.). The three ethnic groups (Bankaria, Newar, and Tamang) were differed in the utilization of medicinal plant. The highest number of medicinal plants were used by the Tamang ethnic group (147 spp.), the lowest by the Newar ethnic group (66 spp.). The most common used plant parts were leaves (33.33%, 63 spp.), underground parts, such as root, rhizome, tuber, bulb (25.40%, 48 spp.), fruits (12.17%, 23 spp.), bark/wood and entire plant (10.05%, 19 spp. each), stem and seed (7.94%, 15 spp. each), flower (4.76%, 9 spp.) and so on. Most of the plants were prepared as decoction (41.80%, 79 spp.), paste (32.80%, 62 spp.), juice (6.88%, 13 spp.), powder, oil, ash, cooked with egg and mustard oil for medicinal uses. Some of the plants were also eaten in raw form. The most common administration method was oral (50%, 94 spp.) followed by dressing (24%, 45 spp.), chewing raw and dried material (3%, 6 spp.), plaster (4%, 8 spp.), massage and inhale (3%, 5 spp.) and rub on the body parts (5%, 10 spp.). The other mode of administration were used in drops (2%, 4 spp.), brush ((1%, 3 spp.), bath and wash (1%, 2 spp.), and gargle. The utilization pattern of medicinal, wild edible plants in Bankaria, Newar and Tamang ethnic group was differed. *Paris polyphylla*, *Persea duthiei*, *Satyrium nepalense*, *Swertia chirayita*, *Asparagus racemosus* was found to be the most preferable medicinal plants. *Diplazium esculentum*, *Dryopteris cochleata*, *Dendrocalamus hamiltonii*, *Bauhinia variegata* are the mostly cited wild vegetables, whereas *Myrica esculenta*, *Rubus ellipticus* were frequently consumed as wild fruits.

Based on Rapid vulnerability assessment (RVA) analysis 12 species such as *Bergenia ciliata*, *Dioscorea deltoidea*, *Asparagus racemosus*, *Paris polyphylla*, *Podophyllum hexandrum*, *Aconitum spicatum*, *Didymocarpus pedicellatus*, *Aconitum laciniatum*, *Astilbe rivularis*, *Cucurliigo orchioides*, *Rauwolfia serpentina* and *Swertia chirayita* were found to be in the high vulnerable plants species in this area. Sustainable harvesting and proper management strategies should be implemented to prevent over exploitation to check the local extinction of important and vulnerable NTFP species. Prioritization should be given on vulnerable plants for domestication.

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Appendix 1: List of angiospermic flora collected from Makawanpur district

DICOTYLEDON

S.N.	Family /Scientific name	Life form	Collection site	Altitude (m)/	Habitat	Voucher no.
<b>Acanthaceae</b>						
1	<i>Aechmanthera gossypina</i> (Wall. ex Nees) Nees	Herb	Aghor	2000	Forest	0101010577NJ
2	<i>Asystasia macrocarpa</i> Nees	Herb	Hetauda	500	Forest	09924279NJ
3	<i>Barleria cristata</i> L.	Herb	Chitlang	1800	Forest	09711171NJ
4	<i>Eranthemum pulchellum</i> Andrews	Herb	Churiamai	650	Forest	09424116NJ
5	<i>Eranthemum purpurascens</i> Nees	Herb	Churiamai	600	Forest	010104431NJ
6	<i>Justicia adhatoda</i> L.	Shrub	Hetauda	500	Fallow	01124644NJ
7	<i>Justicia procumbens</i> var. <i>simplex</i> (D. Don) T. Yamaz.	Herb	Chitlang	1800	Fallow land	01182811NJ
8	<i>Lepidagathis incurva</i> Buch.-Ham. ex D. Don	Herb	Hetauda, Banaskhandi	500	Fallow land	011317730NJ
9	<i>Nelsonia canescens</i> (Lam.) Spreng.	Herb	Hetauda	500	Fallow land	09924284NJ
10	<i>Peristrophe bicalyculata</i> (Retz.) Nees	Herb	Hetauda, Banaskhandi	500	Fallow land	091130417NJ
11	<i>Rungia parviflora</i> (Retz.) Nees	Herb	Hetauda, Banaskhandi	500	Fallow land	091258NJ
12	<i>Strobilanthes atropurpureus</i> Nees	Herb	Hetauda, Manakamana	600	Forest	091130358NJ
13	<i>Strobilanthes capitata</i> (Nees) T. Anders.	Herb	Manakamana, Hetauda	600	Forest	091130354NJ
14	<i>Thunbergia alata</i> L.	Climber	Hetauda	500	Fallow land	011316725NJ
15	<i>Thunbergia coccinea</i> Wall.ex D. Don	Climber	Chitlang	1800	Forest	09823277NJ
16	<i>Thunbergia fragrans</i> Roxb.	Climber	Chitlang	1800	Forest	011828133NJ
<b>Aceraceae</b>						
17	<i>Acer oblongum</i> Wall. ex DC.	Tree	Chitlang-4	1800	Forest	01124624NJ
<b>Amaranthaceae</b>						
18	<i>Achyranthes aspera</i> L.	Herb	Hetauda	500	Fallow land	091130360NJ
19	<i>Achyranthes bidentata</i> Blume	Herb	Aghor	2300	Forest	09823259NJ
20	<i>Aerva lanata</i> (L.) Juss. ex Schult.	Herb	Churiamai	600	Fallow land	0931157NJ
21	<i>Alternanthera paronychioides</i> St. Hil.	Herb	Handikhola	400	Fallow land	010108552NJ
22	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Herb	Hetauda, Ratomatte	500	Fallow land	011317744NJ
23	<i>Alternanthera sessilis</i> (L.) DC.	Herb	Hetauda, Brindavan	500	Fallow land	0931159NJ
24	<i>Amaranthus caudatus</i> L.	Herb	Hetauda	400	Fallow land/Farmer field	011315718NJ
25	<i>Amaranthus lividus</i> L.	Herb	Hetauda	500	Fallow land	09613163NJ
26	<i>Amaranthus spinosus</i> L.	Herb	Hetauda	500	Fallow land	011317736NJ
27	<i>Amaranthus viridis</i> L.	Herb	Handikhola	500	Fallow land/Farmer field	010108532NJ

S.N.	Family /Scientific name	Life form	Collection site	Altitude (m)/	Habitat	Voucher no.
28	<i>Cyathula capitata</i> Moq.	Herb	Chitlang	1800	Fallow land	
29	<i>Cyathula tomentosa</i> (Roth) Moq.	Herb	Aghor, Simbhanjyang	2300	Fallow land	09121423NJ
30	<i>Gomphrena celosioides</i> Mart.	Herb	Hetauda	500	Fallow land	011315709NJ
<b>Anacardiaceae</b>						
31	<i>Buchanania latifolia</i> Roxb.	Tree	Churiamai	600	Forest	010104434NJ
32	<i>Chorespondias axillaris</i> (Roxb.) B. L. Burt & A. W. Hill	Tree	Chitlang	1800	Forest/Fallow land	09924280NJ
33	<i>Rhus parviflora</i> Roxb.	Tree	Chitlang	1800	Forest	09815246NJ
34	<i>Rhus javanica</i> L.	Tree	Chitlang	1800	Forest	0992434NJ
35	<i>Rhus wallichii</i> Hook. f.	Tree	Aghor	2300	Forest	0992435NJ
36	<i>Semecarpus anacardium</i> L.	Tree	Churiamai	600	Forest	010104428NJ
<b>Apocynaceae</b>						
37	<i>Alstonia scholaris</i> (L.) R. Br.	Tree	Hetauda, Piplepokhara	500	Forest	010104480NJ
38	<i>Holarrhena pubescens</i> (Buch.-Ham.) Wall. ex G. Don	Tree	Handikhola	500	Forest	09121363NJ
39	<i>Ichnocarpus frutescens</i> (L.) R. Br.	Shrub	Hetauda	500	Forest	09924281NJ
40	<i>Plumeria rubra</i> L. forma <i>acuctifolia</i> (Poir.) Woodson	Tree	Churiamai	500	Fallow land	011616780NJ
41	<i>Rauwolfia serpentina</i> (L.) Benth. ex Kurz	Herb	Hetauda, Brindavan	500	Forest	011617804NJ
42	<i>Tabernaemontana divaricata</i> (L.) R. Br. ex Roem. & Schult.	Shrub	Hetauda	500	Fallow land	010106494NJ
43	<i>Trachelospermum lucidum</i> (D. Don) K. Schum.	Climber	Chitlang	1800	Forest	09823278NJ
<b>Aquifoliaceae</b>						
44	<i>Ilex excelsa</i> (Wall.) Hook. f.	Tree	Aghor	2200	Forest	011828108NJ
<b>Araliaceae</b>						
45	<i>Brassaiopsis hainla</i> (Buch.-Ham. ex D. Don) Seem.	Tree	Chitlang	1800	Forest	09924338NJ
46	<i>Hedera nepalensis</i> K. Koch	Climber	Aghor	2200	Forest	09103308NJ
47	<i>Macropanax dispermus</i> (Blume) Kuntze	Tree	Chitlang-2	1800	Forest	01125689NJ
<b>Asclepiadaceae</b>						
48	<i>Asclepias curassavica</i> L.	Herb	Hetauda	500	Fallow land	09815212NJ
49	<i>Calotropis gigantea</i> (L.) Dryad.	Shrub	Hetauda	500	Fallow land	091130362NJ
50	<i>Vallisneria spiralis</i> (L.) Kuntze	Climber	Hetauda	500	Fallow land	011314697NJ
<b>Balsaminaceae</b>						
51	<i>Impatiens bicornuta</i> Wall.	Herb	Rhikheswore, Daman	2000	Forest	09103309NJ
52	<i>Impatiens puberula</i> DC.	Herb	Aghor	2200	Forest	011619874NJ
53	<i>Impatiens serratifolia</i> Hook. f.	Herb	Aghor	2200	Forest	093264NJ
<b>Basellaceae</b>						
54	<i>Basella alba</i> L.	Herb	Handikhola	500	Fallow	0114800NJ
<b>Begoniaceae</b>						
55	<i>Begonia picta</i> Sm.	Herb	Aghor	2200	Forest	09823245NJ
56	<i>Begonia rubella</i> Buch.-Ham. ex D. Don	Herb	Aghor, Simbhanjyang	2300	Forest	09924334NJ

S.N.	Family /Scientific name	Life form	Collection site	Altitude (m)/	Habitat	Voucher no.
<b>Berberidaceae</b>						
58	<i>Berberis aristata</i> DC.	Shrub	Chitlang	1800	Forest	01124652NJ
59	<i>Berberis asiatica</i> Roxb. ex DC.	Shrub	Chitlang	1800	Forest	01124648NJ
60	<i>Berberis wallichiana</i> DC.	Shrub	Simbhanjyang	2400	Forest	
61	<i>Mahonia napaulensis</i> DC.	Shrub	Chitlang	1800	Forest	011619904NJ
62	<i>Podophyllum hexadrum</i> Royle	Herb	Simbhanjyang	2300	Forest	0992432NJ
<b>Betulaceae</b>						
63	<i>Alnus nepalensis</i> D. Don	Tree	Aghor	2200	Forest	01125672NJ
64	<i>Betula alnoides</i> Buch.-Ham. ex D. Don	Tree	Aghor	2200	Forest	011619895NJ
<b>Bignoniaceae</b>						
65	<i>Oroxylum indicum</i> (L.) Kurz	Tree	Hetauda, Piplepokhara	500	Forest	091130357NJ
<b>Bombacaceae</b>						
66	<i>Bombax ceiba</i> L.	Tree	Hetauda	500	Fallow land	092936NJ
<b>Boraginaceae</b>						
67	<i>Bothriospermum zeylanicum</i> (Jacq. F.) Druce	Herb	Chitlang	1800	Fallow land	0931161NJ
68	<i>Cynoglossum furcatum</i> Wall.	Herb	Chitlang	1800	Fallow land	01124628NJ
<b>Buxaceae</b>						
69	<i>Sarcococca coriacea</i> (Hook.) Sweet	Shrub	Chitlang	1800	Forest	09823530NJ
<b>Campanulaceae</b>						
70	<i>Campanula pallida</i> Wall.	Herb	Aghor	2200	Fallow land	0101010588NJ
71	<i>Lobelia chinensis</i> Lour.	Herb	Chitlang	1800	Fallow land	0992410NJ
72	<i>Lobelia heyneana</i> Roem. & Schult.	Herb	Aghor	2200	Fallow land	091130399NJ
73	<i>Lobelia pyramidalis</i> Wall.	Herb	Aghor	2200	Fallow land	09424103NJ
74	<i>Pratia nummularia</i> (Lam.) A. Braun & Asch.	Herb	Aghor	2200	Fallow land	09424123NJ
<b>Cannabaceae</b>						
73	<i>Cannabis sativa</i> L.	Herb	Hetauda	500	Fallow land	0115156NJ
<b>Capparaceae</b>						
74	<i>Crateva unilocularis</i> Buch.-Ham.	Tree	Chitlang	1800	Fallow land	011620911NJ
<b>Caprifoliaceae</b>						
75	<i>Lonicera angustifolia</i> Wall. ex DC.	Shrub	Aghor	2200	Forest	0951142NJ
76	<i>Lonicera lanceolata</i> Wall.	Shrub	Aghor	2200	Forest	0951154NJ
<b>Caryophyllaceae</b>						
77	<i>Drymaria diandra</i> Blume	Herb	Chitlang	1800	Fallow land	0951132NJ
78	<i>Stellaria media</i> (L.) Vill.	Herb	Aghor	2200	Fallow land	0951148NJ
79	<i>Stellaria monosperma</i> Buch.-Ham. ex D. Don	Herb	Aghor, Daman	2300	Forest	09121402NJ
80	<i>Stellaria patens</i> D. Don	Herb	Chitlang	1800	Fallow land	0942496NJ

S.N.	Family /Scientific name	Life form	Collection site	Altitude (m)/	Habitat	Voucher no.
81	<i>Stellaria vestita</i> Kurz	Herb	Chitlang	1800	Fallow land	01125691NJ
<b>Chenopodiaceae</b>						
82	<i>Chenopodium album</i> L.	Herb	Hetauda	500	Fallow land/Farmer field	0931164NJ
83	<i>Chenopodium ambrosioides</i> L.	Herb	Hetauda	500	Fallow land	011620919NJ
<b>Cleomaceae</b>						
84	<i>Ariveia viscosa</i> (L.) Raf.	Herb	Hetauda	500	Fallow	01110902NJ
85	<i>Cleome rutidosperma</i> DC.	Herb	Hetauda, Huprachaur	500	Fallow land	010106492NJ
<b>Combretaceae</b>						
86	<i>Terminalia alata</i> Heyne ex Roth	Tree	Handikhola	500	Forest	010108503NJ
87	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Tree	Churiamai	500	Forest	010104429NJ
88	<i>Terminalia chebula</i> Retz.	Herb	Hetauda, Piplepokhara	500	Forest	010104463NJ
<b>Compositae (Asteraceae)</b>						
89	<i>Acmella calva</i> (DC.) R. K. Jansen	Herb	Hetauda, Piplepokhara	500	Fallow land	091130344NJ
90	<i>Adenostemma lavenia</i> (L.) Kuntze	Herb	Aghor	2200	Fallow land	09924320NJ
91	<i>Ageratina adenophora</i> (Spreng.) R. M. Kind & H. Rob.	Herb	Chitlang	1800	Fallow land	091130389NJ
92	<i>Ageratum conyzoides</i> L.	Herb	Hetauda	500	Fallow land	091130361NJ
93	<i>Ageratum houstonianum</i> Mill.	Herb	Churiamai	600	Fallow land	091130368NJ
94	<i>Ainsliaea latifolia</i> (D. Don) Sch. Bip.	Herb	Aghor, Simbhanjyang	2300	Forest	0951134NJ
95	<i>Anaphalis busua</i> (Buch.-Ham. ex D. Don) DC.	Herb	Aghor, Simbhanjyang	2300	Forest	091130373NJ
96	<i>Anaphalis contorta</i> (D. Don) Hook. f.	Herb	Aghor	2200	Forest	01124663NJ
97	<i>Anaphalis margaritacea</i> (L.) Benth.	Herb	Aghor	2200	Forest	091130375NJ
98	<i>Anaphalis triplinervis</i> (Sims) C. B. Clarke	Herb	Aghor	2200	Forest	0101010578NJ
99	<i>Artemisia indica</i> Willd.	Herb	Hetauda, Piplepokhara	500	Forest	01124642NJ
100	<i>Aster albescens</i> (DC.) Koehne	Herb	Aghor, Simbhanjyang	2300	Forest	09815226NJ
101	<i>Bidens bipinnata</i> L.	Herb	Daman	2300	Fallow land	09815214NJ
102	<i>Bidens pilosa</i> L.	Herb	Daman	2300	Fallow land	011317731NJ
103	<i>Blainvillea acmella</i> (L.) Philipson	Herb	Hetauda, Banaskhandi	500	Fallow land	09103301NJ
104	<i>Blumea lacera</i> (Burm. f.) DC.	Herb	Hetauda	500	Fallow	0931160NJ
105	<i>Blumea hieracifolia</i> (D. Don) DC.	Herb	Hetauda	500	Fallow land	09424106NJ
106	<i>Blumeopsis flava</i> (DC.) Gagnep.	Herb	Hetauda, Banaskhandi	500	Forest	091130321NJ

S.N.	Family /Scientific name	Life form	Collection site	Altitude (m)/	Habitat	Voucher no.
107	<i>Caesulia axillaris</i> Roxb.	Herb	Handikhola	500	Fallow	0931162NJ
108	<i>Chromolaena odorata</i> (L.) R. M. King & H. Rob.	Herb	Hetauda, Piplepokhara	500	Fallow land	091130353NJ
109	<i>Cirsium wallichii</i> DC.	Herb	Chitlang	1800	Fallow land	09815241NJ
110	<i>Conyza leucantha</i> (D. Don) Ludlow & P. H. Raven	Herb	Aghor	2200	Forest	
111	<i>Conyza stricta</i> Willd.	Herb	Aghor	2200	Fallow land	011619905NJ
112	<i>Crassocephalum crepidioides</i> (Benth.) S. Moore	Herb	Chitlang	1800	Fallow land	01182896NJ
113	<i>Dichrocephala integrifolia</i> (L.f.) O. Kuntze	Herb	Aghor	2200	Fallow land	01182899NJ
114	<i>Duhaldea cappa</i> (Buch.-Ham. ex D. Don) A. Anderb.	Herb	Aghor	2200	Forest	010104446NJ
115	<i>Eclipta prostrata</i> (L.) L.	Herb	Hetauda	500	Fallow	09823266NJ
116	<i>Elephantopus scaber</i> L.	Herb	Hetauda, Piplepokhara	500	Fallow land	091130334NJ
117	<i>Emilia sonchifolia</i> (L.) DC.	Herb	Churiamai	600	Fallow	011317748NJ
118	<i>Galinsoga ciliata</i> (Raf.) Blake	Herb	Chitlang	1800	Fallow land	01124657NJ
119	<i>Grangea maderaspatana</i> (L.) Poir.	Herb	Chitlang	1800	Fallow land	01124630NJ
120	<i>Gynura bicolor</i> (Willd.) DC.	Herb	Aghor	2200	Forest	0932684NJ
121	<i>Hemistepta lyrata</i> Bunge	Herb	Aghor	2200	Fallow land	011828104NJ
122	<i>Ixeris polycephala</i> Cass.	Herb	Chitlang	1800	Fallow land	0932577NJ
123	<i>Mikania micrantha</i> Kunth	Climber	Hetauda, Manakamana	500	Fallow land	091130356NJ
124	<i>Myriactis nepalensis</i> Less	Herb	Simbhanjyang	2300	Forest	0101010580NJ
125	<i>Parthenium hysterophorus</i> L.	Herb	Hetauda	500	Fallow land	092818NJ
126	<i>Picris hieracioides</i> L.	Herb	AghorSimbhanjyang	2200	Forest	09815224NJ
127	<i>Pseudognaphalium affine</i> (D. Don) Anderb.	Herb	Chitlang	1800	Fallow land	011828127NJ
128	<i>Rhynchospermum verticillatum</i>	Herb	Aghor	2200	Forest	011828128NJ
129	<i>Sassurea deltoidea</i> (DC.) Sch.-Bip.	Herb	Aghor	2200	Forest	011619884NJ
130	<i>Senecio diversifolius</i> Wall. ex DC.	Herb	Simbhanjyang	2300	Forest	011828130NJ
131	<i>Senecio scandens</i> Buch.-Ham. ex D. Don	Herb	Aghor	2200	Forest	091130382NJ
132	<i>Sonchus asper</i> (L.) Hill	Herb	Chitlang	1800	Forest	0912780NJ
133	<i>Sonchus oleraceus</i> L.	Herb	Chitlang	1800	Fallow	0105238NJ
134	<i>Sphaeranthus indicus</i> L.	Herb	Hetauda, Ratomatte	600	Fallow land	09815199NJ
135	<i>Taraxacum officinale</i> F. H. Wigg.	Herb	Chitlang	1800	Fallow land	0932689NJ
136	<i>Tragopogon gracilis</i> D. Don	Herb	Chitlang	1800	Fallow land	011414478NJ
137	<i>Tridax procumbens</i> L.	Herb	Hetauda	500	Fallow land	091130367NJ

S.N.	Family /Scientific name	Life form	Collection site	Altitude (m)/	Habitat	Voucher no.
138	<i>Vernonia cinera</i> (L.) Less.	Herb	Hetauda, Piplepokhara	500	Fallow land	091130348NJ
139	<i>Xanthium indicum</i> Roxb.	Herb	Hetauda	500	Fallow land	0992456NJ
140	<i>Youngia japonica</i> (L.) DC.	Herb	Chitlang	1800	Fallow	0932693NJ
<b>Convolvulaceae</b>						
141	<i>Convolvulus arvensis</i> L.	Creeping herb	Hetauda	500	Fallow land	09613165NJ
142	<i>Cuscuta reflexa</i> Roxb*.	Climber	Hetauda	500	Fallow land	092931NJ
143	<i>Evolvulus alsinoides</i> (L.) L.	Herb	Churiamai	500	Fallow land	010104437NJ
144	<i>Evolvulus nummularius</i> (L.) L.	Herb	Churiamai	500	Fallow land	010104437NJ
145	<i>Ipomoea aquatica</i> Forssk.**	Creeping herb	Hetauda	500	Wetland	095311NJ
146	<i>Merremia hirta</i> (L.) Merr. (New reported species for Nepal)	Creeping herb	Handikhola	500	Fallow land	010108514NJ
147	<i>Merremia umbellata</i> (L.) Hallier f.	Creeping herb	Handikhola	500	Fallow land	0992411NJ
<b>Cordiaceae</b>						
148	<i>Cordia dichotoma</i> J. R. Forst.	Tree	Handikhola	500	Forest	010108534NJ
149	<i>Ehretia laevis</i> Roxb.	Tree	Hetauda	500	Forest	09924381NJ
<b>Coriariaceae</b>						
150	<i>Coriaria napalensis</i> Wall.	Shrub	Aghor	2200	Forest	092839NJ
<b>Cruciferae (Brassicaceae)</b>						
151	<i>Capsella bursa-pastoris</i> (L.) Medik.	Herb	Chitlang-4	1800	Fallow land	01124619NJ
152	<i>Cardamine flexuosa</i> With.	Herb	Chitlang	1800	Fallow land	0932695NJ
153	<i>Rorripa indica</i> (L.) Hiern	Herb	Chitlang	1800	Fallow land	010109578NJ
154	<i>Rorripa nasturtium-aquaticum</i> (L.) Hayek**	Creeping herb	Chitlang	1800	Wetland	0105743NJ
<b>Cucurbitaceae</b>						
155	<i>Diplocyclos palmatus</i> (L.) C. Jeffery	Climber	Aghor	2200	Forest	09924380NJ
156	<i>Herpetospermum pedunculatum</i> (Ser.) Baill.	Climber	Aghor, Simbhanjyang	2300	Forest	09815206NJ
157	<i>Mukia maderaspatana</i> (L.) Roem.	Climber	Hetauda	500	Forest	
158	<i>Solena amplexicaulis</i> (Lam.) Gandhi	Climber	Aghor	2200	Forest	010104477NJ
159	<i>Trichosanthes tricuspidata</i> Lour.	Climber	Aghor	2200	Forest	09815239NJ
160	<i>Trichosanthes wallichiana</i> (Ser.) Wight	Climber	Chitlang	1800	Forest	010108520NJ
<b>Dilleniaceae</b>						
161	<i>Dillenia pentagyna</i> Roxb.	Tree	Hetauda	500	Forest	010108507NJ
<b>Dipsacaceae</b>						
162	<i>Dipsacus inermis</i> Wall.	Herb	Aghor	2200	Forest	011619879NJ
<b>Dipterocarpaceae</b>						
163	<i>Shorea robusta</i> Gaertn.	Tree	Hetauda	500	Forest	092824NJ



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<b>Droseraceae</b>						
164	<i>Drosera peltata</i> var. <i>lunata</i> (Buch.-Ham. ex DC.) C. B. Clarke***	Herb	Chitlang	1800	Fallow land	011619910NJ
<b>Elaeagnaceae</b>						
165	<i>Elaeagnus infundibularis</i> Momiy.	Shrub	Chitlang	1800	Forest	011414754NJ
166	<i>Elaeagnus parviflora</i> Wall. ex Royle	Shrub	Aghor	2200	Forest	0951144NJ
<b>Ericaceae</b>						
167	<i>Gaultheria fragrantissima</i> Wall.	Shrub	Aghor	2200	Forest	0101010585NJ
168	<i>Gaultheria nummuarioides</i> D. Don	Herb	Aghor	2200	Forest	0101010585NJ
169	<i>Lyonia ovalifolia</i> (Wall.) Drude	Tree	Chitlang	1800	Forest	01124627NJ
170	<i>Pieris formosa</i> (Wall.) D. Don	Shrub	Simbhanjyang	2300	Forest	09103310NJ
171	<i>Rhododendron arboreum</i> Sm.	Tree	Aghor, Simbhanjyang	2300	Forest	01124647NJ
172	<i>Rhododendron lepidotum</i> Wall. ex G. Don	Shrub	Daman			09424105NJ
<b>Euphorbiaceae</b>						
173	<i>Antidesma acidum</i> Retz.	Tree	Churiamai	600	Forest	010104473NJ
174	<i>Croton caudatus</i> Geisel	Tree	Hetauda	500	Forest	011318722NJ
175	<i>Euphorbia hirta</i> L.	Herb	Hetauda	500	Fallow land	0951140NJ
176	<i>Euphorbia parviflora</i> L.	Herb	Handikhola	500	Fallow land	011617793NJ
177	<i>Euphorbia prostrata</i> Aiton	Herb	Hetauda	500	Fallow land	011317738NJ
178	<i>Mallotus philippinensis</i> (Lam.) Muell. Arg.	Tree	Handikhola	500	Forest	010108535NJ
179	<i>Manihot esculenta</i> Crantz	Shrub	Hetauda	500	Fallow land	011828114NJ
180	<i>Phyllanthus amarus</i> Schumach. & Thonn.	Herb	Hetauda	500	Fallow land	09815197NJ
181	<i>Phyllanthus emblica</i> L.	Tree	Churiamai	600	Forest	010104454NJ
182	<i>Phyllanthus parvifolius</i> Buch.-Ham. ex D. Don	Herb	Chitlang-4	1800	Forest	01124622NJ
183	<i>Phyllanthus reticulatus</i> Poir.	Shrub	Churiamai	600	Forest	0932688NJ
184	<i>Phyllanthus urinaria</i> L.	Herb	Hetauda	500	Fallow land	09711183NJ
185	<i>Sapium insigne</i> (Royle) Benth. ex Hook. f.	Tree	Churiamai	600	Forest	011314700NJ
<b>Fagaceae</b>						
186	<i>Castanopsis indica</i> (Roxb.) Miq.	Tree	Handikhola	500	Forest	010108508NJ
187	<i>Castanopsis tribuloides</i> (Sm.) A. DC.	Tree	Churiamai	600	Forest	010104435NJ
188	<i>Cyclobalanopsis glauca</i> (Thunb.) Oersted	Tree	Chitlang-4	1800	Forest	09815245NJ
189	<i>Cyclobalanopsis lamellosa</i> (Sm.) Oersted	Tree	Aghor	2200	Forest	011613875NJ
190	<i>Quercus lanata</i> Sm.	Tree	Chitlang	1800	Forest	092944NJ
191	<i>Quercus semecarpifolia</i> Sm.	Tree	Aghor	2200	Forest	011619883NJ
<b>Flacourtiaceae</b>						
192	<i>Xylosma controversum</i> Clos	Shrub	Aghor	2200	Forest	0951150NJ

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<b>Gentianaceae</b>						
193	<i>Canscora decussata</i> (Roxb.) Schult. & Schult. f.	Herb	Hetauda, Manakamana	600	Fallow land	0911305NJ
194	<i>Gentiana capitata</i> Buch.-Ham. ex D. Don	Herb	Chitlang	1800	Fallow land	01124655NJ
195	<i>Gentiana pedicellata</i> (D. Don) Griseb.	Herb	Chitlang	1800	Fallow land	0942499NJ
196	<i>Swertia angustifolia</i> Buch.-Ham ex D. Don	Herb	Hetauda, Manakamana	600	Forest	091130359NJ
197	<i>Swertia chirayita</i> (Roxb. ex Fleming ) H. Karst.	Herb	Aghor	2200	Forest/Farmer field	0101010587NJ
198	<i>Swertia nervosa</i> (G. Don) C. B. Clarke	Herb	Aghor	2200	Forest	011619844NJ
<b>Geraniaceae</b>						
199	<i>Geranium nepalense</i> Sweet	Herb	Aghor	2200	Fallow land	09613170NJ
<b>Gesneriaceae</b>						
200	<i>Chirita urticifolia</i> Buch.-Ham. ex D. Don	Herb	Chitlang	1800	Forest	
201	<i>Didymocarpus pedicellatus</i> R. Br.*****	Herb	Aghor	2200	Forest	09823264NJ
201	<i>Platystemma violoides</i> Wall.*****	Herb	Daman	2400	Forest	011619901NJ
<b>Grossulariaceae</b>						
203	<i>Ribes himalense</i> Royle ex Decne.	Shrub	Simbhanjyang	2500	Forest	0992437NJ
<b>Hydrangeaceae</b>						
204	<i>Deutzia staminea</i> R. Br. ex Wall.	Shrub	Chitlang	1800	Forest	0951131NJ
205	<i>Dichroa febrifuga</i> Lour.	Shrub	Aghor	2200	Forest	091130394NJ
206	<i>Hydrangea aspera</i> Buch.-Ham. ex D. Don	Shrub	Aghor	2200	Forest	09121397NJ
<b>Hypericaceae</b>						
207	<i>Hypericum elodeoides</i> Choicy	Herb	Aghor	2200	Forest	011828107NJ
208	<i>Hypericum japonicum</i> Thunb. ex Murray	Herb	Chitlang	1800	Fallow land	09815233NJ
209	<i>Hypericum uralum</i> Buch.-Ham. ex D. Don	Herb	Aghor	2200	Forest	091130395NJ
<b>Icacinaceae</b>						
210	<i>Natsiatum herpeticum</i> Buch.-Ham. ex Arn.	Climber	Hetauda	500	Forest	011828119NJ
<b>Juglandaceae</b>						
211	<i>Engelhardia spicata</i> var.	Tree	Hetauda	500	Forest	09424108NJ
212	<i>Juglans regia</i> var. <i>kamaonia</i> C. DC.	Tree	Chitlang	1800	Forest	0932687NJ
<b>Labiatae (Lamiaceae)</b>						
213	<i>Anisomelos indica</i> (L.) Kuntze	Herb	Hetauda, Piplepokhara	500	Fallow land	0101011601NJ
214	<i>Callicarpa macrophylla</i> Vahl	Shrub	Hetauda, Manakamna	600	Fallow land	091130349NJ
215	<i>Caryopteris odorata</i> (D. Don) B. L. Robinson	Shrub	Chitlang	1800	Forest	091130383NJ
216	<i>Clerodendrum indicum</i> (L) Kuntze	Herb	Hetauda	500	Fallow land	09424107NJ
217	<i>Clinopodium piperitum</i> (D. Don)	Herb	Aghor	2200	Forest	09924489NJ

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218	<i>Clinopodium umbrosum</i> (M. Bieb.) Kuntze	Herb	Aghor	2200	Fallow land	09924987NJ
219	<i>Colebrookia oppositifolia</i> Sm.	Herb	Hetauda, Piplepokhara	500	Fallow land	091130330NJ
220	<i>Colquhounia coccinea</i> Wall.	Shrub	Simbhanjyang	2400	Forest	09815204NJ
221	<i>Dysophylla auriculata</i> (L.)Bl.	Herb	Handikhola	500	Forest	010108542NJ
222	<i>Elsholtzia blanda</i> (Benth.) Benth.	Herb	Aghor	2200	Forest	091130334NJ
223	<i>Elsholtzia flava</i> (Benth.) Benth.	Herb	Chitlang	1800	Forest	09924276NJ
224	<i>Geniosporum coloratum</i> (D. Don) Kuntze	Herb	Hetauda, Brindavan	500	Forest	09815230NJ
225	<i>Gmelina arborea</i> Roxb.	Tree	Churiamai	600	Forest	011314704NJ
226	<i>Holmskioldia sanguinea</i> Retz.	Shrub	Hetauda	500	Fallow land	
227	<i>Hyptis suaveolens</i> (L.) Poit.	Herb	Hetauda, Banaskhandi	500	Fallow land	091130324NJ
228	<i>Isodon coetsa</i> (Buch.-Ham. ex D. Don) Kudo	Herb	Hetauda, Piplepokhara	500	Forest	011828109NJ
229	<i>Isodon lophanthoides</i> (Buch.-Ham. ex D. Don) H. Hara	Herb	Aghor	2200	Forest	09424121NJ
230	<i>Lamium amplexicaule</i> L.	Herb	Chitlang	1800	Fallow land	01124640NJ
231	<i>Leucas mollissima</i> Wall. ex Benth.	Herb	Hetauda, Banaskhandi	500	Fallow land	091255NJ
232	<i>Leucocephalum canum</i> Sm.	Tree	Chitlang	1800	Forest	09424NJ
233	<i>Mentha spicata</i> L.	Herb	Chitlang	1800	Fallow land/Home garden	09823249NJ
234	<i>Micromeria biflora</i> (Buch.-Ham. ex D. Don) Benth.	Herb	Chitlang	1800	Fallow land	01124646NJ
235	<i>Ocimum americanum</i> L.	Herb	Hetauda	500	Forest	011828120NJ
236	<i>Orthosiphon incurvus</i> Benth.	Herb	Hetauda, Brindavan	500	Forest	011828121NJ
237	<i>Perilla frutescens</i> (L.) Britton	Herb	Hetauda	500	Fallow land	09121411NJ
238	<i>Pogostemon benghalensis</i> (Burm. f.) Kuntze	Herb	Hetauda, Ratomatte	500	Fallow land	0932568NJ
239	<i>Pogostemon glaber</i> Benth.	Herb	Handikhola	500	Fallow land	010108511NJ
240	<i>Premna barbata</i> Wall. ex Schauer	Shrub	Churiamai	600	Forest	010104443NJ
241	<i>Prunella vulgaris</i> L.	Herb	Aghor	2200	Forest	0101010579NJ
242	<i>Salvia plebeia</i> R. Br.	Herb	Hetauda	500	Fallow land	0959155NJ
243	<i>Scutellaria barbata</i> D. Don	Herb	Chitlang	1800	Forest	0942497NJ
244	<i>Scutellaria discolor</i> Colebr.	Herb	Chitlang-4	1800	Forest	01124616NJ
245	<i>Teucrium quadrifarium</i> Buch.-Ham. ex D. Don	Herb	Aghor	2200	Forest	09924298NJ
	<b>Lardijabalaceae</b>					
246	<i>Holboellia latifolia</i> Wall.	Climber	Chitlang	1800	Forest	099244NJ
	<b>Lauraceae</b>					
247	<i>Cinnamomum tamala</i> (Buch.-Ham.)	Tree	Aghor	2200	Forest/Ho	091252NJ
248	<i>Lindera neesiana</i> (Wall. ex Nees) Kurz	Tree	Chitlang	1800	Forest	09711183NJ

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249	<i>Lindera pulcherrima</i> (Nees) Benth. ex Hook. f.	Tree	Chitlang	1800	Forest	0932579NJ
250	<i>Litsea glutinosa</i> (Lour.) C. B. Rob.	Tree	Churiamai	600	Forest	09320634NJ
251	<i>Persea duthiei</i> (King ex Hook. F.) Kosterm	Tree	Chitlang	1800	Forest	09823526NJ
252	<i>Persea odoratissima</i> (Nees) Kosterm.	Tree	Chitlang	1800	Forest	091130390NJ
<b>Lecythydaceae</b>						
253	<i>Careya arborea</i> Roxb.	Tree	Hetauda	500	Forest	011314703NJ
<b>Leeaceae</b>						
254	<i>Leea asiatica</i> (L.) C. E. Ridsdale	Shrub	Handikhola	500	Forest	011617821NJ
<b>Leguminosae (Fabaceae)</b>						
255	<i>Acacia catechu</i> (L.f.) Willd.	Tree	Hetauda,	500	Fallow	01132022NJ
256	<i>Acacia pennata</i> (L. f.) Willd.	Shrub	Hetauda, Brindavan	500	Forest	01132059NJ
257	<i>Aeschynomene indica</i> L.	Herb	Handikhola	500	Fallow land	010108558NJ
258	<i>Albizia julibrissin</i> Durazz.	Tree	Chitlang	1800	Forest	0951127NJ
259	<i>Alysicarpus vaginalis</i> (L.) DC.	Creeping herb	Handikhola	500	Fallow land	0118283NJ
260	<i>Bauhinia purpurea</i> L.	Tree	Churiamai	600	Forest/Ho megarden	010104441NJ
261	<i>Bauhinia vahlii</i> Wight & Arn.	Climber	Churiamai	600	Forest	010104465NJ
262	<i>Bauhinia variegata</i> L.	Tree	Aghor	2200	Fallow land/Home garden	0951151NJ
263	<i>Meizotropis buteiformis</i> Voigt	Shrub	Churiamai	600	Fallow land	0101011609NJ
264	<i>Caesalpinia decapetala</i> (Roth)	Shrub	Simbhanjyang	2300	Forest	011619906NJ
265	<i>Cajanus scarabaeoides</i> (L. ) du Petit-Thou	Creeping herb	Handikhola	500	Fallow land	010108515NJ
266	<i>Campylotropis speciosa</i> (Royle ex Schindl.) Schindl.	Shrub	Aghor	2200	Forest	09103315NJ
267	<i>Cassia fistula</i> L.	Tree	Hetauda	500	Fallow land	091130370NJ
268	<i>Chamaecrista mimosoides</i> (L.) Greene	Herb	Handikhola	500	Fallow land	010108546NJ
269	<i>Codariocalyx motorius</i> (Houtt.) H. Ohashi	Creeping herb	Hetauda, Banaskhandi	500	Fallow land	09103302NJ
270	<i>Codariocalyx gyroides</i> (Roxb. ex Link) Hassk	Creeping herb	Hetauda	500	Fallow land	09121406NJ
271	<i>Crotalaria acicularis</i> Buch.-Ham. ex Benth.	Herb	Hetauda, Brindavan	500	Fallow land	0911306NJ
272	<i>Crotalaria alata</i> Buch.-Ham. ex D. Don	Herb	Handikhola	500	Fallow land	010108560NJ
273	<i>Crotalaria albida</i> Heyne ex Roth	Herb	Hetauda, Piplepokhara	500	Fallow land	0101010514NJ
274	<i>Crotalaria humifusca</i> Graham ex Benth.	Herb	Aghor	2200	Fallow land	0911307NJ
275	<i>Crotalaria pallida</i> Aiton	Herb	Handikhola	500	Fallow land	010108545NJ

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276	<i>Crotalaria sessiliflora</i> L.	Herb	Hetauda, Banaskhandi	500	Fallow land	010109570NJ
277	<i>Dalbergia latifolia</i> Roxb.	Tree	Hetauda, Manahari	500	Forest	
278	<i>Dalbergia sissoo</i> Roxb. ex DC.	Tree	Hetauda	500	Forest	011315711NJ
279	<i>Desmodium concinnum</i> DC.	Herb	Aghor	2200	Forest	09924292NJ
280	<i>Desmodium confertum</i> DC.	Herb	Churiamai	600	Forest	010104460NJ
281	<i>Desmodium heterocarpon</i> (L.) DC.	Herb	Churiamai	600	Forest	091130385NJ
282	<i>Desmodium laxiflorum</i> DC.	Herb	Handikhola	500	Forest	010108553NJ
283	<i>Desmodium microphyllum</i> (Thunb.) DC.	Herb	Churiamai	600	Forest	09320604NJ
284	<i>Desmodium oojeinense</i> (Roxb.) H. Ohashi	Tree	Churiamai	600	Forest	011314702NJ
285	<i>Desmodium podocarpum</i> DC.	Herb	Chitlang	1800	Forest	09823269NJ
286	<i>Desmodium triflorum</i> (L.) DC.	Herb	Hetauda	500	Forest	011317737NJ
287	<i>Erythrina arborescens</i> Roxb.	Tree	Hetauda	500	Forest	011620907NJ
288	<i>Flemingia macrophylla</i> (Willd.) Merr.	Herb	Churiamai, Piplepokhara	600	Forest	010104447NJ
289	<i>Flemingia strobilifera</i> (L.) W. T. Aiton	Herb	Hetauda, Banaskhandi	500	Forest	091130319NJ
290	<i>Indigofera bracteata</i> Graham ex Baker	Herb	Aghor	2200	Forest	011619848NJ
291	<i>Indigofera heterantha</i> Wall. ex Baker	Herb	Chitlang	1800	Forest	09815232NJ
292	<i>Indigofera linifolia</i> (L.f.) Retz.	Herb	Handikhola	500	Fallow land	010108563NJ
293	<i>Indigofera cassioides</i> Rottler ex DC.	Shrub	Churiamai	600	Forest	010104474NJ
294	<i>Lathyrus aphaca</i> L.	Herb	Chitlang	1800	Fallow land	0932578NJ
295	<i>Lotus corniculatus</i> L.	Herb	Chitlang	1800	Fallow land	011620912NJ
296	<i>Medicago lupulina</i> L.	Herb	Hetauda	500	Fallow land	011828115NJ
297	<i>Meliolotus indica</i> (L.) All.	Herb	Hetauda	500	Fallow land	011828116NJ
298	<i>Milletia fructicosa</i> (DC.) Benth. ex Baker	Shrub	Churiamai	600	Forest	010104453NJ
299	<i>Mimosa pudica</i> L.	Herb	Hetauda, Piplepokhara	500	Fallow land	091130338NJ
300	<i>Mimosa rubicaulis</i> Lam.	Herb	Hetauda, Brindavan	500	Forest	09815195NJ
301	<i>Mucuna puriens</i> (L.) DC.	Climber	Chitlang	1800	Forest	010109577NJ
302	<i>Parochetus communis</i> Buch.-Ham. ex D. Don	Creeping herb	Chitlang	1800	Fallow land	011828123NJ
303	<i>Piptanthus nepalensis</i> (Hook.) D. Don	Shrub	Chitlang	1800	Forest	09711184NJ
304	<i>Pueraria peduncularis</i> (Roxb.) Benth.	Climber	Handikhola	500	Forest	010108543NJ
305	<i>Senna floribunda</i> (Cav.) H. S. Irwin	Herb	Chitlang	1800	Fallow land	011828129NJ
306	<i>Senna occidentalis</i> (L.) Link	Herb	Hetauda, Huprachaur	500	Fallow land	010106496NJ

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307	<i>Senna tora</i> (L.) Roxb.	Herb	Hetauda, Huprachaur	500	Fallow land	09815229NJ
308	<i>Stylosanthes hamata</i> (L.) Taub.	Shrub	Hetauda, Hatia	500	Fallow land	0101011605NJ
309	<i>Tamarindus indica</i> L.	Tree	Hetauda	500	Fallow land/Home garden	0911308NJ
310	<i>Uraria lagopus</i> DC.	Herb	Hetauda,	500	Forest	091256NJ
311	<i>Uraria rufescens</i> (DC.) Schindl.	Herb	Hetauda,	500	Forest	010108540NJ
312	<i>Vicia angustifolia</i> L.	Herb	Hetauda	500	Fallow land	092821NJ
313	<i>Vicia hirsuta</i> (L.) Gray	Herb	Chitlang	1800	Fallow land	09424126NJ
314	<i>Vicia sativa</i> L.	Herb	Chitlang	1800	Fallow land	0932690NJ
<b>Linaceae</b>						
315	<i>Reinwardtia indica</i> Dumort.	Herb	Hetauda,	500	Fallow	091130341NJ
<b>Loranthaceae</b>						
316	<i>Dendrophthoe falcata</i> (L.f.) Etting.*	Shrub	Churiamai	600	Forest	09121424NJ
317	<i>Helixanthera ligustrina</i> (Wall.) Danser*	Shrub	Chitlang	1800	Forest	0951146NJ
318	<i>Scurrula elata</i> (Edgew.) Danser*	Shrub	Daman	2300	Forest	09711177NJ
319	<i>Scurrula parasitica</i> L.*	Shrub	Chitlang	1800	Forest	01124643NJ
320	<i>Taxillus umbellifer</i> (Schult.) Danser*	Shrub	Churiamai, Hetauda	600	Forest	0932571NJ
<b>Lythraceae</b>						
321	<i>Ammannia auriculata</i> Willd.	Herb	Hetauda	500	Fallow land	092811NJ
322	<i>Ammannia baccifera</i> L.	Herb	Hetauda	500	Fallow land	09815188NJ
323	<i>Lagerstroemia parviflora</i> Roxb.	Tree	Handikhola	500	Forest	010108524NJ
324	<i>Lawsonia inermis</i> L.	Shrub	Hetauda	500	Fallow land	0101011607NJ
325	<i>Rotala indica</i> (Willd.) Koehne	Herb	Hetauda	500	Fallow land	09103305NJ
326	<i>Rotala rotundifolia</i> (Buch.-Ham. ex	Herb	Hetauda, Brin	500	Fallow	09424112NJ
327	<i>Woodfordia fruticosa</i> (L.) Kurz	Shrub	Churiamai	600	Forest	010104476NJ
<b>Magnoliaceae</b>						
328	<i>Michelia champaca</i> L.	Tree	Handikhola	500	Forest	011620917NJ
<b>Malvaceae</b>						
329	<i>Abelmoschus moschatus</i> Medik.	Herb	Hetauda	500	Fallow land	010109571NJ
330	<i>Malva verticillata</i> L.	Herb	Hetauda	500	Fallow land/Farm ar field	011620908NJ
331	<i>Sida acuta</i> Burm. f.	Herb	Hetauda,	500	Fallow	010104485NJ
332	<i>Sida cordata</i> (Burm. f.) Borss.	Herb	Churiamai	600	Fallow land	010104484NJ
333	<i>Sida cordifolia</i> L.	Herb	Churiamai	600	Fallow land	0111011606NJ
334	<i>Thespesia lampas</i> (Cav.) Dalzell & Gibson	Herb	Churiamai	600	Forest	010104472NJ
335	<i>Urena lobata</i> L.	Herb	Hetauda,	500	Fallow	091130347NJ

S.N.	Family /Scientific name	Life form	Collection site	Altitude (m)/	Habitat	Voucher no.
<b>Melastomaceae</b>						
336	<i>Melastoma malabathricum</i> L.	Herb	Churiamai	600	Forest	010104423NJ
337	<i>Melastoma normale</i> D. Don	Herb	Hetauda, Pip	500	Forest	091130337NJ
338	<i>Osbeckia chinensis</i> L.	Herb	Chitlang-9	1800	Forest	01125667NJ
339	<i>Osbeckia nepalensis</i> Hook.	Herb	Chitlang	1800	Forest	09823272NJ
340	<i>Osbeckia nutans</i> Wall. ex C. B. Clarke	Herb	Churiamai	600	Forest	010104459NJ
341	<i>Osbeckia stellata</i> Buch.-Ham. ex D. Don	Herb	Aghor	2200	Forest	011828122NJ
342	<i>Oxysspora paniculata</i> (D. Don) DC.	Herb	Chitlang	1800	Forest	0992420NJ
<b>Meliaceae</b>						
343	<i>Azadirachta indica</i> A. Juss.	Tree	Hetauda	500	Fallow land	09924330NJ
344	<i>Heynea trijuga</i> Roxb. ex Sims	Tree	Handikhola	500	Forest	099243NJ
345	<i>Toona ciliata</i> M. Roem.	Tree	Aghor	2200	Forest	011828134NJ
<b>Menispermaceae</b>						
346	<i>Cissampelos pareira</i> L.	Climber	Aghor	2200	Forest	09424118NJ
347	<i>Stephania elegans</i> Hook. f. & Thoms.	Climber	Aghor	2200	Forest	0992449NJ
348	<i>Stephania glandulifera</i> Miers	Climber	Chitlang	1800	Forest	09924295NJ
349	<i>Tinospora sinensis</i> (Lour.) Merr.	Climber	Handikhola	500	Forest	010108520NJ
<b>Moraceae</b>						
350	<i>Artocarpus heterophyllus</i> Lam.	Tree	Hetauda	500	Fallow land/Home garden	09924327NJ
351	<i>Artocarpus lakoocha</i> Wall. ex Roxb.	Tree	Handikhola	500	Forest	011617789NJ
352	<i>Ficus glomerata</i> Roxb.	Tree	Chitlang	1800	Forest	010108526NJ
353	<i>Ficus hispida</i> L.f.	Tree	Handikhola	500	Forest	010108530NJ
354	<i>Ficus lacor</i> Buch.-Ham.	Tree	Churiamai	600	Forest/Homestead	09320611NJ
355	<i>Ficus oligodon</i> Miq.	Tree	Churiamai	600	Forest	010104457NJ
356	<i>Ficus nervosa</i> Heyne ex Roth var. <i>nervosa</i>	Tree	Handikhola	500	Forest	010108523NJ
357	<i>Ficus sarmentosa</i> Buch.-Ham. ex D. Don****	Climber	Chitlang	1800	Forest	01124638NJ
358	<i>Ficus semicordata</i> Buch.-Ham. ex D. Don	Tree	Hetauda	500	Fallow land	092932NJ
359	<i>Maclura cochinchinensis</i> (Lour.) Corner	Climber	Chitlang	1800	Forest	011619900NJ
360	<i>Morus serrata</i> Roxb.	Tree	Hetauda	500	Fallow land/Home garden	010104436NJ
<b>Moringaceae</b>						
361	<i>Moringa oleifera</i> Lam.	Herb	Hetauda	500	Fallow land/Home garden	011828117NJ
<b>Myricaceae</b>						
362	<i>Myrica esculenta</i> Buch.-Ham. ex D. Don	Tree	Chitlang-4	1800	Forest	01124623NJ
<b>Myrsinaceae</b>						
363	<i>Maesa chisia</i> Buch.-Ham. ex D. Don	Shrub	Aghor	2200	Forest	092841NJ

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364	<i>Maesa macrophylla</i> (Wall.) A. DC.	Shrub	Churiamai	600	Forest	010104470NJ
365	<i>Myrsine africana</i> L.	Shrub	Chitlang	1800	Forest	01124649NJ
366	<i>Myrsine capitellata</i> Wall.	Tree	Churiamai	600	Forest	010104472NJ
367	<i>Myrsine semiserrata</i> Wall.	Tree	Aghor	2200	Forest	011828118NJ
<b>Myrtaceae</b>						
368	<i>Cleistocalyx operculatus</i> (Roxb.) Merr. Perry	Tree	Churiamai	600	Forest	010104458NJ
369	<i>Eugenia Jambolana</i> Lam.	Tree	Handikhola	500	Forest	011617806NJ
370	<i>Syzygium cumini</i> (L.) Skeels	Tree	Churiamai	600	Forest/Ho megarden	010104452NJ
<b>Nyctaginaceae</b>						
371	<i>Boerhavia diffusa</i> L.	Herb	Hetauda, Huprachaur	500	Fallow land	010106495NJ
<b>Oleaceae</b>						
372	<i>Jasminum dispersum</i> Wall.	Climber	Chitlang	1800	Forest	01125669NJ
373	<i>Jasminum humile</i> L.	Shrub	Chitlang	1800	Forest/Ho megarden	0951129NJ
374	<i>Ligustrum nepalense</i> Wall.	Shrub	Chitlang	1800	Forest	01124624NJ
<b>Onagraceae</b>						
375	<i>Ludwigia hyssopifolia</i> (G. Don) Exell	Herb	Handikhola	500	Wetland	010108541NJ
376	<i>Ludwigia octovalvis</i> (Jacq.) P. H.	Herb	Handikhola	500	Wetland	010108513NJ
377	<i>Oenothera rosea</i> L'Her. ex Aiton	Herb	Hetauda	500	Fallow land	0932567NJ
<b>Orobanchaceae</b>						
378	<i>Aeginetia indica</i> L.*	Herb	Hetauda, Brindavan	500	Forest	09815186NJ
379	<i>Orobanche aegyptiaca</i> Pers.*	Herb	Hetauda	500	Mustard field	0951304NJ
<b>Oxalidaceae</b>						
380	<i>Oxalis corniculata</i> L.	Herb	Chitlang	1800	Fallow land	092953NJ
381	<i>Oxalis corymbosa</i> DC.	Herb	Hetauda	500	Fallow land	09121415NJ
382	<i>Oxalis latifolia</i> Humb.	Herb	Hetauda	500	Fallow land	09613166NJ
<b>Papaveraceae</b>						
383	<i>Argemone mexicana</i> L.	Herb	Hetauda	500	Fallow land	011317749NJ
384	<i>Corydalis chaerophylla</i> DC.	Herb	Aghor	2200	Forest	09103307NJ
385	<i>Corydalis longipes</i> DC.	Herb	Aghor	2200	Forest	0118287NJ
386	<i>Dicentra scandens</i> (D. Don) Walp.	Climber	Aghor	2200	Forest	09103313NJ
387	<i>Fumaria parviflora</i> Lam.	Herb	Chitlang	1800	Farmer field	09311NJ
<b>Passifloraceae</b>						
388	<i>Passiflora foetida</i> L.	Creeping herb	Churiamai	600	Fallow land	011828124NJ
<b>Phytolaccaceae</b>						
389	<i>Phytolacca acinosa</i> Roxb.	Herb	Aghor	2200	Forest/Ho megarden	011619896NJ
<b>Piperaceae</b>						
390	<i>Peperomia pellucida</i> (L.) Kunth	Herb	Chitlang	1800	Forest	09815234NJ



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391	<i>Peperomia tetraphylla</i> (G. Forst.) Hook. & Arn.****	Herb	Chitlang	1800	Forest	01124661NJ
392	<i>Piper longum</i> L.	Climber	Handikhola	500	Homegarden	010108536NJ
393	<i>Piper mullesua</i> D. Don****	Herb	Chitlang	1800	Forest	01124639NJ
394	<i>Piper nepalense</i> Miq.	Herb	Chitlang	1800	Forest	01124625NJ
395	<i>Piper wallichii</i> (Miq.) Hand.-Mazz.	Climber	Aghor	2300	Forest	091130379NJ
<b>Plantaginaceae</b>						
396	<i>Plantago erosa</i> Wall.	Herb	Aghor	2200	Fallow land	0101010677NJ
<b>Plumbaginaceae</b>						
397	<i>Plumbago zeylanica</i> L.	Herb	Hetauda	500	Fallow land	092819NJ
<b>Polygonaceae</b>						
398	<i>Aconogonum molle</i> (D. Don) H. Hara	Herb	Chitlang-9	1800	Forest	0932575NJ
399	<i>Fagopyrum dibotrys</i> (D. Don) H. Hara	Herb	Chitlang	1800	Fallow land	09815225NJ
400	<i>Persicaria barbata</i> (L.) H. Hara	Herb	Aghor	2000	Forest	011828125NJ
401	<i>Persicaria capitata</i> (Buch.-Ham. ex D. Don) H. Gross	Herb	Aghor	2000	Forest	09924299NJ
402	<i>Persicaria chinensis</i> var. <i>bracteata</i> (Lam.) H. Hara	Herb	Aghor	2200	Forest	091130380NJ
403	<i>Persicaria hydropiper</i> (L.) Spach	Herb	Hetauda	500	Fallow land	09424110NJ
404	<i>Persicaria nepalensis</i> (Meisn.) H. Gross	Herb	Aghor	2200	Fallow land	09924296NJ
405	<i>Persicaria posumbo</i> (Buch.-Ham ex	Herb	Aghor	2200	Fallow	09924300NJ
406	<i>Persicaria runcinata</i> (Buch.-Ham. ex D. Don) H. Gross	Herb	Aghor	2200	Fallow land	0101010582NJ
407	<i>Persicaria viscosa</i> (Buch.-Ham. ex D. Don) Nakai	Herb	Hetauda	500	Fallow land	011317732NJ
408	<i>Polygonum chinensis</i> var. <i>ovalifolia</i> (Meisn.) H. Hara	Herb	Aghor	2200	Forest	09103318NJ
409	<i>Polygonum plebeium</i> R. Br.	Herb	Hetauda	500	Fallow land	011317742NJ
410	<i>Rumex nepalensis</i> Spreng.	Herb	Aghor	2200	Fallow land	09613164NJ
<b>Portulacaceae</b>						
411	<i>Portulaca oleracea</i> L.	Herb	Handikhola	500	Fallow land	010109578NJ
<b>Primulaceae</b>						
412	<i>Anagallis arvensis</i> L.	Herb	Chitlang	1800	Forest	092952NJ
413	<i>Lysimachia alternifolia</i> Wall.	Herb	Hetauda,	600	Forest	09815194NJ
414	<i>Primula atrodentata</i> W. W. Sm.	Herb	Aghor	2200	Forest	09815244NJ
415	<i>Primula denticulata</i> Sm.	Herb	Simbhanjyang	2300	Forest	09424104NJ
<b>Ranunculaceae</b>						
416	<i>Aconitum ferox</i> Wall. ex Ser.	Herb	Simbhanjyang	2400	Forest	09815201NJ
417	<i>Aconitum laciniatum</i> (Bruhl) Stapf.	Herb	Simbhanjyang	2400	Forest	0118281NJ
418	<i>Aconitum spicatum</i> (Bruhl) Stapf.	Herb	Simbhanjyang	2300	Forest	0118282NJ

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419	<i>Anemone vitifolia</i> Buch.-Ham. ex DC.	Herb	Simbhanjyang	2300	Forest	09815202NJ
420	<i>Clematis buchananiana</i> DC.	Climber	Simbhanjyang	2300	Forest	09924348NJ
421	<i>Clematis montana</i> Buch.-Ham. ex DC.	Climber	Simbhanjyang	2300	Forest	09924349NJ
422	<i>Ranunculus diffusus</i> DC.	Herb	Simbhanjyang	2300	Fallow land	09815208NJ
423	<i>Ranunculus sceleratus</i> L.	Herb	Chitlang	1800	Fallow land	09924293NJ
424	<i>Thalictrum chelidonii</i> DC.	Herb	Simbhanjyang	2300	Forest	09815209NJ
425	<i>Thalictrum foliolosum</i> DC.	Herb	Chitlang-4	1800	Forest	01124613NJ
<b>Rhamnaceae</b>						
426	<i>Ziziphus incurva</i> Roxb.	Tree	Chitlang-9	1800	Forest	01125666NJ
427	<i>Ziziphus mauritiana</i> Lam.	Shrub	Hetauda,	500	Forest	010104439NJ
428	<i>Ziziphus rugosa</i> Lam.	Shrub	Churiamai	600	Forest	0101010400NJ
<b>Rosaceae</b>						
429	<i>Eriobotrya dubia</i> (Lindl.) Decne.	Tree	Chitlang	1800	Forest	09924390NJ
430	<i>Fragaria nubicola</i> Lindl. ex Lacaita	Herb	Chitlang	1800	Forest	01125679NJ
431	<i>Potentilla festiva</i> Sojak	Herb	Aghor	2200	Forest	0101010574NJ
432	<i>Potentilla indica</i> (Andrews) Wolf	Herb	Chitlang	1800	Fallow land	09424117NJ
433	<i>Potentilla kleiniana</i> Wight	Herb	Chitlang	1800	Fallow land	01125690NJ
434	<i>Prinsepia utilis</i> Royle	Shrub	Chitlang	1800	Fallow land	01125692NJ
435	<i>Prunus cerasoides</i> D. Don	Tree	Chitlang	1800	Fallow land	01124641NJ
436	<i>Pyracantha crenulata</i> (D. Don) M. Roem.	Shrub	Chitlang-4	1800	Forest	01124618NJ
437	<i>Pyrus pashia</i> Buch.-Ham. ex D. Don	Tree	Chitlang	1800	Forest/ Homegarden	091130381NJ
438	<i>Rosa multiflora</i> Thunb.	Shrub	Chitlang	1800	Forest	01124645NJ
439	<i>Rubus acuminatus</i> Sm.	Climber	Aghor	2200	Forest	09815236NJ
440	<i>Rubus ellipticus</i> Sm.	Shrub	Chitlang	1800	Fallow land	01125693NJ
441	<i>Rubus foliolosus</i> D. Don	Herb	Chitlang	1800	Forest	01124654NJ
442	<i>Rubus paniculatus</i> Sm.	Climber	Chitlang	1800	Forest	01125671NJ
443	<i>Rubus penduculosus</i> Sm.	Climber	Daman	2300	Forest	010109680NJ
444	<i>Rubus rugosus</i> Sm.	Shrub	Aghor	2300	Forest	09103317NJ
445	<i>Stranvaesia nussia</i> (D. Don) Decne.	Tree	Chitlang	2200	Forest	01124617NJ
<b>Rubiaceae</b>						
446	<i>Galium asperifolium</i> Wall.	Creeping herb	Aghor	2200	Forest	0101010589NJ
447	<i>Galium asperuloides</i> Edgew.	Creeping herb	Chitlang	1800	Forest	09711180NJ
448	<i>Galium hirtiflorum</i> Req. ex DC.	Creeping herb	Aghor	2200	Forest	09815205NJ
449	<i>Hedyotis lineata</i> Roxb.	Herb	Hetauda	500	Fallow land	092820NJ
450	<i>Hedyotis scandens</i> Roxb.	Climber	Chitlang	1800	Forest	0951145NJ

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451	<i>Hyptianthera stricta</i> Wight & Arn.	Herb	Churiamai	600	Forest	010104462NJ
452	<i>Knoxia corymbosa</i> Willd.	Herb	Manakamana, Hetauda	600	Forest	091130355NJ
453	<i>Luculia gratissima</i> (Wall.) Sweet	Shrub	Chitlang-2	1800	Forest	01125684NJ
454	<i>Paederia foetida</i> L.	Climber	Handikhola	500	Forest	010108564NJ
455	<i>Rubia manjith</i> Roxb. ex Fleming	Climber	Hetauda	500	Fallow land	09815235NJ
456	<i>Spermacoce alata</i> Aubl.	Herb	Handikhola	500	Fallow land	
457	<i>Spermacoce setidens</i> (Miq.) Boerl.	Herb	Handikhola	500	Fallow land	010108555NJ
458	<i>Spermadictyon suaveolens</i> Roxb.	Shrub	Hetauda	500	Forest	092929NJ
459	<i>Tamilnadia uliginosa</i> (Retz.) Tirveng. & Sastre	Tree	Hetauda	500	Forest	011619861NJ
460	<i>Wendlandia coriacea</i> (Wall.) DC.	Shrub	Daman	2300	Forest	0932592NJ
461	<i>Wendlandia exserta</i> (Roxb.) DC.	Shrub	Churiamai	600	Forest	0932583NJ
<b>Rutaceae</b>						
462	<i>Aegle marmelos</i> (L.) Correa	Tree	Hetauda	500	Fallow land/Home garden	09823265NJ
463	<i>Boenninghausenia albiflora</i> (Hook.) Rchb. ex Meisn.	Herb	Aghor	2200	Forest	09815220NJ
464	<i>Clausena excavata</i> Burm. f.	Shrub	Churiamai	600	Forest	010104442NJ
465	<i>Murraya koenigii</i> (L.) Spreng.	Tree	Hetauda	500	Fallow land	092937NJ
466	<i>Zanthoxylum armatum</i> DC.	Shrub	Chitlang	1800	Forest/Homestead	0942494NJ
<b>Sambucaceae</b>						
467	<i>Sambucus hookeri</i> Rehder	Shrub	Hetauda	500	Fallow land	0932570NJ
468	<i>Viburnum cylindricum</i> Buch.-Ham. ex D. Don	Shrub	Chitlang	1800	Forest	01125675NJ
469	<i>Viburnum erubescens</i> Wall.	Shrub	Chitlang	1800	Forest	01125694NJ
470	<i>Viburnum mullaha</i> Buch.-Ham. ex D. Don	Shrub	Chitlang	1800	Forest	09924294NJ
<b>Santalaceae</b>						
471	<i>Osyris wightiana</i> Wall. ex Wight	Shrub	Aghor	2200	Forest	0952139NJ
<b>Sapindaceae</b>						
472	<i>Cardiospermum helicacabum</i> L.	Climber	Hetauda, Huprachaur	500	Fallow land	01182895NJ
473	<i>Dobinea vulgaris</i> Buch.-Ham. ex D. Don	Shrub	Chitlang	1800	Forest	01125682NJ
474	<i>Sapindus mukorossi</i> Gaertn.	Tree	Churiamai	600	Forest	011620915NJ
475	<i>Schleichera oleosa</i> (Lour.) Oken	Tree	Handikhola	500	Forest	010104448NJ
<b>Sapotaceae</b>						
476	<i>Diploknema butyracea</i> (Roxb.) H. J. Lam	Tree	Churiamai	600	Forest	010104461NJ
<b>Saurauraceae</b>						
477	<i>Houttuynia cordata</i> Thunb.	Herb	Aghor	2200	Forest	09711181NJ
<b>Saurauriaceae</b>						
478	<i>Saurauia napaulensis</i> DC.	Tree	Chitlang	1800	Forest	09424115NJ

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<b>Saxifragaceae</b>						
479	<i>Astilbe rivularis</i> Buch.-Ham. ex D. Don	Herb	Aghor	2200	Forest	0101010586NJ
480	<i>Bergenia ciliata</i> (haw.) Sternb.*****	Herb	Daman	2300	On rock	09815213NJ
<b>Scrophulariaceae</b>						
481	<i>Hemiphragma heterophyllum</i> Wall.	Herb	Aghor	2200	Forest	0101010572NJ
482	<i>Lindenbergia grandiflora</i> (Buch.-Ham. ex D. Don) Benth.	Herb	Chitlang	1800	Forest	01124658NJ
483	<i>Lindenbergia indica</i> (L.) Vatke	Herb	Hetauda	500	Fallow land	09924282NJ
484	<i>Lindernia anagallis</i> (Burm. f. Pennell	Herb	Hetauda	500	Fallow land	09424114NJ
485	<i>Lindernia antipoda</i> (L.) Alston	Herb	Hetauda, Manakamana	600	Fallow land	09121404NJ
486	<i>Lindernia crustacea</i> (L.) F. Muell.	Herb	Aghor	2200	Fallow land	011828564NJ
487	<i>Mimulus tenellus</i> var. <i>nepalensis</i> (Benth.) Tsoong ex Yang	Herb	Chitlang	1800	Fallow land	09424122NJ
488	<i>Pedicularis bifida</i> (Buch.-Ham. ex D. Don) Pennell	Herb	Simbhanjyang	2400	Forest	09815207NJ
489	<i>Scoparia dulcis</i> L.	Herb	Hetauda	500	Fallow land	091130365NJ
<b>Solanaceae</b>						
490	<i>Datura metel</i> L.	Herb	Hetauda, Huprachaur	500	Fallow land	010106498NJ
491	<i>Datura stramonium</i> L.	Herb	Hetauda	500	Fallow land	09924315NJ
492	<i>Physalis divaricata</i> D. Don	Herb	Hetauda	500	Fallow land	011315719NJ
493	<i>Solanum aculeatissimum</i> Jacq.	Herb	Chitlang	1800	Fallow land	01125678NJ
494	<i>Solanum nigrum</i> L.	Herb	Aghor	2200	Fallow land	0932582NJ
495	<i>Solanum torvum</i> Sw.	Shrub	Hetauda	500	Fallow land	011315713NJ
496	<i>Solanum surattense</i> Burm. f.	Herb	Hetauda	500	Fallow land	011828131NJ
<b>Sterculiaceae</b>						
497	<i>Pentapetes phoenicia</i> L.	Herb	Handikhola	500	Forest	011617800NJ
<b>Symplocaceae</b>						
498	<i>Symplocos pyrifolia</i> Wall. ex G. Don	Tree	Chitlang	1800	Forest	01124635NJ
499	<i>Symplocos sumuntia</i> Buch.-Ham. ex D. D. Don	Tree	Chitlang	1800	Forest	0951143NJ
<b>Talinaceae</b>						
500	<i>Talinum cuneifolium</i> Willd.	Herb	Hetauda	500	Fallow land	011317727NJ
<b>Theaceae</b>						
501	<i>Eurya acuminata</i> DC.	Shrub	Chitlang	1800	Forest	
502	<i>Schima wallichii</i> (DC.) Korth.	Tree	Chitlang	1800	Forest	092943NJ

S.N.	Family /Scientific name	Life form	Collection site	Altitude (m)/	Habitat	Voucher no.
<b>Thymeleaceae</b>						
503	<i>Daphne papyracea</i> Wall. ex Steud.	Shrub	Chitlang	1800	Forest	09121422NJ
504	<i>Wikstroemia canescens</i> Meisn.	Shrub	Daman	2300	Forest	0992455NJ
<b>Tiliaceae</b>						
505	<i>Corchorus aestuans</i> L.	Herb	Hetauda	500	Fallow land	09113010NJ
506	<i>Grewia optiva</i> J. R. Drumm. ex Burret	Tree	Churiamai	600	Forest	010108517NJ
507	<i>Grewia sclerophylla</i> Roxb. ex G. Don	Tree	Handikhola	500	Forest	011617795NJ
508	<i>Triumfetta pilosa</i> Roth	Herb	Hetauda, Brindavan	500	Fallow land	09815200NJ
<b>Ulmaceae</b>						
509	<i>Celtis australis</i> L.	Tree	Chitlang	1800	Fallow land	09924344NJ
<b>Umbelliferae (Apiaceae)</b>						
510	<i>Bupleurum hamiltonii</i> N.P.Balacr.	Herb	Aghor, Simbhanjyang	2300	Forest	09103306NJ
511	<i>Centella asiatica</i> (L.) Urb.	Herb	Chitlang	1800	Fallow land	0101010571NJ
512	<i>Heracleum nepalense</i> D. Don	Herb	Daman	2300	Forest	
513	<i>Oenanthe javanica</i> (Blume ) DC.	herb	Chitlang	1800	Fallow land	0992414NJ
514	<i>Selinum wallichianum</i> (DC.) Raizada & Saxena	Herb	Daman	2300	Forest	09924290NJ
515	<i>Vicatia conifolia</i> DC.	Herb	Hetauda	500	Forest	09924309NJ
<b>Urticaceae</b>						
515	<i>Boehmeria macrophylla</i> Hornem.	Herb	Aghor	2300	Fallow land	09823244NJ
516	<i>Boehmeria rugulosa</i> Wedd.	Herb	Chitlang	1800	Forest	011828150NJ
517	<i>Debregeasia latifolia</i> Wedd.	Shrub	Chitlang	1800	Forest	01125683NJ
518	<i>Elatostema lineolatum</i> Wight	Herb	Handikhola	500	Forest	09815191NJ
519	<i>Elatostema sessile</i> J. R. Forst. & G.	Herb	Chitlang	1800	Forest	01124620NJ
520	<i>Girardinia diversifolia</i> (Link) Friis	Herb	Aghor	2300	Forest	09823271NJ
521	<i>Gonostegia hirta</i> (Blume) Miq.	Herb	Aghor	2300	Fallow land	011828103NJ
522	<i>Lecanthus peduncularis</i> (Royle) Wedd.	Herb	Aghor	2300	Fallow land	09923254NJ
523	<i>Oreocnide frutescens</i> (Thunb.) Miq.	Shrub	Aghor	2300	Forest	0951303NJ
524	<i>Pilea symmeria</i> Wedd.	Herb	Aghor	2300	Forest	09815218NJ
525	<i>Pilea umbrosa</i> Wedd.	Herb	Daman	2300	Forest	09815219NJ
526	<i>Pouzolzia zeylanica</i> (L.) Benn. & R. Br.	Herb	Aghor	2300	Fallow land	0101010581NJ
527	<i>Pouzolzia sanguinea</i> (Blume ) Merr.	Herb	Aghor	2300	Fallow land	0101010583NJ
528	<i>Urtica dioica</i> L.	Herb	Chitlang	1800	Fallow land	092930NJ
<b>Valerianiaceae</b>						
529	<i>Valeriana hardwickii</i> Wall.	Herb	Simbhanjyang	2400	Forest	09815210NJ

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530	<i>Valeriana jatamansii</i> Jones	Herb	Daman	2300	Forest	0951133NJ
<b>Verbenaceae</b>						
531	<i>Lantana camara</i> L.	Herb	Hetauda	500	Fallow land	092823NJ
532	<i>Vitex negundo</i> L.	Shrub	Hetauda	500	Fallow land	0101011608NJ
<b>Violaceae</b>						
533	<i>Viola betonicifolia</i> Sm.	Herb	Chitlang	1800	Forest	0932691NJ
534	<i>Viola canescens</i> Wall.	Herb	Chitlang-4	1800	Forest	01124621NJ
535	<i>Viola hamiltoniana</i> D. Don	Herb	Chitlang	1800	Forest	0951149NJ
536	<i>Viola pilosa</i> Blume	Herb	Chitlang	1800	Forest	0951302NJ
<b>Viscaceae</b>						
537	<i>Viscum album</i> L.*	Shrub	Chitlang	1800	Forest	0992454NJ
<b>Vitaceae</b>						
538	<i>Ampelocissus divaricata</i> (Wall. ex M. A. Lawson) Planch.	Climber	Churiamai	600	Forest	010104450NJ
539	<i>Cissus javana</i> DC.	Climber	Handikhola	500	Forest	010108521NJ
540	<i>Tetrastigma napaulense</i> (DC.) C. L. Li	Climber	Aghor	2200	Forest	011828132NJ
<b>Zygophyllaceae</b>						
541	<i>Tribulus terrestris</i> L.	Shrub	Handikhola	500	Fallow land	0992451NJ
<b>MONOCOTYLEDON</b>						
<b>Amaryllidaceae</b>						
542	<i>Zephyranthes carinata</i> Herb.	Herb	Chitlang	1800	Fallow land	09924311NJ
<b>Araceae</b>						
543	<i>Acorus calamus</i> L.	Herb	Hetauda	500	Fallow land/Home garden	0931156NJ
544	<i>Arisaema concinnum</i> Schott	Herb	Daman	2300	Forest	09613159NJ
545	<i>Arisaema erubescens</i> (Wall.) Schott	Herb	Simbhanjyang	2400	Forest	09924325NJ
546	<i>Arisaema tortuosum</i> (Wall.) Schott	Herb	Daman	2300	Forest	09613158NJ
547	<i>Arisaema utile</i> Hook. f. ex Schott	Herb	Aghor	2300	Forest	09924326NJ
548	<i>Typhonium bulbiferum</i> Dalz	Herb	Hetauda	500	Fallow land	011616772NJ
<b>Commelinaceae</b>						
549	<i>Amischophacelus axillaris</i> (L.) Rao ex Kammathy	Herb	Handikhola	500	Fallow land	0101010600NJ
550	<i>Commelina benghalensis</i> L.	Herb	Piplepokhara, Hetauda	500	Fallow land	09815227NJ
551	<i>Floscopa scandens</i> Lour.	Herb	Aghor	2300	Forest	09311NJ
552	<i>Murdannia nudiflora</i> (L.) Brenan	Herb	Aghor	2300	Fallow land	09823267NJ
<b>Cyperaceae</b>						
553	<i>Carex baccans</i> Nees	Herb	Chitlang	1800	Forest	09815240NJ
554	<i>Carex cruciata</i> Wahlenb.	Herb	Chitlang	1800	Forest	091130384NJ
555	<i>Carex inanis</i> C. B. Clarke	Herb	Chitlang	1800	Forest	0959154NJ
556	<i>Carex nubigena</i> D. Don ex Tilloch and Taylor	Herb	Chitlang	1800	Forest	09823270NJ
557	<i>Cyperus compresus</i> L.	Herb	Hetauda, Brindavan	500	Forest	09924364NJ

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558	<i>Cyperus esculentus</i> L.	Herb	Hetauda, Brindavan	500	Forest	0951139NJ
559	<i>Cyperus iria</i> L.	Herb	Chitlang	1800	Forest	09924365NJ
560	<i>Cyperus nutans</i> Vahl	Herb	Hetauda, Brindavan	500	Forest	09924366NJ
561	<i>Cyperus rotundus</i> L.	Herb	Chitlang	1800	Forest	09924314NJ
562	<i>Fimbristylis dichotoma</i> (L.) Vahl	Herb	Chitlang	1800	Forest	09924396NJ
563	<i>Fimbristylis miliacea</i> (L.) Vahl	Herb	Chitlang	1800	Forest	09924398NJ
564	<i>Kyllinga brevifolia</i> Rottb.	Herb	Hetauda, Brindavan	500	Forest	091251NJ
565	<i>Lipocarpa chinensis</i> (Osbeck) Kern	Herb	Chitlang	1800	Forest	099249NJ
566	<i>Pycreus pumilus</i> (L.) Nees	Herb	Handikhola	500	Forest	0951141NJ
567	<i>Pycreus sanguinolentus</i> (Vahl) Nees ex C. B. Clarke	Herb	Chitlang	1800	Forest	09823274NJ
568	<i>Schoenoplectus mucronatus</i> (L.) Palla	Herb	Chitlang	1800	Forest	0992443NJ
<b>Dioscoreaceae</b>						
569	<i>Dioscorea bulbifera</i> L.	Climber	Aghor	2200	Forest	010104432NJ
570	<i>Dioscorea deltoidea</i> Wall. ex Kunth	Climber	Aghor	2200	Forest	010104440NJ
571	<i>Dioscorea hamiltonii</i> Hook. f.	Climber	Chitlang	1800	Forest	010109574NJ
572	<i>Dioscorea hispida</i> Dennst.	Climber	Handikhola	500	Forest	010109572NJ
573	<i>Dioscorea kaemoonensis</i> Kunth	Climber	Chitlang	1800	Forest	010109573NJ
574	<i>Dioscorea pentaphylla</i> L.	Climber	Handikhola	500	Forest	010108518NJ
<b>Eriocaulaceae</b>						
575	<i>Eriocaulen nepalense</i> Prescott ex Bong.	Herb	Chitlang	1800	Wetland	09924391NJ
<b>Graminae</b>						
576	<i>Agrostis myriantha</i> Hook. .	Herb	Chitlang	1800	Forest	09924321NJ
577	<i>Anthraxon lancifolius</i> (Trin. Hochst.	Herb	Chitlang	1800	Forest	09924322NJ
578	<i>Apluda mutica</i> L.	Herb	Chitlang	1800	Forest	092951NJ
579	<i>Drepanostachyum falcatum</i> (Nees) Keng f.	Herb	Chitlang	1800	Forest	0951135NJ
580	<i>Arundinella nepalensis</i> Trin.	Herb	Chitlang	1800	Forest	010104475NJ
581	<i>Bambusa tulda</i> Roxb.	Herb	Handikhola	500	Forest	09924331NJ
582	<i>Bothriochloa bladhii</i> (Retz.) S. T. Blake	Herb	Chitlang	1800	Forest	09924336NJ
583	<i>Capillipedium assimile</i> (Steud.) A. Camus	Herb	Chitlang	1800	Forest	09924342NJ
584	<i>Chrysopogon aciculatus</i> (Retz.) Trin.	Herb	Chitlang	1800	Forest	09924347NJ
585	<i>Coix lachryma-jobi</i> L.	Herb	Chitlang	1800	Fallow land	09924355NJ
586	<i>Cymbopogon flexuosus</i> (Nees ex Steud.) W.	Herb	Hetauda, Brindavan	500	Fallow land	09924361NJ
587	<i>Cymbopogon jwarancusa</i> (Jones) Schult.	Herb	Hetauda, Brindavan	500	Fallow land	09924362NJ
588	<i>Cynodon dactylon</i> (L.) Pers.	Herb	Chitlang	1800	Fallow land	09924363NJ
589	<i>Cyrtococcum accrescens</i> (Trin.) Stapf.	Herb	Hetauda, Brindavan	500	Fallow land	09924367NJ

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590	<i>Dendrocalamus hamiltonii</i> Munro	Herb	Chitlang	1800	Fallow land	010108500NJ
591	<i>Desmostachya bipinnata</i> (L.) Stapf.	Herb	Hetauda, Brindavan	500	Fallow land	09924376NJ
592	<i>Digitaria ciliaris</i> (Retz.) Keler	Herb	Hetauda, Brindavan	500	Fallow land	091130371NJ
593	<i>Digitaria cruciata</i> (Nees ex Steud.) A Camus	Herb	Chitlang	1800	Fallow land	09924379NJ
594	<i>Echinochloa colona</i> (L.) Link	Herb	Hetauda, Brindavan	500	Fallow land	091253NJ
595	<i>Elusine indica</i> (L.) Gaertn.	Herb	Hetauda, Brindavan	500	Fallow land	09121408NJ
596	<i>Eragrostis atrovirens</i> (Desf.) Trin ex Steud.	Herb	Hetauda, Brindavan	500	Fallow land	09121409NJ
597	<i>Eragrostis amabilis</i> (L.) Wight and Arn. ex Nees	Herb	Hetauda, Brindavan	500	Fallow land	09924386NJ
598	<i>Eragrostis uniolooides</i> (Retz.) Nees ex Steud.	Herb	Hetauda, Brindavan	500	Fallow land	010104486NJ
599	<i>Eragrostris japonica</i> (Thunb.) Trin.	Herb	Hetauda, Brindavan	500	Fallow land	09924387NJ
600	<i>Eragrostris nigra</i> Nees ex Steud.	Herb	Hetauda,	500	Fallow	0932685NJ
601	<i>Erianthus ravennae</i> (L.) P. Beauv.	Herb	Hetauda	500	Forest	091130387NJ
602	<i>Eulalia mollis</i> (Griseb.) Kuntze	Herb	Churiamai	600	Forest	011617792NJ
603	<i>Eulaliopsis bipinata</i> (Retz.) C. E.	Herb	Churiamai	600	Forest	
604	<i>Festuca leptopogon</i> Stapf	Herb	Chitlang	1800	Fallow land	09924395NJ
605	<i>Imperata cylindrica</i> (L.) Raeusch.	Herb	Chitlang	1800	Fallow	0942498NJ
606	<i>Microstegium nudum</i> (Trin.) A. Camus	Herb	Chitlang	1800	Fallow land	0992412NJ
607	<i>Miscanthus nepalensis</i> (Trin.) Hack.	Herb	Chitlang	1800	Forest	01125687NJ
608	<i>Oplismenus burmanii</i> (Retz.) P. Beauv.	Herb	Chitlang	1800	Fallow land	0992415NJ
609	<i>Oplismenus compositus</i> (L.) P. Beauv.	Herb	Chitlang	1800	Fallow land	0992416NJ
610	<i>Panicum psilopodium</i> Trin.	Herb	Chitlang	1800	Fallow land	0992422NJ
611	<i>Paspalum scrobiculatum</i> L.	Herb	Chitlang	1800	Fallow land	0951153NJ
612	<i>Phalaris minor</i> Retz.	Herb	Chitlang	1800	Fallow land	011828126NJ
613	<i>Poa annua</i> L.	Herb	Chitlang	1800	Fallow land	0992430NJ
614	<i>Pogonatherum crinitum</i> P. Beauv.	Herb	Chitlang	1800	Fallow land	0992433NJ
615	<i>Polypogon fugax</i> Nees ex Steud.	Herb	Chitlang	1800	Fallow land	0951128NJ
616	<i>Saccharum spontaneum</i> L.	Herb	Chitlang	1800	Fallow land	010108516NJ
617	<i>Sacciolepis indica</i> (L.) Chase	Herb	Chitlang	1800	Fallow land	09121410NJ



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618	<i>Setaria geniculata</i> (Lam.)P. Beauv.	Herb	Hetauda	500	Fallow land	092928NJ
619	<i>Sporobolus fertilus</i> (Steud.) Clayton	Herb	Chitlang	1800	Fallow land	0992447NJ
620	<i>Thysanolaena latifolia</i> (Roxb. ex Hornem.) Honda	Herb	Way to Hetauda	600	Fallow land	092835NJ
<b>Hydrocharitaceae</b>						
621	<i>Hydrilla verticillata</i> (L.f.) C. Presl.**	Herb	Handikhola	500	Wetland	011617792NJ
<b>Hypoxidaceae</b>						
622	<i>Curculigo orchoides</i> Gaertn.	Herb	Aghor	2200	Forest	09823256NJ
623	<i>Hypoxis aurea</i> Lour.				Forest	099245NJ
<b>Juncaceae</b>						
624	<i>Juncus wallichianus</i> J. Gay ex Laharpe	Herb	Chitlang	1800	Fallow land	011828110NJ
<b>Liliaceae</b>						
625	<i>Allium wallichii</i> Kunth	Herb	Simbhanjyang	2400	Forest	09823258NJ
626	<i>Asparagus filicinus</i> Buch.-Ham. ex D. Don	Herb	Chitlang	1800	Forest	01124626NJ
627	<i>Asparagus racemosus</i> Willd.	Herb	Hetauda	500	Forest/Farmer field	09924278NJ
628	<i>Chlorophytum arundinaceum</i> Baker	Herb	Churiamai	600	Forest	09924345NJ
629	<i>Chlorophytum nepalense</i> (Lindl.) Baker	Herb	Simbhanjyang	2300	Forest	09924346NJ
630	<i>Disporum cantoniensis</i> (Lour.) Merr.	Herb	Aghor	2200	Forest	09815215NJ
631	<i>Lilium nepalense</i> D. Don	Herb	Daman	2300	Forest	09613162NJ
632	<i>Ophiopogon intermedius</i> D. Don	Herb	Aghor	2200	Forest	09711178NJ
633	<i>Paris polyphylla</i> Sm.	Herb	Simbhanjyang	2400	Forest	0992423NJ
634	<i>Smilax aspera</i> L.	Climber	Chitlang	1800	Forest	01124634NJ
635	<i>Smilax lanceifolia</i> Roxb.	Climber	Chitlang	1800	Forest	092949NJ
636	<i>Smilax menispermoides</i> A. DC.	Climber	Chitlang	1800	Forest	09924277NJ
637	<i>Smilax ovalifolia</i> Roxb. ex D. Don	Climber	Hetauda, Banaskhandi	500	Forest	010108505NJ
638	<i>Tupistra aurantiaca</i> (Wall. ex Baker) Hook. f.	Herb	Chitlang	1800	Forest	01124633NJ
<b>Orchidaceae</b>						
639	<i>Anthogonium gracile</i> Wall. ex Lindl.	Herb	Aghor	2200	Forest	09823261NJ
640	<i>Arundina graminifolia</i> (D. Don) Hochr.	Herb	Aghor	2200	Forest	09924329NJ
641	<i>Bulbophyllum umbellatum</i> Lindl.****	Herb	Simbhanjyang	2400	Forest	09924339NJ
642	<i>Calanthe plantaginea</i> Lindl.	Herb	Aghor	2200	Forest	0951137NJ
643	<i>Calanthe tricarinata</i> Lindl.	Herb	Daman	2300	Forest	09924340NJ
644	<i>Coelogyne corymbosa</i> Lindl.****	Herb	Chitlang	1800	Forest	09924350NJ
645	<i>Coelogyne cristata</i> Lindl.****	Herb	Chitlang	1800	Forest	09320965NJ
647	<i>Coelogyne nitida</i> (Wall. ex D. Don) Lindl.****	Herb	Chitlang	1800	Forest	011414758NJ
648	<i>Coelogyne ovalis</i> Lindl.****	Herb	Chitlang	1800	Forest	09924353NJ

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649	<i>Coelogyne stricta</i> (D. Don) Schltr.****	Herb	Chitlang	1800	Forest	09924354NJ
650	<i>Cymbidium aloifolium</i> (L.) Sw.****	Herb	Churiamai	600	Forest	09924358NJ
651	<i>Cymbidium elegans</i> Lindl.****	Herb	Daman	2300	Forest	09924359NJ
652	<i>Cymbidium lancifolium</i> Hook.****	Herb	Daman	2300	Forest	09924360NJ
653	<i>Dendrobium amoemum</i> Wall. ex	Herb	Chitlang	1800	Forest	09924368NJ
654	<i>Dendrobium anceps</i> Sw.****	Herb	Chitlang	1800	Forest	010108566NJ
655	<i>Dendrobium aphyllum</i> (Roxb.) C. E. C. Fisch.****	Herb	Chitlang	1800	Forest	09924369NJ
656	<i>Dendrobium bicameratum</i> Lindl.****	Herb	Simbhanjyang	2400	Forest	09924370NJ
657	<i>Dendrobium chrysanthemum</i> Wall. ex Lindl.****	Herb	Simbhanjyang	2400	Forest	09924371NJ
658	<i>Dendrobium densiflorum</i> Lindl.****	Herb	Simbhanjyang	2400	Forest	09424560NJ
659	<i>Dendrobium fimbriatum</i> Hook.****	Herb	Simbhanjyang	2400	Forest	09924372NJ
660	<i>Dendrobium heterocarpum</i> Wall. ex Lindl.****	Herb	Simbhanjyang	2400	Forest	09924373NJ
661	<i>Dendrobium longicornu</i> Lindl.****	Herb	Aghor	2200	Forest	09924313NJ
662	<i>Dendrobium moschatum</i> (Buch.-Ham.) Sw.****	Herb	Aghor	2200	Forest	09924374NJ
663	<i>Dendrobium transparens</i> Wall. ex Lindl.****	Herb	Aghor	2200	Forest	09924375NJ
664	<i>Ephemerantha macraei</i> (Lindl.) P. F. Hunt & Summerh.****	Herb	Daman	2200	Forest	09424120NJ
665	<i>Epigeneium amplum</i> (Lindl.) Summerh.****	Herb	Daman	2200	Forest	09924384NJ
666	<i>Eria coronaria</i> (Lindl.) Rchb.f.****	Herb	Chitlang	1800	Forest	09924383NJ
667	<i>Eria spicata</i> (D. Don) Hand.-Mazz.****	Herb	Chitlang	1800	Forest	09924389NJ
668	<i>Esmeralda clarkei</i> Rchb.f.****	Herb	Daman	2400	Forest	09924392NJ
669	<i>Gastrochilus acutifolius</i> (Lindl.) Kuntze****	Herb	Daman	2400	Forest	099241NJ
670	<i>Liparia viridifolia</i> (Bl.) Lindl.****	Herb	Chitlang	1800	Forest	099248NJ
671	<i>Lusia zeylanica</i> Lindl.****	Herb	Simbhanjyang	2400	Forest	0101010590NJ
672	<i>Malaxis cylindrostachya</i> (Lindl.) Kuntze	Herb	Simbhanjyang	2400	Forest	011828113NJ
673	<i>Otochilus fuscus</i> Lindl.****	Herb	Simbhanjyang	2400	Forest	0992417NJ
674	<i>Otochilus lancilabius</i> Seidenf.****	Herb	Simbhanjyang	2400	Forest	0992418NJ
675	<i>Otochilus porrectus</i> Lindl.****	Herb	Simbhanjyang	2400	Forest	0992419NJ
676	<i>Pholidota articulata</i> Lindl.****	Herb	Chitlang	1800	Forest	0992426NJ
677	<i>Pholidota imbricata</i> Hook.****	Herb	Chitlang	1800	Forest	0992427NJ
678	<i>Pholidota protracta</i> Hook. f.****	Herb	Daman	2400	Forest	09711182NJ
679	<i>Pleione humulis</i> (Sm.) D.Don****	Herb	Daman	2400	Forest	0992428NJ

S.N.	Family /Scientific name	Life form	Collection site	Altitude (m)/	Habitat	Voucher no.
680	<i>Pleione praecox</i> (Sm.) D. Don****	Herb	Daman	2400	on rock	0992429NJ
681	<i>Rhyncostylis retusa</i> (L.) Bl.*****	Herb	Chitlang	1800	Forest	0992436NJ
682	<i>Satyrrium nepalense</i> D. Don	Herb	Daman	2400	Forest	0992442NJ
683	<i>Spiranthis sinensis</i> (Pers.) Ames	Herb	Aghor	2200	Forest	09924291NJ
684	<i>Trudelia cristata</i> (Lindl.) Senghas****	Herb	Aghor	2200	Forest	0992452NJ
<b>Pontederaceae</b>						
685	<i>Eichhornia crassiceps</i> (Mart.) Solms**	Herb	Handikhola	500	Wetland	010108550NJ
686	<i>Monocharia hastata</i> (L.) Solms**	Herb	Handikhola	500	Wetland	010108551NJ
<b>Zingiberaceae</b>						
687	<i>Cautleya spicata</i> (Sm.) Baker****	Herb	Aghor	2200	Forest	0101010676NJ
688	<i>Costus speciosus</i> (Koenig) J. E. Sm.	Herb	Aghor	2200	Forest/Ho megarden	09924356NJ
689	<i>Curcuma angustifolia</i> Roxb.	Herb	Hetauda	500	Forest	09725185NJ
690	<i>Curcuma aromatica</i> Salisb.	Herb	Churiamai	600	Forest	09711172NJ
691	<i>Globba clarkei</i> Baker	Herb	Aghor	2200	Forest	
692	<i>Globba racemosa</i> Sm.	Herb	Aghor	2200	Forest	09924297NJ
693	<i>Hedychium conccineum</i> Sm.	Herb	Aghor	2200	Forest	099242NJ
694	<i>Hedychium spicatum</i> Sm.	Herb	Aghor	2200	Forest	09815223NJ
695	<i>Roscoea purpurea</i> Sm.	Herb	Aghor	2200	Forest	0992439NJ

Source: Field survey 2009-2011 (Note: \*Parasite, \*\*Aquatic, \*\*\* Insectivorous, \*\*\*\*Epiphytic, \*\*\*\*\*Lithophytes)

**Appendix 2: Lists of angiospermic flora housed in KATH herbarium, not collected in the present study**

S.N.	Family / Scientific name	Locality	Collectors	Collector number
<b>Acanthaceae</b>				
1	<i>Echinacanthus attenuatus</i> Nees	Makawanpurgarhi-Dunge	Kanai & Bista	674761
2	<i>Phlogacanthus thyrsoiflorus</i> (Roxb.) Nees	Hetauda	T.B.Shrestha	3911
3	<i>Ruellia beddomei</i> C. B. Clarke	Hetauda-Amlekhganj	P.R. Shakya	9336
4	<i>Strobilanthes auriculata</i> Nees	Churiya-Purano Gaon	C.A.Pendry et al.	DNEP2A185
5	<i>Strobilanthes lamiifolia</i> (Nees) T. Anderson	Old road from Hetauda-Kathmandu via Bhimfedi,	C.A.Pendry et al.	DNEP2A208
6	<i>Strobilanthes multidentata</i> C. B. Clarke	Below Aghari on Hetauda-Kathmandu	C.A.Pendry et al.	DNEP2B228
7	<i>Strobilanthes subnudata</i> C.B. Clarke	Simbhamjyang, Daman	C.A.Pendry et al.	
<b>Aceraceae</b>				
4	<i>Acer campbellii</i> Hook. f. & Thom.	Simbhajyang	T.B.Shrestha	17216
<b>Amaryllidaceae</b>				
5	<i>Crinum amoenum</i> Roxb.	Palung	N.K.Bhattarai	86/256
<b>Apocynaceae</b>				
6	<i>Nerium oleander</i> L.	Makawanpurgarhi	Kanai & Bista	11828
7	<i>Thevetia peruviana</i> (Pers.) Merr.	Makawanpurgarhi	Kanai & Bista	16827
<b>Araceae</b>				
	<i>Arisaema intermedium</i> Bl.	Simbhajyang	M.S.Bista	17218
	<i>Remusatia vivipara</i> Schott.	Changdung	N.P.Manandhar	3506
8	<i>Rhaphidophora glauca</i> (Wall.) Schott	Bhainse		
9	<i>Scindapsus officinalis</i> (Roxb.) Schott	Churia Hill	P.R.Shakya	9399
<b>Araliaceae</b>				
10	<i>Panax pseudo ginseng</i> Wall. Subsp. <i>Pseudo-ginseng</i>	Simbhanjyang	H.Kanai	673325
<b>Asclepiadaceae</b>				
11	<i>Calotropis procera</i> Br.	Kamle	N. P. Manandhar & L. P. Kattel	754
12	<i>Ceropegia longifolia</i> Wall.	Tistan deorali	H.Kanai	673302
<b>Balsaminaceae</b>				
13	<i>Impatiens racemosa</i> DC.	Daman	J. F. Dobremez	317
<b>Begoniaceae</b>				
14	<i>Begonia josephii</i> DC.	Simbhajyang	H.Kanai	673326
15	<i>Begonia ovalifolia</i> DC.	Rhikheswore	S.B.Malla & S.B.Rajbhandari	42
<b>Boraginaceae</b>				
16	<i>Trigonotis multicaulis</i> (DC.) Benth. ex C. B. Clarke	Tistan deorali	H.Kanai	673304
<b>Buxaceae</b>				
17	<i>Sarcococca hookeriana</i> Baill.	Simbhamjyang	C. A.Pendry et al.	DNEP2A222
18	<i>Sarcococca wallichii</i> Stapf	Way to Bhimfede	C.A.Pendry et al.	DNEP2A202

S.N.	Family / Scientific name	Locality	Collectors	Collector number
<b>Campanulaceae</b>				
19	<i>Campanula sylvatica</i> Wall.	Tistung	N.P.Manandhar	3413
20	<i>Codonopsis affinis</i> Hk.f.	Tistung	M.S.Bista	369
21	<i>Codonopsis purpurea</i> Wall.	Simbhajyang	S.B.Malla	2240
<b>Caprifoliaceae</b>				
22	<i>Viburnum coriaceum</i> Bl.	Way to Rhikheswore	S.B.Malla	228
<b>Casuarianaceae</b>				
23	<i>Casuariana equisetifolia</i> L.	Hetauda	Joshi & Bajracharya	75/2332
<b>Celastraceae</b>				
24	<i>Euonymus echinatus</i> Wall.	Simbhajyang	C.A.Pendry et al.	DNEP2A2 37
<b>Commelinaceae</b>				
25	<i>Commelina paludosa</i> Blume	Torque	N.P.Manandhar	12671
26	<i>Murdania scapiflora</i> Royle	Hetauda	Suwal and party	238
<b>Compositae</b>				
27	<i>Anaphalis cinnamoemea</i> C.B.Cl.	Simbhajyang	S.B.Saha	162
28	<i>Anaphalis adnata</i> Wall. ex DC.	Bajhdanda village	C.A.Pendry et al.	DNEP2B1 68
29	<i>Blumeopsis falcata</i> (D. Don) Merrill.	Hetauda	H.K.Sainju & B.Roy	1029/S.R.
30	<i>Senecio acuminatus</i> Wall. ex DC.	Simbhamjyang	A.V.Upadhaya & S. B. Rajbhandari	2248
31	<i>Senecio densiflorus</i> Wall.ex DC.	Daman	N.P.Manandhar	2248
32	<i>Siegesbeckia orientalis</i> L.	Makaldamar	N.P.Manandhar	12626
33	<i>Synedrella nodiflora</i> Gaertn.	Badahakim bridge	C.A.Pendry et al.	DNEP2A1 40
34	<i>Vernonia squarrosa</i> (D.Don) Less.	Saraswati forest	C.A.Pendry et al.	DNEP2B1 37
<b>Convolvulaceae</b>				
35	<i>Porana grandiflora</i> Wall.	Simbhajyang	H.Kanai	673338
36	<i>Argyreia sikkimensis</i> (C.B. Clarke) Ooststr.	Sarswati forest		
<b>Cornaceae</b>				
37	<i>Cornus oblonga</i> Wall.	Aglochucidanda, Tistung	M.S.Bista	3642
<b>Cucurbitaceae</b>				
38	<i>Melothira maderaspatana</i> (L.) Cogn	Hetauda	P.R.Shakya	9312
39	<i>Trichosanthes lepiniata</i> (Haud.) Cogn	Chisapanigadi, Bhimpheidi	D.P.Joshi	17483
<b>Cuscutaceae</b>				
40	<i>Cuscuta santapaunii</i> Banerji	Daman/Tistung	Suwal et al.	911
<b>Cyperaceae</b>				
41	<i>Cyperus aristatus</i> Rottb.	Brindavan	V.L.Gurung et	487/77
42	<i>Cyperus difformis</i> L.	Brindavan	V.L.Gurung et	330/76
43	<i>Eriophorum comosum</i> Wall. ex Nees	Brindavan	V.L.Gurung et	317/76
<b>Euphorbiaceae</b>				
44	<i>Macaranga pustulata</i> King ex Hook.f.	10km N of Bhimpede	C.A.Pendry et al.	DNEP2B2 05
<b>Fumariaceae</b>				
45	<i>Corydalis cornuta</i> Royle	Simbhanjyang		

S.N.	Family / Scientific name	Locality	Collectors	Collector number
<b>Gentianaceae</b>				
46	<i>Swertia paniculata</i> Wall.	Simbhanjyang	S.B.Saha	171
47	<i>Swertia speciosa</i> D. Don	Simbhanjyang	N.K.Bhattarai	86/167
<b>Geraniaceae</b>				
48	<i>Geranium wallichianum</i> Sw.	Daman	Upadhyaya & Rajbhandari	2281
<b>Gesneriaceae</b>				
49	<i>Didymocarpus aromaticus</i> Wall.	Rhikheswore	S.B.Malla	225
50	<i>Didymocarpus villosus</i> D. Don	Simbhanjyang	N.K.Bhattarai	86/168
<b>Graminae</b>				
51	<i>Agrostis pilosula</i> Trin.	Chitlang Phedi	K.R.Rajbhandari et al.	75/239
52	<i>Apocopus paleacea</i> (Trin.) Hoch.	Deorali danda(Kulekhani)	K.R.Rajbhandari	75/290
53	<i>Brachiaria kurzii</i> (Hook.f.) A.Camus	Hetauda	J.F.Dobremez	792
54	<i>Chrysopogon gryllus</i> (L.) Trin.	Deoralidanda(Kulekhani)	H.Kanai & T.B.Shrestha	672730
55	<i>Cymbopogon microtheca</i> (Hook. f.) A. Camus	Makawanpurgadhi	H.Kanai	674751
56	<i>Cymbopogon pendulus</i> (Nees ex Steud.) Wats	Bhainse	K.R.Rajbhandari	30/75
57	<i>Dactyloctenium aegyptium</i> (L.) P.Beauv.	Brindavan	V.L.Gurung et al.	412/77
58	<i>Digitaria adscendens</i> (H.B.K.) Herr.	Brindavan		
59	<i>Echinochloa crusugalli</i> (L.) P. Beauv.	Brindavan	V.L.Gurung et	484/177
60	<i>Eragrostinella bifaria</i> (Vahl.)	Bhimphedi	K.R.Rajbhandari	75/944
61	<i>Ischaemum rugosum</i> Salish.	Brindavan	V.L.Gurung et	320/76
62	<i>Microstegium ciliatum</i> (Trin.) A. Camus	Kulekhani	K.R.Rajbhandari	75/911
63	<i>Neyrantia reynaudiana</i> (Kunth.) King	Bhainse	M.M.Amatya & K.R.Rajbhandari	33/75
64	<i>Panicum nutans</i> Linn.	Brindavan	V.L.Gurung et	411/77
65	<i>Panicum patens</i> Linn.	Brindavan	V.L.Gurung et	491/77
66	<i>Paspalum distichum</i> Linn.	Chitlang	Joshi et al.	75/247
67	<i>Perotis hordeiformis</i> Nees	Hetauda	K.R.Rajbhandari	75/948
68	<i>Phragmites karka</i> (Retz.) Trim.	Chitlang	K.R.Rajbhandari	75/755
69	<i>Setaria forbesiana</i> (Nees ex Steud.) Hook. f.	Bhimphedi	K.R.Rajbhandari	75/945
70	<i>Setaria pallide-fusca</i> (Stapf.)	Brindavan	V.L.Gurung et	75/946
71	<i>Setaria plicata</i> (Lamk.) T. Cooke	Chisapanigarhi	Rajbhandari et al.	75/924
72	<i>Sporobolus diander</i> (Retz.) P.Beauv.	Brindavan	V.L.Gurung et	376/76
73	<i>Sporobolus piliferus</i> (Trin.) Kunth.	Kulekhani	K.R.Rajbhandari	75/919
74	<i>Themeda arundinacea</i> (Roxb.) Ridl.	Deoralidanda (Kulekhani)	K.R.Rajbhandari	75/905
75	<i>Themeda hookeri</i> (Griseb.) A. Camus	Chitlang Phedi	K.R.Rajbhandari	75/941
76	<i>Themeda villosa</i> (Poir.) A. Camus	Bhimphedi	K.R.Rajbhandari	75/903
77	<i>Tripogon filiformis</i> Nees ex Steud.	Chitlang Phedi	K.R.Rajbhandari	75/238
<b>Grossulariaceae</b>				
78	<i>Ribes emodense</i> Rehd.	Simbhanjyang	T.B.Shrestha	17214
<b>Hydrangeaceae</b>				
79	<i>Hydrangea anomala</i> D.Don	Tistung deorali	M.S.Bista	5880

S.N.	Family / Scientific name	Locality	Collectors	Collector number
<b>Hydrophyllaceae</b>				
80	<i>Hydrolea zeylanica</i> Vahl	Makawanpurgarhi		674996
<b>Hypericaceae</b>				
81	<i>Hypericum cordifolium</i> Choicy	Tistung	N.P.Manandhar	3425
82	<i>Hypericum hookerianum</i> Wight et Arn.	Simbhanjyang	S.B.Malla & S.B.Rajbhandari	67
83	<i>Hypericum patulum</i> Thunb.	Daman	J.F.Dobremez	763
84	<i>Hypericum podocarpoides</i> N.Robson	Torque	N.P.Manandhar	12669
<b>Juncaceae</b>				
85	<i>Juncus elegans</i> Royle	Rikheswore	S.B.Malla & S.B.Rajbhandari	
<b>Labiatae</b>				
86	<i>Anisochilus pallidus</i> Wall. ex Benth.	Saraswati forest	C.A.Pendry et al.	DNEP2B159
87	<i>Coleus barbatus</i> Benth.	Bhimphedi	K. R. Rajbhandari et al	932
88	<i>Coleus forskohlii</i> (Willd.)	Bhimphedi	K.R.Rajbhandari et al.	932
89	<i>Elscholtzia strobilifera</i> Benth.	Simbhanjyang	S.B.Shah	173
90	<i>Leucas cephalotes</i> (Roth) Spreng.	Hatiya	N.K.Bhattacharai	86/61
91	<i>Leucas lavandulaefolia</i> Sm.	Hetauda	N.K.Bhattacharai	
92	<i>Plectranthus barbatus</i> Andrews	Bhimphedi	C.A.Pendry et al.	DNEP2B209
93	<i>Plectranthus striatus</i> Benth.	Aglochucidanda, Tistung	M.S.Bista	3638
94	<i>Pogostemon amaranthoides</i> Benth.	Thoplasi	N.P.Manandhar	13780
95	<i>Rabdosia repens</i> (Wall. ex Benth.) Hara	Simbhanjyang		
96	<i>Rabdosia scrophularioides</i> (Wall.) Hara	Rhikhesore	S.B.Malla	243
97	<i>Rabdosia ternifolia</i> (D. Don) Hara	Hetauda	Suwal et al.	984
<b>Lauraceae</b>				
98	<i>Dodecadenia grandiflora</i> Nees	Simbhanjyang	T.B. Shrestha	3908
99	<i>Litsea monopetala</i> (Roxb.) Pers.	Chanpkharka	N.P.Manandhar	3480
100	<i>Machilus edulis</i> King ex Hook. f.	Makawanpurgadhi	Kanai & Bista	11056
<b>Leguminosae</b>				
101	<i>Acacia rugata</i> (Lam.) Voigt	Hetauda	T.B.Shrestha	3918
102	<i>Albizia chinensis</i> (Osbeck.) Merr.	Lothar	T.K.Bhattacharya	187
103	<i>Albizia lucidior</i> (Steud.) Nielson	Chainpur	N.P.Manandhar	13901
104	<i>Amphicarpaea edgeworthii</i> Benth.	Simbhanjyang	H.Kanai	673324
105	<i>Bauhinia malabarica</i> Roxb.	Hetauda	J.F.Dobremez	736
106	<i>Bauhinia retusa</i> Ham.	Bhimphedi	K.R.Rajbhandari et al.	75/902
107	<i>Cassia sophora</i> L.	Bhimphedi	K.R.Rajbhandari et al.	75/935
108	<i>Cochlianthus gracilis</i> Benth.	Simbhanjyang	S.B.Rajbhandari & A.Upadhyaya	2244
109	<i>Crotalaria cytisoides</i> Roxb. ex DC.	Aglochucidanda, Tistung	M.S.Bista	3651
110	<i>Crotalaria kanaii</i> Ohashi	Aglochucidanda, Tistung	M.S.Bista	3654
111	<i>Crotalaria sericea</i> Retz.	Hetauda	S.B.Malla	4603
112	<i>Desmodium elegans</i> DC.	Simbhajyang	T.B.Shrestha	17215

S.N.	Family / Scientific name	Locality	Collectors	Collector number
113	<i>Desmodium multiflorum</i> DC.	Aghor		
114	<i>Desmodium triangulare</i> (Retz.) Schidl.	Hetauda-Amlekh		
115	<i>Dumasia villosa</i> DC.	Aglochucidanda, Tistung	M.S.Bista	5878
116	<i>Erythrina stricta</i> Roxb.	Hetaura	M.S.Bista	2584
117	<i>Indigofera cylindracea</i> Grah ex Bak.	Simbhanjyang	D.P.Joshi	17488
118	<i>Millettia glaucencens</i> Kurz	Makawanpurgadhi	Kanai & Bista	11986
119	<i>Millettia auriculata</i> Baker ex Brandis	Badahakim bridge	C.A.Pendry et al.	DNEP2A164
120	<i>Spatholobus parviflorus</i> (Roxb. ex DC.) G. Kuntze	Hetauda	J.F.Dobremez	785
<b>Liliaceae</b>				
121	<i>Polygonatum punctatum</i> Royle	Aglochucidanda, Tistung	M.S.Bista	5856
<b>Loranthaceae</b>				
122	<i>Loranthus vestitus</i> Wall ex Roxb.	Aglochucidanda, Tistung	M.S.Bista	3627
<b>Malpighiaceae</b>				
123	<i>Hiptage madaplota</i> Gaertn.	Hetauda	T.B. Shrestha	3915
<b>Moraceae</b>				
124	<i>Cudrania javanensis</i> Tri	Hetauda	M.S.Bista	3691
125	<i>Ficus hederacea</i> Roxb.	Hetauda Farm	M.S.Bista	3693
126	<i>Ficus nemoralis</i> Wall.	Chanpkharka	N.P.Manandhar	3482
127	<i>Ficus scandens</i> Roxb.	Hetauda	M.S.Bista	3693
128	<i>Ficus subincisa</i> Buch.-Ham	Aibung	N.P.Manandhar	3488
129	<i>Morus alba</i> L.	Hetauda	N.K.Bhattarai	87/147
<b>Ochnaceae</b>				
130	<i>Ochna pumila</i> Buch.-Ham.	Hetauda	P.N.Suwal & S.B.Rajbhandari	236
<b>Oleaceae</b>				
131	<i>Fraxinus floribunda</i> Wall.	10km N of Bhimpede	C.A.Pendry et al.	DNEP2B210
132	<i>Jasminum glandulosum</i> Wall.	Tistan deorali	H.Kanai	673301
133	<i>Jasminum nepalense</i> Spreng.	Tistung	H.Kanai	673301
<b>Onagraceae</b>				
134	<i>Circaea repens</i> Wall. ex DC.	Aglochucidanda, Tistung	M.S.Bista	3638
135	<i>Circaea alpina</i> L.	Simbhanjyang	H.Kanai	673363
136	<i>Circaea lutetiana</i> L.	Rhikheswore	S.B.Malla	229
137	<i>Epilobium roseum</i> Schneb.	Simbhanjyang	S.B.Malla	249
<b>Orchidaceae</b>				
138	<i>Bulbophyllum affine</i> Lindl.	Makawanpurgadi	K.J.White	10
139	<i>Bulbophyllum hookeri</i> (Duthie) Smith	Daman	K.J.White	3
140	<i>Bulbophyllum retusiusulum</i> Reichenb.f.	Simbhanjyang	R.B.Tamang	36
141	<i>Bulbophyllum rigidum</i> K. & P.	Daman	K.R.Rajbhandari & S.Bhattarai	85A
142	<i>Dendrobium denudans</i> D.Don	Makawanapurgadi	K.J.White & B.R.Sharma	24
143	<i>Epipactis gigantea</i> Douglas ex Hook.	Kamle	N.P.manandhar, L.P.Kattel	11848
144	<i>Eria bractescens</i> Lindl.	Makawanpurgadi	K.J.White	13
145	<i>Eria extinctoria</i> (Lindl.) Oliver	Churiakhola	K.J.White	1
146	<i>Eulophia mackinnoni</i> Duthie	Brindavan	P.R.Shakya et al.	3654
147	<i>Gastrochilus dasyogon</i> (Sm.) Kuntze	Makawanpurgadi	K.J.White	19



S.N.	Family / Scientific name	Locality	Collectors	Collector number
148	<i>Hemipilia cordifolia</i> Lindl.	Daman	R.Rana et al.	3663
149	<i>Herminium angustifolium</i> (Lindl.) Benth.	Aglochucidanda, Tistung	M.S.Bista	3661
150	<i>Papiliomantha uniflora</i> (Lindl.) Garay	Mahaveer	K.J.White	18
151	<i>Pholidota recurva</i> (Bl.) Lindl.	Makawanpurgadi	K.J.White	22
152	<i>Vandopsis undulata</i> (Lindl.)	Chanpkharka	N.P.Manandhar	3484
<b>Palmae</b>				
153	<i>Calamus tenuis</i> Roxb.	Hetauda	Suwal & Rajbhandari	235
<b>Piperaceae</b>				
154	<i>Peperomia exigua</i> Miq.	Bhimphedi	K.R.Rajbhandari et al.	75/934
<b>Plantaginaceae</b>				
155	<i>Plangago major</i> L.	Simbhanjyang	N.K.Bhattarai	86/175
<b>Polygalaceae</b>				
156	<i>Polygala triphylla</i> Buch.-Ham.	Kulekhani	Shrestha & Adhikari	17341
<b>Polygonaceae</b>				
157	<i>Bistorta amplexicaulis</i> (Don) Greene	Simbhanjyang	H.Kanai	673322
158	<i>Persicaria pubescens</i> (Bl.) Hara	Simbhanjyang	S.B.Shah	172
159	<i>Polygonum campanulatum</i> (Hook. f.) Hara	Simbhanjyang	S.B.Shah	
<b>Primulaceae</b>				
160	<i>Primula petiolaris</i> Wall,	Simbhanjyang	H.Kanai	670660
<b>Ranunculaceae</b>				
161	<i>Anemone elongata</i> D. Don	Simbhanjyang	Rajbhandari & Upadhyay	2710
162	<i>Anemone rivularis</i> Buch.-Ham.	Daman	S.B.Malla	993
163	<i>Anemone trullifolia</i> Hook. f. Thoms.	Simbhajyang	Rajbhandari & Upadhyaya	2210
164	<i>Clematis roylei</i> Rehder	Simbhanjyang		
165	<i>Delphinium stapeliosum</i> Bruhl. Ex Huth	Simbhajyang	S.B.Saha	182
166	<i>Ranunculus pensylvanicus</i> L.	Simbhajyang	S.B.Saha	170
167	<i>Thalictrum virgatum</i> HK.f. & Th.	Simbhajyang	Rajbhandari & Upadhyaya	2247
<b>Rhamnaceae</b>				
168	<i>Sageretia oppositifolia</i> (Wall.) Brogn.	Chitlang	M.S.Bista	3217
<b>Rosaceae</b>				
169	<i>Photinia inegrifolia</i> Lindl.	Tistung	M.S.Bista	5859
170	<i>Potentilla lineata</i> Trev.	Daman	Upadhyaya & Rajbhandari	2226
171	<i>Rubus fockeanus</i> Kurz	Simbhajyang	S.B.Malla & S.B.Rajbhandari	54
<b>Rubiaceae</b>				
172	<i>Galium aparine</i> L.	Pairang	N.P.Manandhar	12713
173	<i>Galium rotundifolium</i> Linn.	Simbhajyang		9301
174	<i>Hymenopogon parasiticus</i> Wall.	Simbhajyang	H.Kanai	6733327
175	<i>Ophiorrhiza thomsonii</i> Hook. f.	Rhikheswore	S.B.Malla	230
176	<i>Pavetta tomentosa</i> Roxb.	Hetauda	J.F.Dobremez	788
177	<i>Rubia charifolia</i> Wall. ex G. Don	Hetauda, Manokamana	C.A.Pendry et al.	DNEP2B1 75
178	<i>Rubia wallichiana</i> Decne.	Bhimphedi	C.A.Pendry et al.	DNEP2B2 20
179	<i>Uncaria sessilifrutus</i> Roxb.	Makawanpurgarhi	Kanai & Bista	11335

S.N.	Family / Scientific name	Locality	Collectors	Collector number
<b>Santalaceae</b>				
180	<i>Dufrenoya platyphylla</i> (Spreng.) Stauffer	Daman	J.D.A.Stainton	5298
<b>Saurauriaceae</b>				
181	<i>Saurauia fasciculata</i> Wall.	Makawanpurgarhi	Kanai & Bista	11069
<b>Saxifragaceae</b>				
182	<i>Saxifraga diversifolia</i> Wall. ex Ser.	Tistung		
<b>Scrophulariaceae</b>				
183	<i>Alectra arvensis</i> (Benth.) Merr.	Manokamana temple		
184	<i>Limnophila repens</i> (Benth.) Benth.	Hetauda	C.A.Pendry et al.	DNEP2B188
185	<i>Lindernia pusilla</i> (Willd.) Bold.	Manakamana temple		
186	<i>Vandellia nummularifolia</i> Don	Rhikheswore	S.B.Malla	245
<b>Smilacaceae</b>				
187	<i>Smilax elegans</i> Wall.	Deorali	N.P.Manandhar	3445
<b>Solanaceae</b>				
188	<i>Solanum indicum</i> L.	Hetauda	N.K.Bhattarai	87/129
189	<i>Physalis angulata</i> L.	Tamabharai		
<b>Sonneratiaceae</b>				
190	<i>Duabanga gradiflora</i> (Roxb. ex DC.) Walp.	Hetauda	C. Pendry et al.	DNEP2A150
<b>Symplocaceae</b>				
191	<i>Symplocos racemosa</i> Roxb.	Hetaura	M.S.Bista	3326
192	<i>Symplocos ramossisima</i> Wall.	Deorali	N.P.Manandhar	3449
<b>Tamaricaceae</b>				
193	<i>Tamarix dioica</i> Roxb.	Hetauda	N.K.Bhattarai	87/148
<b>Theaceae</b>				
194	<i>Eurya cerasifolia</i> (D.Don) Kobuski	Aghari	C.A.Pendry et al.	DNEP3B234
<b>Thymeleaceae</b>				
195	<i>Daphne bholua</i> Buch.-Ham. Ex D.Don	Tistung	M.S.Bista	3602
<b>Tiliaceae</b>				
196	<i>Grewia multiflora</i> Juss.	Makaldamar	N.P.Manandhar & L.P. Kattel	11819
<b>Umbelliferae</b>				
197	<i>Sanicula elata</i> Buch.-Ham. ex D. Don	Simbhajyang	H.Kanai	67329
<b>Urticaceae</b>				
198	<i>Boehmeria rotundifolia</i> D.Don	Hetauda	P.R.Shakya	9349
199	<i>Debregeasia longifolia</i> (Burm.f.) Wedd.	Makaldamar	N.P.Manandhar & L.P. Kattel	11810
200	<i>Gonostegia oppositifolia</i> Turcz.	Daman	S.B.Malla	4557
201	<i>Laportea interrupta</i> Wight	Simbhamjyang	H.Kanai	673334
202	<i>Maoutia puya</i> (Hook.) Wedd.	Makaldamar	N.P.Manandhar	1264
203	<i>Pilea glaberrima</i> (Bl.) Bl.	Badahakim bridge	C.A.Pendry et al.	DNEP2A149
204	<i>Pilea scripta</i> (D. Don) Wedd.	Churiahill	P.R.Shakya	9363
205	<i>Pilea smilacifolia</i> Wedd.	Makaldamar	N.P.Manandhar & L.P. Kattel	31806
206	<i>Pilea wightii</i> Wedd.	Daman	J. F. Dobremez	808
207	<i>Pouzolzia viminea</i> Wedd.	Daman	J.F.Dobremez	500
<b>Verrbenaceae</b>				
208	<i>Callicarpa vestita</i> Wall.	Hetauda, Badahakim bridge	C.A.Pendry et al.	DNEP2A156

S.N.	Family / Scientific name	Locality	Collectors	Collector number
	<i>Clerodendrum serratum</i> Spreng.	Hetauda	P.R.Shakya	9308
209	<i>Clerodendrum viscosum</i> Vent.	Katunje (Makawanpur)	M.S.Bista	2590
<b>Vitaceae</b>				
210	<i>Leea aspera</i> Edgew.	Hetauda- Amlekhganj	P.R.Shakya	9338
211	<i>Leea robusta</i> Roxb.	Hetauda farm	P.R.Shakya	9311
212	<i>Parthenocissus semicordata</i> (Law.) Bl.	Deorali-Kulekhani	H.kanai & T.B.Shrestha	
213	<i>Tetrastigma obtectum</i> (Wall. ex M. A. Lawson) Planch ex Franch	Deorali-Chitlang		
<b>Zingiberaceae</b>				
214	<i>Cautleya gracilis</i> Sm.	Chisapanigadi, Bhimphedi	D.P.Joshi	17481
215	<i>Roscoea alpina</i> Royle	Daman	M.Ghimire	649

Source: Herbarium specimens preserved in National Herbarium and Plant Laboratories (KATH), Godawari, Lalitpur, Nepal

### **Appendix 3: Questionnaire for medicinal plants**

Date:

Study site:

Name of respondent:

Ethnic group:

Gender: Male/Female

Age:

Scientific name:

Family:

Local name:

1. Which plants do you use for medicine?
2. Which plant parts use for medicine?
3. In what type of disease, you use this plant?
4. What type of method do you prepare medicine from this plant?
5. How do you apply?
6. From where do you collect this medicinal plants?Forest/Roadside/Riverside/Homegarden/Farmer field
7. Is this plant abundant/common/rare in nature?
8. Do you have any knowledge to conserve this plant in natural forest?
9. Do you sell medicinal plants?
10. Do you cultivate medicinal plants in your home garden/farmer field?
11. Do you prefer this plant the most or least for use? Yes/No

#### **Appendix 4: Questionnaire for wild edible plants**

Date:

Village name:

Name of respondent:

Ethnic group:

Gender: Male/Female

Age:

Scientific name:

Family:

Local name:

Habitat:

1. Which edible plants are often used?
2. Which plant parts do you use?
3. From where you collect wild edible plants? forest/homegarden/field
4. How often do you collect?
5. Do you have indigenous knowledge of consumption and method of preparation?
6. When is the harvesting time?
7. How much plants harvested per year?
8. Do you have any knowledge to conserve this plant in natural forest?
9. What do you think about for conservation of edible plants?
10. Who collect the plant child/woman/man?
11. What are traditional methods of edible plants preservation?
12. Do you cultivate edible plants in your home garden?
13. Do you sell edible plants?
14. Do you prefer this plant the most or least?

## **Appendix 5: Questionnaire for Conservation status of plant resources**

Name of plants:

Family:

Name of trader/informants/collector:

Age:

Gender:

Scientific name:

Family:

Local name:

1. Which plant parts do you sell?
2. From where do you collect this plants?
3. How much plant do you sell per year?
4. How much plant do you harvest per year?
5. What type of method do you harvest from nature?
6. Do you sell in local market or outside the market?
7. Do you cultivate in your homegarden/field?
8. Is it difficult to germinate from seed?
9. Which propagation method do you use?
10. What are the main causes of loss of plants in nature?
11. Do you have any knowledge for conservation of this plant resources?

## **Appendix 6: Conferences Attended**

**JOSHI N., SIWAKOTI M., KEHLENBECK K. (2013): Developing a domestication priority setting approach for wild vegetable species to improve food security in Makawanpur district, Central Nepal.** Oral paper presentation at International Research on Food Security, Natural Resource Management and Rural Development, Tropentag, 17-19 September, University of Hohenheim, Hohenheim, Germany. Book of Abstract, pp 404

**JOSHI N. and SIWAKOTI M. (2012): Wild Edible Plants Utilized by Newar Community of Chitlang Village of Makawanpur District, Nepal.** Oral paper presentation. The Sixth National Conference on Science and Technology, organized by Nepal Academy of Science and Technology, Khumaltar, Lalitpur, September 25-27, 2012, Kathmandu, Nepal. Abstract pp. 92.

**JOSHI N. and SIWAKOTI M. (2011): Wild Fruit Resources and Market Survey in Makawanpur District, Central Nepal.** Oral paper presentation at XXI Annual Conference of Indian Association For Angiosperm Taxonomy and National Seminar on Biodiversity Conservation and Climate Change (BCCC-11) December 2-4, 2011, Bhubaneswar, Odisha, India. Souvenir-Cum-Abstracts, pp. 94.

**JOSHI N. SIWAKOTI M., KEHLENBECK K. (2011): Developing a priority setting approach for domestication of indigenous fruit and nut species in Makawanpur district, Nepal.** Oral paper presentation at 2<sup>nd</sup> International Symposium on Underutilized Plant Species "Crops for the Future-Beyond Food Security 27<sup>th</sup> June-1<sup>st</sup> July 2011, The Royale Chulan Kuala Lumpur, Malaysia. Book of Abstract, pp 44.

**JOSHI N. and SIWAKOTI M. (2010): Status of Wild and Domesticated fruits of Makawanpur district.** Oral paper presentation at International Conference on Biodiversity, Livelihood and Climate Change in Himalayas, December 12<sup>nd</sup>-14<sup>th</sup>, Kathmandu, Nepal. Book of Abstract, pp 16.

## **Appendix 7: Publications (Attached copy)**

**JOSHI, N., Siwakoti, M. and Kehlenbeck, K. 2013. Developing a priority setting approach for domestication of indigenous fruit and nut species in Makawanpur district, Nepal. *Acta Horticulturae* (ISHS) 979: 97-106.**

**JOSHI, N. and M. Siwakoti (2012): Wild Vegetables Used by Local Community of Makawanpur District and Their Contribution to Food Security and Income Generation. *Nepal Journal of Science and Technology*, Nepal Academy of Science and Technology Kathmandu, Nepal, 13 (1): 59-66.**

**JOSHI, N. and Siwakoti, M. 2012: *Merremia hirta* (Linnaeus) Merrill (Convolvulaceae): a new record for Nepal. *Pleione* 6 (2): 442-445.**



# Wild Vegetables Used by Local Community of Makawanpur District and Their Contribution to Food Security and Income Generation

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## Abstract

Wild vegetables were collected from forests, home gardens, road sides, fallow lands and farmers' fields of Makawanpur district. Information regarding local names, seasonal availability, mode of consumption and priority for utilization were gathered by interviews with key informants, traders' interviews and market survey of study sites. Some of nutritive values including relative importance of wild vegetables were recorded from literature. A total of 68 wild plant species belonging to 58 genera and 40 families were identified as wild vegetables. Of these, 53 species were herbs, 5 climbers, 4 species shrubs, 4 species trees, and 2 species aquatic runners. The wild vegetables were harvested mainly from March to July by women for household consumption and were also sold in the market. *Amaranthus lividus*, *Bambusa tulda*, *Bauhinia purpurea*, *Chenopodium album*, *Dendrocalamus hamiltonii*, *Diplazium esculentum*, *Dryopteris cochleata*, *Ficus lacor*, *Ipomoea aquatica*, *Macropanax dispermus*, *Phytolacca acinosa*, *Rorripa nasturtium-aquaticum*, *Tectaria coduanata*, were frequently used as wild vegetables. About 16 wild vegetables were sold in the market. Thus, wild vegetables not only contributed to subsistence and nutritional security of the local people, but also a source of income generation. Despite their importance, these plants have been threatened. The utilization and cultivation of these vegetables should be promoted to maintain the dietary needs of the household in Nepal. This paper attempts to highlight the use and priority of wild vegetables mainly leafy and tender shoot vegetables of Makawanpur district.

**Key words:** conservation, diversity, ethnobotany, neglected vegetables

## Introduction

Wild plants have been used by human beings for medicinal and food purposes since time immemorial. In many parts of the world, use of wild plants not negligible (Pieroni *et al.* 2007). It plays a very important role in the livelihoods of rural communities as an integral part of the subsistence strategy of people in many developing countries (Zemedu & Mesfin 2001). Wild vegetables are important sources of vitamins and minerals (Odav *et al.* 2007). Sundriyal and Sundriyal (2003) documented the diversity and traditional values of Himalayan wild edible plants. The nutritional value of traditional wild vegetables is high (Sundriyal &

Sundriyal 2004, Orech *et al.* 2007). Numerous publications provide a valuable knowledge of edible wild plants in various locations of Nepal (Anonymous 1982, Manandhar 1995, 1997, Siwakoti *et al.* 1997; Shrestha & Dhillion 2006, Bhattarai *et al.* 2009). However, diet surveys tend to ignore the wild plants in comparison to cultivated ones (Etkin 1994). Increased use of traditional vegetables can contribute to enhance people's health and standard of living as well as the economic and social status. Nepal houses about 1500 species as medicinal plants and about 200 species as vegetables (Manandhar 2002). Gathering of wild vegetables for both self-consumption and selling in markets are still very common practice in

Nepal, particularly in rural areas. During food scarcity periods, a large number of people from urban and rural communities heavily depend on wild vegetables (Anonymous 1982). However, many traditional wild vegetables are replaced by the introduction of exotic vegetables and improved varieties. Further, habitat degradation and poor marketing opportunities for traditional vegetables are responsible for losing their value (Joshi *et al.* 2007). The wild vegetables are marginalized in current agricultural practice as well as poor utilization due to lack of awareness (Maikhuri *et al.* 2004). There is an urgent need for conservation of wild plants, which can be useful in case of genetic erosion or for crop improvement (Kala 2007). Most of the wild vegetables grown naturally are resistant to several biotic and abiotic stresses, they required fewer inputs, and are comparatively nutritionally superior than cultivated crops (Bhardwaj *et al.* 2007). Despite these advantages, most traditional wild edible plants are generally uncultivated and underutilized (Grevetti & Ogle 2000). This study was conducted with the objectives of identifying various wild vegetables, document their uses, seasonal availability, relative importance, priorities of consumption and nutritive values of some selected species.

## Methodology

### Study area

Makawanpur district is situated in Inner Tarai lowland and mid-Hills of Narayani zone of the Central Development Region, Nepal (Fig. 1). The district extends over an area of 2426 sq. km and is located between the latitudes 27°10' to 27°40'N and 84°41' to 85°31'E longitudes. It ranges 166 m at Inner Tarai lowland (Raigaon, Hattidhunga) to 2300 m at



Fig. 1. Map of study sites

Mahabharat peak (mid-Hills) Simbhanjyang. It is one of the unique districts of Nepal with geographical wonders.

Makawanpur district was selected for this study due to its wide altitudinal range, rich plant diversity and diverse ethnic groups with unique traditional knowledge. The main ethnic groups in this district are Tamang (49%), Brahmin (15%), Chhetri (11%), Newar (7%), Gurung (5%), Chepang (4%) and Bankaria (0.02%) (DDC 2003). The Tamang, Bankaria and Chepang are mostly living close to forests and depend a lot on the natural resources, whereas the Newar and Chhetri are traditionally farmers and living in urban and sub-urban settings. Total forest area coverage in Makawanpur district is 59% followed by crop land 25%, rivers and lakes 7%, and pasture and barren land 9% (DFO 2002). Tree vegetation is dominated by *Shorea robusta*, *Terminalia tomentosa*, *Lagerstroemia parviflora*, *Pinus roxburghii*, *Quercus semecarpifolia*, *Myrica esculenta*, etc. Shrubs include *Viburnum erubescens*, *Rubus ellipticus*, *Pyracantha crenulata*, *Woodfordia fruticosa*, etc. Detail information on altitudes, settings and ethnic groups of the study sites are given in Table 1.

### Data collection

The present study was conducted in 12 sites of the district during the years 2009 to 2011 (Fig. 1, Table 1). The sites were selected in three agro-climatic zones (altitude range 400-2300 msl). Attention was given to collect the information only for leafy and tender shoot of wild vegetables.

Table 1. Altitude, ethnic groups in the selected 12 study sites of Makawanpur district

Study site	Altitude (m)	Settings	Main ethnic groups
Hetauda	500	Urban	Newar/Chhetri
Handikhola	400-630	Rural	Bankaria
Hamamadi	400	Rural	Tamang/Chhetri
Churiamai	630	Rural	Tamang
Daman	2100	Rural	Tamang
Aghor	2000-2130	Rural	Tamang
Simbhanjyang	2300	Rural	Tamang
Chisapani	1800	Rural	Tamang
Tistung	1800	Suburban	Newar
Chitlang	1800	Rural	Newar
Bhainse	1100	Rural	Tamang
Bhimpheedi	1000	Suburban	Newar

Source: Field survey, 2009

The ethnobotanical methods were applied to investigate how local people used vegetables from forests, home gardens, farmers' field, fallow land and road sides. Data were gathered by using semi-structured questionnaires, informal talks, including field observation and survey of plants, in forests, crop fields and fallow lands. Market surveys and discussion with sellers were also conducted. Identification of the collected specimens was made with the help of relevant references (Hara & Williams 1979, Hara *et al.* 1982, Grierson & Long 1983-2001, Notlite 1994, 2000, Siwakoti & Varma 1999, Press *et al.* 2000).

Interviews were conducted with 34 key informants who were randomly selected from four different ethnic groups such as Tamang, Newar, Chhetri and Bankaria. A list of these knowledgeable key informants was compiled with the help of respective village heads. Among them, 13 were females and 21 were males. They were asked: (1) which leafy vegetables did they use for food, (2) where and when did they harvest them, and (3) how much quantity did they consume daily/week/month, etc.

Relative importance was ranked using the number of times the species was cited as being used by the informants (Belem *et al.* 2009). A survey of local villages and road side markets in the same area was done to confirm the respondent's statements on marketing potential of the mentioned species. Prioritization of

the wild vegetables were prepared using a set of criteria such as taste, sale, ethnic use, and eaten by both children and adults (Joshi *et al.* 2011).

## Results and Discussion

### Diversity of wild vegetables

A total of 68 wild plant species belonging to 56 genera and 40 families was identified as leafy vegetables (Table 2). Of them, 53 (78%) species were herbs, 5 (7%) climbers, 4 (6%) shrubs, 4 (6%) trees and 2 (3%) species aquatic runners. About 80% of the species were collected from natural or semi-natural areas, particularly forest, road side and fallow land. Wild vegetables such as *Aconogonum molle*, *Bauhinia purpurea*, *Ficus lacor*, *Phytolacca acinosa*, *Bambusa tulda*, *Dendrocalamus hamiltonii* were domesticated in home gardens by few local people. The *Amaranthus lividus*, *A. viridis* and *Chenopodium album* were cultivated as well as available in the wild. These species were mainly collected from the wild elsewhere, however, in the study area they were also cultivated for marketing purpose. *Tragopogon gracilis* and *Talinum cuneifolium* are the new additional wild vegetables of Nepal. A total of 23 (34%) leafy vegetable species were collected from fallow lands followed by 9 (13%) species from road side, 3 species from farmers' field and 2 species occurred on both road sides and farmers' fields. Similarly, 24 (35%) species were gathered from the forests (Table 2).

**Table 2.** Wild vegetables used by local communities of Makawanpur district (Note: HG=homegarden; Ne=Newar, Che=Chhetri, Ta=Tamang, Ba=Bankaria)

No.	Scientific name	Life form	Family	Local name	NP (RI)	Collection sites	Ethnic group use	Seasonal availability	Abundance	Market available	Voucher number
1	<i>Aconogonum molle</i> (D. Don) H. Hara	Herb	Polygonaceae	Thotne	16	HG/Forest	Ne, Che, Ta, Ba	May-July	Rare	Yes	0932575NJ
2	<i>Allium wallichii</i> Kunth	Herb	Liliaceae	Banlasun	19	Forest	Ta, Ba, Ne	Aug-Oct	Rare	No	09823258NJ
3	<i>Alternanthera sessilis</i> (L.) DC.	Herb	Amaranthaceae	Bhringisag	5	Roadside	Ba, Ta	May-July	Common	No	0931159NJ
4	<i>Amaranthus lividus</i> L.	Herb	Amaranthaceae	Lattesag	26	Roadside/ Farmer field	Ne, Ta, Che, Ba	July-Aug.	Common	Yes	09613163NJ
5	<i>Amaranthus spinosus</i> L.	Herb	Amaranthaceae	Kandelatte	8	Roadside	Ba, Ta	July-Aug.	Common	No	011315718NJ
6	<i>Amaranthus viridis</i> L.	Herb	Amaranthaceae	Lattesag	20	Roadside	Ne, Ta, Che, Ba	July-Aug.	Common	Yes	010108532NJ
7	<i>Anagallis arvensis</i> L.	Herb	Primulaceae	Armale	5	Fallow land	Ta, Ba	Aug-Sept.	Rare	No	092952NJ
8	<i>Arisaema tortuosum</i> (Wall.) Schott.	Herb	Araceae	Banko	5	Forest	Ta, Ba	July-Aug.	Occasional	No	09613158NJ
9	<i>Asparagus filicinus</i> Buch.-Ham. ex D. Don	Herb	Asparagaceae	Bankurilo	14	Forest	Ta, Ba	Mar.-May	Rare	No	01124626NJ
10	<i>Asparagus racemosus</i> var. <i>subaerosus</i> Baker	Herb	Asparagaceae	Kurilo	18	Forest	Ta, Che, Ba, Ne	Mar.-May	Rare	No	01010853NJ
11	<i>Asparagus racemosus</i> Willd.	Herb	Asparagaceae	Kurilo	18	Forest	Ta, Che, Ba, Ne	Mar.-May	Rare	No	09924278NJ
12	<i>Bambusa tulda</i> Nees	Shrub	Poaceae	Tusa	30	HG/Forest	Ne, Che, Ta, Ba	Mar.-May	Rare	Yes	0951135NJ
13	<i>Basella alba</i> L.	Climber	Basellaceae	Poisag	9	Roadside	Ba	June-July	Rare	No	0114800NJ
14	<i>Bauhinia purpurea</i> L.	Tree	Leguminosae	Tanki	25	HG/Forest	Ta, Ba	Mar.-May	Rare	No	01010444NJ
15	<i>Bidens pilosa</i> L.	Herb	Compositae	Kuro		Roadside	Ba	June-July	Common	No	011317731NJ
16	<i>Blumea lacera</i> (Burm.f.) DC.	Herb	Compositae	Kurkure	10	Roadside	Ba, Ne	May-June	Occasional	No	0931160NJ
17	<i>Boehmeria platyphylla</i> D. Don	Herb	Urticaceae	Kamle	14	Forest	Ta, Ba	Jun-Aug	Occasional	No	09823244NJ

18	<i>Boehmeria terifolia</i> D. Don	Herb	Urticaceae	Chalnisu	10	Forest	Ta, Ba	Jun-Aug	Occasional	No	011619873NJ
19	<i>Boerhavia diffusa</i> L.	Herb	Nyctaginaceae		8	Roadside	Ba	Jun-Aug	Occasional	No	010106495NJ
20	<i>Chenopodium album</i> L.	Herb	Chenopodiaceae	Bethe	22	Roadside/ Farmer field	Ne, Che, Ta, Ba	Mar.-May	Common	Yes	0931164NJ
21	<i>Chenopodium ambrosioides</i> L.	Herb	Chenopodiaceae	Ratolatte	12	Fallow land	Ba	Mar.-May	Common	No	011620919NJ
22	<i>Chlorophytum nepalense</i> (Lindl.) Baker	Herb	Liliaceae	Baniasun	14	Forest	Ta, Ba	June-July	Rare	No	09924286NJ
23	<i>Clematis buchananiana</i> DC.	Climber	Ranunculaceae	Jungelahara	4	Forest	Ta	Jul.-Aug	Rare	No	09924293NJ
24	<i>Cleome viscosa</i> L.	Herb	Cleomaceae	Bantori	4	Roadside	Ne, Che	June-July	Occasional	No	01110902NJ
25	<i>Commelina benghalensis</i> L.	Herb	Commelinaceae	Kanesag	6	Forest	Ba, Ta	Jun-Aug	Occasional	No	09815227NJ
26	<i>Cratogeomys hamiltonii</i> Nees Am. ex Munro	Tree	Capparidaceae	Siplekan		HG		Mar.-Apr.	Rare	No	011620911NJ
27	<i>Diplazium esculentum</i> (Retz.) Sw.	Herb	Woodsiaceae	Niuro	30	Forest	Ne, Che, Ba, Ta	Mar.-July	Occasional	Yes	09424119NJ
29	<i>Dryopteris cochleata</i> (Ham. ex D. Don) C. Chr.	Herb	Dryopteridaceae	Gheeniuro	30	Forest	Ne, Che, Ba, Ta	May-June	Occasional	Yes	091130323NJ
30	<i>Eclipta prostrata</i> (L.) L.	Herb	Compositae	Bhringraj	23	Farmer field	Ne, Ta	Jun-Aug	Occasional	No	09823266NJ
31	<i>Emilia sonchifolia</i> (L.) DC.	Herb	Compositae	Dudhe	5	Fallow land	Ta, Ba	Feb.-Mar.	Occasional	No	011317748NJ
32	<i>Euphorbia hirta</i> L.	Herb	Euphorbiaceae	Dudhejhar	5	Roadside	Ba	Jan.-Mar.	Occasional	No	0951140NJ
33	<i>Fagopyrum dibotrys</i> (D. Don) H. Hara	Herb	Polygonaceae	Titefaper	15	Farmer field/ Fore	Ne, Che, Ba, Ta	Jun-Aug	Occasional	No	09815225NJ
34	<i>Fagopyrum esculentum</i> Moench.	Herb	Polygonaceae	Mithefaper	20	Farmer field	Ne, Che, Ba, Ta	Jun-Aug	Occasional	No	0115657NJ
35	<i>Ficus lacor</i> Buch.-Ham. ex D. Don	Tree	Moraceae	Kavro	26	HG	Ta, Che	Mar.-May	Rare	No	0103770NJ
36	<i>Girardinia diversifolia</i> (Link) Friis	Herb	Urticaceae	Allosag	11	Forest	Ta, Ba	Jun-Aug	Occasional	No	09823271NJ
37	<i>Holarrhena pubescens</i> (Buch.-Ham.) Wall. ex G. Don	Shrub	Apocynaceae	Kurchi	2	Fallow land	Ba	Mar.-May	Occasional	No	09121363NJ
38	<i>Houttuynia cordata</i> Thunb.	Herb	Saururaceae	Gane	9	Forest	Ne, Ba, Ta	Jun-Aug	Rare	No	09711181NJ
39	<i>Impatiens bicornuta</i> Wall.	Herb	Balsaminaceae	Tiuri	0	Forest	Ta, Ba	Jun-Aug	Rare	No	09103309NJ
40	<i>Iponomea aquatica</i> Forssk.	Runner	Convolvulaceae	Karmisag	25	Fallow land	Ne, Che, Ta, Ba	All round year	Occasional	Yes	0953111NJ
41	<i>Lathyrus aphaca</i> L.	Herb	Leguminosae	Bankhesari	4	Fallow land	Ba	Mar.-May	Rare	No	0932578NJ
42	<i>Lilium nepalense</i> D. Don	Herb	Liliaceae	Khiraulo	8	Forest	Ne, Ta, Ba	Mar.-May	Rare	No	09613162NJ
43	<i>Lygodium japonicum</i> (Thunb.) Sw.	Climber	Schizaeaceae	Parewauri	4	Forest	Ta, Ba	Mar.-May	Rare	No	010104487NJ
44	<i>Macropanax dispemus</i> (Blume) Kuntze	Tree	Araliaceae	Chinia	30	Forest	Ne, Ta, Che	Mar.-June	Occasional	Yes	01125689NJ
45	<i>Malva verticillata</i> L.	Herb	Malvaceae	Lafesag	14	Fallow land	Ne, Ta, Che	Mar.-June	Occasional	Yes	011620908NJ
46	<i>Oenanthe javanica</i> (Blume) DC.	Herb	Umbelliferae		15	Fallow land	Ta, Ne, Ba	Jun-Aug	Rare	No	0105657NJ
47	<i>Phoenix humilis</i> Royle ex Becc. & Hook. f.	Shrub	Palmaceae	Thakal	15	Forest	Ta	Jun-Aug	Rare	No	010104430NJ
48	<i>Phytolacca acinosa</i> Roxb.	Herb	Phytolaccaceae	Jaringosag	25	HG/Forest	Ne, Che, Ta	June-July	Rare	Yes	011619896NJ
49	<i>Plantago erosa</i> Wall.	Herb	Plantaginaceae	Isbgol	10	Fallow land	Ta, Ba	Feb.-Mar.	Common	No	01010445NJ
50	<i>Pouzolzia zeylanica</i> (L.) Benn.	Herb	Urticaceae	Nichasag	11	Forest	Ta, Ba	Jun-Aug	Occasional	No	09823255NJ
51	<i>Pteris biauaria</i> L.	Herb	Pteridaceae	Dantheniuro	24	Forest	Ne, Che, Ta, Ba	Jun-Aug	Occasional	No	010104468NJ
52	<i>Rorippa nasturtium-aquaticum</i> (L.) Hayek	Runner	Cruciferae	Kholesag	28	Fallow land	Ne, Ba, Che, Ta	Mar.-July	Common	Yes	0105743NJ
53	<i>Rumex nepalensis</i> Spreng.	Herb	Polygonaceae	Halhalesag	18	Fallow land	Ba, Ta	Jun-Aug	Common	No	09613164NJ
54	<i>Senna tora</i> (L.) Roxb.	Herb	Leguminosae	Tapre	6	Fallow land	Ba	June-July	Common	No	010106493NJ
55	<i>Smilax lanceifolia</i> Roxb.	Climber	Smilacaceae	Kukurdaino	18	Forest	Ta, Ba	Jun-Aug	Occasional	No	092949NJ
56	<i>Smilax ovalifolia</i> Roxb. ex D. Don	Climber	Smilacaceae	Kukurdaino	20	Forest	Ta, Ba	Jun-Aug	Rare	No	010108505NJ
57	<i>Solanum nigrum</i> L.	Herb	Solanaceae	Kalobih	5	Fallow land	Ba	Aug.-Sept.	Common	No	0932582NJ
58	<i>Sonchus oleraceus</i> L.	Herb	Compositae	Dudhejhar	8	Fallow land	Ba, Ta	Jun-Aug	Occasional	No	0105238NJ
59	<i>Stellaria media</i> (L.) Vill.	Herb	Caryophyllaceae	Armalejhar	5	Fallow land	Ta, Che, Ba	Jun-Aug	Occasional	No	0951148NJ
60	<i>Stellaria monosperma</i> Buch.-Ham. ex D. Don	Herb	Caryophyllaceae	Jethimadhu	5	Forest	Ta	Jun-Aug	Rare	No	09121402NJ
61	<i>Talinium cuneifolium</i> Willd.	Herb	Portulacaceae	Chiniasag	5	Fallow land	Ne, Che	Mar.-May	Rare	Yes	011317727NJ
62	<i>Tectaria coadunata</i> (Wall. ex J. Sm.) C. Chr.	Herb	Dryopteridaceae	Dantheniuro	26	Forest	Ne, Che, Ta, Ba	Jun-Aug	Occasional	Yes	010104479NJ
63	<i>Tragopogon gracilis</i> D. Don	Herb	Compositae	Dowajha	9	Fallow land	Ne	Apr.-May	Rare	No	011414478NJ
64	<i>Trianthema portulacastrum</i> L.	Herb	Aizoaceae	Kulfasag	3	Fallow land	Ba	Apr.-May	Occasional	No	0105563NJ
65	<i>Urtica dioica</i> L.	Herb	Urticaceae	Sisnu	19	Fallow land	Ne, Che, Ta, Ba	Jun-Aug	Common	Yes	092930NJ
66	<i>Vicia angustifolia</i> L.	Herb	Leguminosae	Kutilkosa	9	Fallow land	Ba	Jun-Aug	Occasional	No	092821NJ
67	<i>Vicia hirsuta</i> (L.) Gray	Herb	Leguminosae	Kutilkosa	10	Fallow land	,Ba	Jun-Aug	Occasional	No	09424126NJ
68	<i>Youngia japonica</i> (L.) DC.	Herb	Compositae		6	Fallow land	Ba	Mar.-May	Common	No	0932693NJ

Source: Field study 2009-2011

NP: Number of persons who cited the species. Total number of informants is 34; RI: Relative importance

According to local peoples' perception, wild vegetables with high relative importance (RI) in this area were *Amaranthus lividus*, *B. tulda*, *B. purpurea*, *C. album*, *D. hamiltonii*, *Dryopteris cochleata*, *Eclipta prostrata*, *Ficus lacor*, *Ipomoea aquatica*, *Macropanax dispermus*, *Phytolacca acinosa*, *Rorripa nasturtium-aquaticum*, *Tectaria coadunata*, etc. (Table 2).

**Consumption and nutritive value of wild vegetables**

Rural women were the major players in utilizing wild traditional food plants including vegetables. They held and maintained a good knowledge on gathering locations and seasons, preservation, consumption and processing of wild vegetables. It was found that Tamang and Bankaria communities were the major consumers of wild vegetables as they lived nearby the forest. The Newar and Chhetri mainly lived in urban

and sub-urban areas and were attracted to more improved varieties and exotic vegetables than wild vegetables.

The estimated quantity of fresh vegetables consumed by each informant's house per day during the period of survey was nearly 500g. The average number of persons in each household was 10, hence each person consumed 50g of wild vegetables per day. Based on the interviews with key informants during field visits, the following 7 species were top ranked with regard to taste and consumption frequency by both children and adults: *B. tulda*, *C. album*, *D. hamiltonii*, *Diplazium esculentum*, *Dryopteris cochleata*, *Ipomoea aquatica*, *Tectaria coduanata*. The second ranked preferred species were *A. viridis*, *Macropanax dispermus*, *Pteris biaurita*, *Urtica dioica* (Table 3). These wild vegetables did not require any special

**Table 3.** Potential priority wild vegetables of Makawanpur district with their ranking after calculating the priority index

Species	Priority for taste (3=high)	Priority for sale (3=high)	Ethnic groups use (no.)	Eaten by children and adults (1=Yes)	Priority index	Rank for consumption
<i>Aconogonum molle</i>	2	2	4	0	8	4
<i>Amaranthus lividus</i>	2	3	4	0	9	3
<i>Amaranthus spinosus</i>	1	1	2	0	4	8
<i>Amaranthus viridis</i>	3	3	4	0	10	2
<i>Bambusa tulda</i>	3	3	4	1	11	1
<i>Asparagus filicinus</i>	3	1	2	1	7	5
<i>Asparagus racemosus</i>	3	1	4	1	9	3
<i>Asparagus racemosus</i> var. <i>subacerosus</i>	3	1	4	1	9	3
<i>Chenopodium album</i>	3	3	4	1	11	1
<i>Chlorophytum nepalense</i>	3	1	2	1	7	5
<i>Dendrocalamus hamiltonii</i>	3	3	4	1	11	1
<i>Diplazium esculentum</i>	3	3	4	1	11	1
<i>Dryopteris cochleata</i>	3	3	4	1	11	1
<i>Eclipta prostrata</i>	3	2	2	0	7	5
<i>Girardiana diversifolia</i>	2	1	2	0	5	7
<i>Ipomoea aquatica</i>	3	3	4	1	11	1
<i>Macropanax dispermus</i>	3	3	3	1	10	2
<i>Phoenix humilis</i>	3	1	1	1	6	6
<i>Phytolacca acinosa</i>	3	2	3	0	8	4
<i>Pteris biaurita</i>	3	2	4	1	10	2
<i>Smilax ovalifolia</i>	3	1	2	0	7	5
<i>Talinum cuneifolium</i>	3	2	2	0	7	5
<i>Tectaria coadunata</i>	3	3	4	1	11	1
<i>Urtica dioica</i>	3	3	4	0	10	2

Source: Field study 2009-2011



processing for cooking or consumption, except the removal of stings and some other microstructures of nettles of some species. All wild vegetables were boiled and cooked with cooking oil, salt and spices. However, some of wild vegetables were boiled and prepared by mixing with fried seed powder of *Glycine max*, *Sesamum indicum* or *Perilla frutescens* (Table 4). Some species like *Phytolacca acinosa* leaves required some special treatment in order to reduce the

bitterness, such as boiled and washed several times before the final preparation of vegetable. Wild vegetables were nutritious as they contained high protein and other nutrients which helped in the food security of rural people. Nutrient values of some priority wild vegetables are given in (Table 5). This table is based on the work of Sundriyal and Sundriyal (2004).

**Table 4.** Traditional knowledge on mode of consumption of prioritized wild vegetables

Species name	Occurrence	Part used	Mode of consumption
<i>Bambusa tulda</i>	Grows in forest edge, also cultivated in home garden.	Tender shoots	Outer covering is removed. Soft inner shoots are smashed and fried with cooking oil or cooked with potato.
<i>Chenopodium album</i>	Occurs in fallow land. Women cultivated in potato and wheat crops.	Tender shoots	Tender shoots are fried with egg. Tender shoots are also mixed with <i>Glycine max</i> , <i>Perilla frutescens</i> , <i>Sesamum indicum</i> fried flour and spices.
<i>Dendrocalamus hamiltonii</i>	Commonly occurs in forest area and roadside. This plant is collected from wild, also found domesticated in home garden.	Tender shoot	Cooked with potato. Also cut into small pieces and covered with Banana leaves to make fermented shoot, which can be preserved for longer period.
<i>Diplazium esculentum</i>	Frequently occurs in moist forest.	Tender fronds	Fried with cooking oil
<i>Dryopteris cochleata</i>	Frequently occurs in moist forest.	Tender fronds	Fried with cooking oil
<i>Ipomoea aquatica</i>	Grows in slow running water and pond.	Tender shoot and leaves	Fried with cooking oil

Source: Field study 2009-2011

### Marketing and income generation

A total of 16 wild vegetable species were found to be sold in the urban markets (Table 2). In rural markets only few vegetables were sold. The common marketable wild vegetables were *D. esculentum*, *A. lividus*, *A. viridis*, *B. tulda*, *D. hamiltonii*, *D. cochleata*, *Fagopyrum esculentum*, *Ipomoea aquatica*, *Macropanax dispermus*, *Malva verticillata*, *Rorripa nasturtium-aquaticum*, *Talinum cuneifolium* and *Urtica dioica*. Some species such as *F. esculentum*, *A. viridis*, *C. album* were cultivated mainly for selling in the markets. The market price of leafy vegetables ranged from 20-40 rupees per one bundle (about 400-500g). It is found that one vegetable seller earned up to Rs100 per day. It means marketing of vegetables could contribute to income generation and poverty reduction in the study areas.

### Seasonal availability of the wild vegetable

Availability of wild vegetables varied season to season

of the year. Informants reported that the highest number of species i.e 37 species could be harvested in the months of May to August, whereas only few species are harvested in the month of January to April (Table 2). Some species such as *A. lividus*, *A. viridis*, *U. dioica*, *R. nasturtium-aquaticum*, were consumed during the vegetable shortage period.

### Abundance of wild vegetables

Out of the 68 wild vegetable species, 26 were threatened in their abundance in the natural habitats, mainly the forest areas (Table 2). A variety of reasons were mentioned by local communities for species reduction in their natural habitat. The main reasons or threat were the unsustainable harvesting methods, land erosion, increase of agricultural land area, poor marketing opportunities, etc. It was also mentioned that there was an increasing practice of cultivating exotic and improved varieties of vegetables instead of indigenous wild ones.

**Table 5.** Nutritive value of some wild vegetables

Botanical name	Protein (%)	Vitamin C mg/100g	K (%)	P (%)	Ca (%)	Na (%)	Fe (mg/100g)
<i>Bambusa tulda</i>	3.9	4		0.041	0.033		0.4
<i>Chenopodium album</i>	4.63						
<i>Dendrocalamus hamiltonii</i>	3.9		0.057	0.065	1.12	0.039	
<i>Euphorbia hirta</i>	4.65						
<i>Fagopyrum esculentum</i>	10.3		0.5	0.36	0.12		64.9
<i>Rorripa nasturtium- aquaticum</i>	2.09	564.1	3.61	0.68	1	0.66	42.6
<i>Oenanthe javanica</i>	17.13		4.96	0.22			13
<i>Phytolacca acinosa</i>	27.25		5.6	0.21			17
<i>Plantago major</i>		17.5		0.36		0.04	23
<i>Sonchus oleracea</i>	18.7		0.03			0.003	
<i>Urtica dioica</i>	30.4						

Source: Sundriyal and Sundriyal (2004)

Note: K=Pottasium, P=Phosphorus, Ca=Calcium, Na=Sodium, Fe=Iron

The informants were asked to classify the abundance of the 68 wild vegetable species in three classes, from common, occasional and rare. They classified 14 species as common, 28 occasional and 26 species rare. The species such as *D. esculentum*, *Malva verticillata*, *I. aquatica*, *B. tulda*, *Dryopteris cochleata*, *Aconogonum molle*, *Asparagus racemosus*, *A. filicinus*, etc., were considered to be rare because they had a high demand at local markets, hence unsustainable harvesting has been increased in their natural habitats. Indigenous wild vegetable species are also far neglected in regional and national policies and no conservation or domestication strategies to promote them. Introduction of exotic vegetable species, improved varieties, and poor marketing value including urbanization process have contributed to decrease the abundance of wild vegetables.

Traditional knowledge on the use of wild plants is still practiced by the rural people of Makawanpur district those lived close to forests. Rural communities in these areas are more knowledgeable about wild vegetables. There may be more than 68 species of wild vegetables species in this study, therefore, detailed research in the future is still needed. Women are important partners as they play the major role in the collection, preparation and marketing of wild vegetables. Wild vegetable are tasty and rich in proteins, amino acids, and vitamins. The indigenous people have also knowledge about toxicity of plants that is usually increased in mature state. Such knowledge are lacking in people of urban area. Wild vegetables are mainly sold at road side local

markets. There is a great potential for domesticating the wild vegetable.

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## ***Merremia hirta* (Linnaeus) Merrill [Convolvulaceae]: a new record for Nepal**

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### **Abstract**

*Merremia hirta* (Linnaeus) Merrill, (Convolvulaceae) is described as new record for Nepal. This plant material was collected from Makawanpur district of Central Nepal. The morphological characteristics of this plant are compared with its allied species.

**Key words:** Convolvulaceae, *Merremia*, Makawanpur district, Nepal, New record

### **INTRODUCTION**

*Merremia* Dennstedt ex Endlicher is a genus of Convolvulaceae, belonging to tribe Merremieae. Members of the genus are commonly known as wood rose. The genus *Merremia* Dennstedt ex Endlicher has about 80 species distributed throughout the tropical region of Africa, Asia, Australia, North and South America (Yu Huang Cao Shu 1995). There are more than 150 species listed under the genus *Merremia* (International Plant Names Index, September 2010) and 54 accepted species are recorded in <http://www.plantlist.org/browse/A/Convolvulaceae/Merremia>.

*Merremia hirta* (Linnaeus) Merrill, was originally described as *Convolvulus hirtus* by Linnaeus (1753). A total of 5 species under the genus *Merremia* Dennstedt ex Endlicher are reported from Nepal, these include *M. emarginata* (Burman) H. Hallier, *Merremia hederacea* (Burman f.) H. Hallier, *M. umbellata* (Linnaeus) H. Hallier f. subsp. *orientalis* (Hallier f.) van Ooststroom, *M. vitifolia* (Burman) H. Hallier (Hara *et al* 1982; Press *et al* 2000; Anonymous 2001). Out of these, *Merremia umbellata* (Linnaeus) Hallier f. subsp. *orientalis* (Hallier f.) van Ooststroom and *Merremia vitifolia* (Burman f.) Hallier f. are deposited at National Herbarium and Plant Laboratories, Lalitpur, Nepal, KATH (Anonymous 1976; Rajbhandari *et al* 2012). *Merremia hirta* (Linnaeus) Merrill, which has been collected from the Makawanpur district, is a new addition to flora of Nepal.

### **MATERIALS AND METHODS**

This work is based upon the study of specimens collected from Handikhola area of Makawanpur district, Central Nepal. While critically examining the morphological characters of the collected specimens the unique features were pointed out. For correct identification of the species, web media like [www.coldh.mnhn.fr/scientificName/Merremia/hirta](http://www.coldh.mnhn.fr/scientificName/Merremia/hirta),

www.biodiversitylibrary.org/name/Merremia hirta and www.tropicos.org/Name/8502865 were consulted. Herbarium specimens of *Merremia* at National Herbarium and Plant Laboratories, Lalitpur (KATH) and Tribhuvan University Central Herbarium, Kirtipur (TUCH) were also examined to confirm this specimen. The collected specimens (both fresh and dry) were critically studied using the literature such as Merrill (1912); Ooststroom (1939; 1953), Biju & Mathew (1994); Yu Huang Cao Shu (1995); Mill (1999); Johnson (2009). Measurement of the vegetative and reproductive parts was taken from the collected materials. Flowers and fruits were studied using a dissecting microscope. Then this specimen was compared with the image of the type specimen, Linnaeus Herbarium No. 218.56. It was confirmed that the plant was *Merremia hirta* (Linnaeus) Merrill, that was never before recorded from Nepal. Therefore, a detailed taxonomic account and illustration (Figure 1) are provided for easier identification, and a comparison with its allied species has also been provided (Table 1). The herbarium specimens have been deposited at National Herbarium and Plant Laboratories, Lalitpur, Nepal (KATH) and Tribhuvan University Central Herbarium, Kirtipur, Nepal (TUCH).

### TAXONOMIC ACCOUNT

*Merremia hirta* (Linnaeus) Merrill in Philip. J. Sci. 7, Bot. 244. 1912; Ooststroom, Blumea 3: 307, 1939. *Convulvulus hirtus* Linnaeus, Sp. Pl. 1:159. 1753. *C. caespitosus* Roxburgh, Fl. Ind. 2: 70. 1824. *Ipomoea linifolia* Blume, Bijdr. 72. 1825. *I. philippinensis* Choisy, Mem. Soc. Phys. Geneve 6: 475. 1833. *M. caespitosa* (Roxburgh) Hallier f. in Engl. Bot. Jahrb. 16: 552. 1893. Winkler in Engl. Bot. Jahrb. 49: 378. 1913. [Figure 1].

Twinning or prostrate herb. Stem slender, 20 – 150 cm long, hirsute or subglabrous, hollow, subfistular, brown. Lamina variable in shape on the same plant, linear to ovate, oblong-lanceolate, ovate-oblong or ovate, borne on one side, 2 – 6 x .5 – 2 cm, entire, obtuse to slightly emarginate or mucronate, base obtuse to cordate or truncate or hastate, both surfaces glabrous or sparsely pilose beneath. Petiole slender, 1 – 2 cm long, hirsute or glabrous at maturity. Cymes axillary, 1 – 3 flowered; peduncles 1.5 – 7.5 cm, slender, pilose; pedicel slender, glabrous, 3 – 5 mm, longer in fruit; bracts 1 – 2 mm long, ovate, acute-obtuse, glabrous. Flowers 1.5 – 2 cm across. Sepals light green, glabrous, unequal, outer 2 oblong-elliptic, 3 – 4 mm long, 1 mm broad, accrescent in fruit, inner 3 oblong or oblong-elliptic, 4.5 – 6 mm, accrescent, 6 – 8 mm in fruit. Corolla pale yellow or yellow or whitish, campanulate, 1.5 – 2 cm across, glabrous, membranous with wavy margin. Stamens 3, pale yellow; anthers pale yellow, spirally twisted; filament inflated at base, hairy. Pistils included; stigma inconspicuous; style 4 – 5 mm long, glabrous, persistent in fruit; ovary green, glabrous, 4-loculed. Capsule broadly ovoid to globose, thin walled, green, glabrous, light brown at maturity, papery, 6 – 9 mm across, 1-celled, 4-valved, crowned with stout style. Seeds dark brown, 3 – 4, glabrous, subglobose, 1 – 2 mm across.

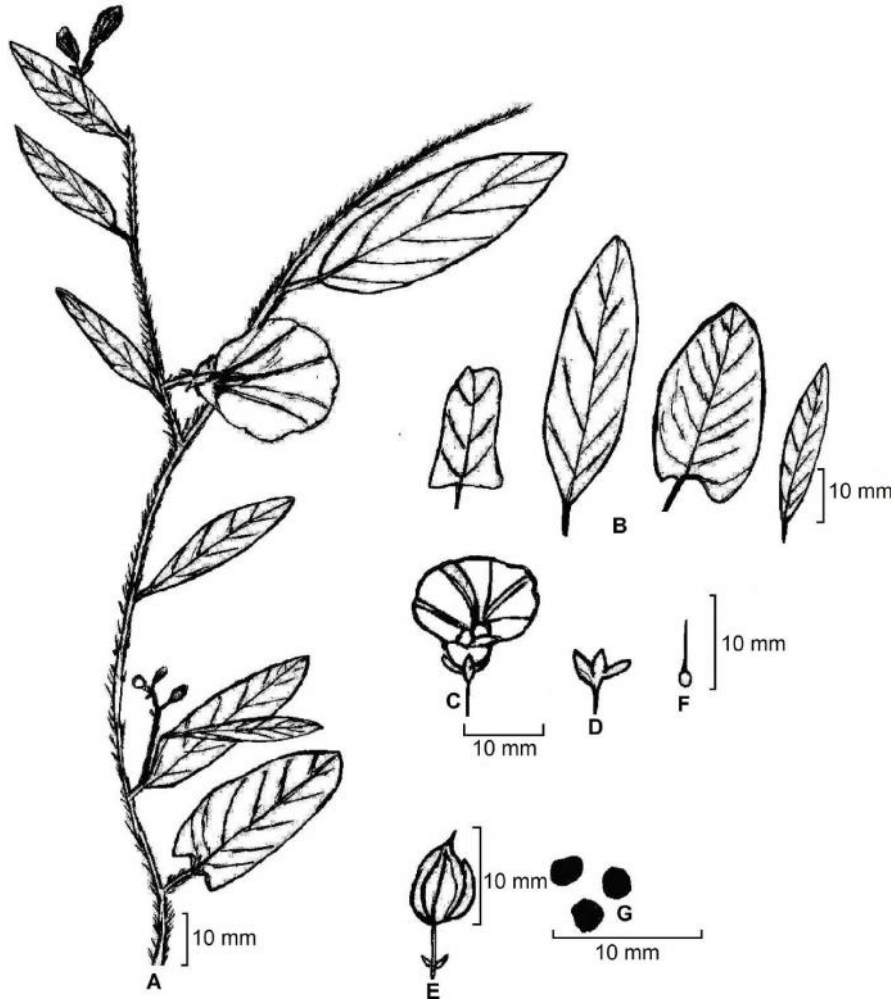
**Type:** Unspecified Locality, Linnaeus 218.56 (HT: LINN !)

**Distribution:** China, India, Indonesia, Laos, Malaysia, Myanmar, Philippines, Thailand, Vietnam, North Australia, Papua New Guinea, now in Nepal.

**Habitat:** Dry open grasslands, cultivated rice fields, roadsides, thickets forest margins from 150 – 1500 m.

**Flowering & Fruiting:** August – November

**Exsiccate:** NEPAL, Makawanpur district, Handikhola (between Rapti river and Handikhola), 27°26'60" N and 84°53'50" E, 418 m, 8.viii.2010, N. Joshi, 01088514NJ.



**Figure 1.** *Merremia hirta* (Linnaeus) Merrill: A. Flowering branch; B. Various types of leaves; C. Flower; D. Calyx; E. Fruit; F. Gynoecium; G. Seeds. (Based on N. Joshi 01088514NJ)

**Table 1.** Distinguishing characteristics of *Merremia hirta* and *Merremia umbellata*.

Characters	<i>Merremia hirta</i>	<i>Merremia umbellata</i>
Stem	Hirsute	Glabrous
Seeds	Glabrous	Hirsute

**Comparison with allied species:** The morphological character of *M. hirta* is very similar to *M. umbellata*, but differs from it by having hirsute stem and glabrous seed. In *M. vitifolia*, the lamina are palmately 5 – 7 lobed, lobes coarsely dentate; outer 2 sepals 15 – 20 mm long in flower, but in *M. hirta* lamina is unlobed, variable in shapes from linear lanceolate to oblong. It differs from *M. hederacea* with outer sepals broadly obovate to spatulate, apex broadly notched, or distinctly mucronate, whereas in *M. hirta*, the 2 outer sepals are ovate, obtuse or acute, not notched. *M. emarginata*, the lamina are reniform or broadly ovate, emarginate, whereas in *M. hirta*, apex not deeply emarginate.

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- [www.tropicos.org/Name/8502865](http://www.tropicos.org/Name/8502865)
- [www.coldh.mnhn.fr/scientificName/Merremia/hirta](http://www.coldh.mnhn.fr/scientificName/Merremia/hirta)

# Developing a Priority Setting Approach for Domestication of Indigenous Fruit and Nut Species in Makawanpur District, Nepal

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**Keywords:** biodiversity hotspot, ethnobotany, genetic resource, plant conservation, traditional knowledge, underutilised

## Abstract

Makawanpur district in Central Nepal is considered one of the richest biodiversity hotspots of the country, harbouring numerous indigenous underutilised fruit and nut species important for nutrition and income generation of rural households. However, many of these useful plant species are threatened due to deforestation, agricultural expansion and over-exploitation. Enhanced cultivation after domestication of these species may contribute to their conservation through use but limited funds call for species priority setting. The aim of this study was to document indigenous fruit and nut species and the related traditional knowledge, to contribute to species priority setting. In three agro-climatic zones (altitude range 400-2300 m a.s.l.) of Makawanpur district, indigenous fruit and nut species were surveyed in natural forests, homegardens, farmers' fields and along roadsides. Information about species' local names, utilisation, seasonal availability and preference ranking was gathered by field observation, interviews and participatory rural appraisal, involving key informants of four ethnic groups (Tamang, Bankaria, Chhetri and Newar). In total 54 indigenous fruit and nut species were recorded, of which 16 species were grown in homegardens. Only 7 of the 54 species were at least partly domesticated; 16 species had a market value for income generation. The more urban Newar respondents mentioned only 27 of the 54 species as useful, whereas Tamang, who live in remote areas close to forests, mentioned 48 as useful. Fruit and nut availability varied a lot between seasons. From January to April produce of only 1-2 species was available, compared with 20 species in November. Thus, species priority setting for domestication should consider seasonality of species to provide fruits and nuts year-round. Secondly, only species that are used by many different tribes should be selected. Further selection criteria include nutritional value of the produce, adaptability of the species to climate change and its market potential.

## INTRODUCTION

Nepal is situated on the southern slopes of the central Himalayas and occupies a total area of 147,181 km<sup>2</sup>. More than 90% of Nepal's population live in rural areas and nearly 50% in absolute poverty (CBS, 2001). Nepal's rich biodiversity is a reflection of its unique geographic position and its altitudinal (60-8848 m a.s.l.) and climatic variations (MFSC/GEF/UNDP, 2002). Different vegetation types, ranging from tropical to alpine, results in the occurrence of about 6000 species of flowering plants (Press et al., 2000). Out of these, 1500 species were recorded as useful plants, including 200 species bearing edible fruits and nuts (Manandhar, 2002). However, most of these indigenous fruits and nuts are not domesticated or cultivated, but gathered from natural stands. Many of these species are said to be threatened and continue to disappear due to deforestation, agricultural expansion and over-exploitation (Shrestha and Joshi, 1996). Together with the erosion of genetic resources of indigenous fruit and nut species, traditional knowledge

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of rural communities related to these species and their uses runs the risk of being lost. For most parts of Nepal, the rich plant diversity and indigenous knowledge related to it are not comprehensively documented except for a few attempts (Anonymous, 1982; Bajracharya, 1984; Manandhar, 2002).

Makawanpur district of Central Nepal is considered one of the rich biodiversity hotspots of the country and harbours numerous indigenous underutilised fruit and nut species important for nutrition and income generation of rural households. The extensive traditional knowledge of the district's diverse ethnic groups related to uses and management of wild fruit and nut plant resources is not yet documented. Efforts are under way to systematically document, collect and utilise the largely eroding genetic resources and the related knowledge on Nepalese indigenous fruit and nut species (Maden and Dhakal, 1998; Shrestha and Dhillon, 2006; Joshi et al., 2009). Little is known about the nutritive values of wild fruits and nuts occurring in Nepal (Bhandari, 1978; Bajracharya, 1980; Sundriyal and Sundriyal, 2004).

Enhanced cultivation after domestication of these species may contribute to their 'conservation through use' and to improve livelihoods of rural communities as reported for other regions of the world (Akinnifesi et al., 2008). The huge number of wild fruit and nut species and limited funds call for species priority setting, which should consider producers' and consumers' needs and preferences, the species' market potentials and scientists' expertise on the species' agronomy, nutritional value and conservation status. In Nepal, however, there is so far neither a programme on domestication of indigenous fruit and nut species nor a plan for species priority setting as the first step for domestication. The aim of this study was to document the diversity of indigenous fruit and nut species, the related traditional knowledge and the preferences of local communities in Makawanpur district to develop a species priority setting approach.

## **MATERIALS AND METHODS**

### **Study Area**

Makawanpur district – located in the Central Development Region of Nepal between 27°10'-27°40' latitude and 84°41'-85°31' longitude – was selected for this study based on its wide altitudinal range, diverse ethnic groups and documented richness in plant diversity and traditional knowledge. This district has an elevation range from 200 to 2700 m a.s.l. and extends over an area of 2426 km<sup>2</sup>. Forest covers 59% of the district's area, agriculture 25%, rivers and lakes 7% and pasture and barren land 9% (DFO, 2002). The vegetation types include tropical, subtropical and temperate vegetation, reflecting the different climatic zones of this district. According to the last population census (CBS, 2001), the district's total population is roughly 390,000 with about 83% of the population living in rural areas. The main ethnic groups living in Makawanpur district are Tamang (49%), Brahmin (15%), Chhetri (11%), Newar (7%), Gurung (5%), Chepang (4%) and Bankaria (0.02%) (DDC, 2000). The ethnic groups Tamang, Bankaria and Chepang are mostly living close to forests and still depend a lot on its natural resources, whereas the Newar and Chhetri traditionally were farmers, but now rather living in urban and peri-urban settings because many prefer to work as office employees, traders or craftsmen. Details on altitudes, population sizes and ethnic groups of the selected study sites are given in Table 1.

### **Methods**

The present study was based on intensive field surveys conducted during the years 2009 to 2010 in Makawanpur district, where 11 study sites (Fig. 1; Table 1) were selected according to a stratified sampling approach in three agro-climatic zones (altitude range 400-2300 m a.s.l.). Inventories of indigenous fruit and nut species were made in natural forests, homegardens and along road sides together with local elder key informants. Species were identified by consulting herbarium specimens and relevant literature (Hara et al., 1982; Grierson and Long, 1983-2001; Press et al., 2000), and specimens were

preserved in the National Herbarium and Plant Laboratories (Index herbariorum KATH), Department of Plant Resources, Kathmandu, Nepal. Interviews were performed with 34 key informants (1-6 per study site) randomly selected from a list of potentially knowledgeable respondents compiled by the respective village head. The respondents represented a wide range of age classes (20-69 years) and four different ethnic groups, namely Tamang (17 respondents), Newar (8), Chhetri (7), and Bankaria (2). Thirteen respondents were female and 21 male. The used semi-structured questionnaire included questions on fruit consumption, harvesting time and location, knowledge on conservation, present and past abundance, methods of regeneration, methods of preservation, priorities for taste and sale, preference of species in different age groups and information on marketing. A survey of local village and roadside markets in the same area was used to confirm the respondents' statements on marketing potential of the mentioned species.

## RESULTS AND DISCUSSION

### Diversity and Use of Fruit and Nut Species

In total, 54 fruit and nut species belonging to 20 families and 41 genera were recorded, of which 6 species were climbers, 7 herbs, 18 shrubs and 23 trees. Out of the 54 fruit species, 49 species were reported to be collected from forests, three species from roadsides (two species exclusively from this location), and 14 (*Aegle marmelos*, *Artocarpus heterophyllus*, *Choerospondias axillaris*, *Cleistocalyx operculatus*, *Diploknema butyracea*, *Ficus hispida*, *Juglans regia* var. *kamaonia*, *Morus serrata*, *Phyllanthus emblica*, *Pyrus pashia*, *Tamarindus indica*, *Syzygium cumini*, *Zanthoxylum armatum*, *Ziziphus mauritiana*) from homegardens (three species, *A. heterophyllus*, *A. marmelos* and *T. indica*, exclusively from this location). In a mean, the respondents mentioned 9.2 fruit and nut species each, ranging from one to 21 species per respondent. No differences between male and female respondents were found. Age of respondent and years of formal education did not correlate with species numbers mentioned.

In the three altitude zones surveyed (lowland, midland, highland), total species number per zone was 27-28 (Fig. 2). The high number of total species in the highlands was surprising because only three respondents had been interviewed in this zone, but 15 and 16 in the low- and the midlands, respectively. It is probable that even more species would have been recorded for the highlands if more respondents had been interviewed. Species similarity was different among the altitude zones. In the lowlands, as many as 23 species were exclusively found in this zone only, whereas the midlands and the highlands had four and three unique species only, respectively (Fig. 2). In contrast, midland and highland were quite similar, as they shared as many as 20 species, whereas both zones did not share a single species with the lowlands. Only four species were found in all three zones (Fig. 2). Mean total species numbers mentioned per respondent and number of species collected from forests were similar among altitude zones, but species number cultivated in homegardens was significantly higher in the lowlands than the midlands (4.9 versus 1.3,  $p < 0.001$ ). Similarly, the mean number of species sold was significantly higher in the lowlands than the midlands (5.3 versus 2.4;  $p = 0.040$ ). In the highlands, the mean number of species cultivated in homegardens was 2.3 and a mean of 3.3 species were sold. The higher numbers of cultivated and sold species in the lowlands may be related to more favourable climate for growing fruits and easily accessible markets in the lowlands. Sundriyal et al. (2004) reported a similar decrease of wild fruit species with increasing altitude in Sikkim Himalaya, eastern India.

When analysing species reported by the different ethnic groups, Tamang used 48 species, Newar 27, Chhetri 32, and Bankaria 10. This result, however, reflects the different sample sizes per ethnic group, ranging from 17 to two. A higher number of species could be expected if more Bankaria people had been interviewed. Only 5 species were mentioned by all four ethnic groups, 20 other species by three groups, 8 by two groups and 21 further species by only one single group. No differences among ethnic groups were found concerning mean number of collected species, apart from

homegardens, where the Chhetri mentioned collecting significantly more species than the Tamang (5.0 versus 1.9;  $p=0.016$ ), whereas Newar and Bankaria were in between (3.8 and 2.0, respectively). The indigenous Tamang people, who mainly live in remote areas of the midlands, started to cultivate crops only recently (about 40 years ago). Before, their livelihoods completely depended on the forests for gathering and hunting wild species, which is still of importance. That may be the reason why Tamang were leading in giving names of indigenous fruit and nut species, but last in collecting species from their homegardens. The Bankaria have a similar history and environment, thus, they also grow rather few fruit and nut species in their homegardens. Males and females were similarly engaged in collecting indigenous fruit and nut species, but activities differed with regard to age classes. Respondents mentioned that 46 out of the 54 species were preferred by children, but adults prefer to consume only 27 species, among them many species found in homegardens, for example *A. marmelos*, *S. cumini*, *T. indica* and *Z. mauritiana*. Adults view many fruits as food only for children, e.g., *Berberis aristata*, *Melastoma malabathricum* or *Viburnum mullaha*.

### Seasonal Availability

Availability of produce from fruit and nut species varied a lot between seasons of the year. Respondents mentioned only few species (1-2) to be harvested in the months January to April (Fig. 3), leading to very low fruit consumption during winter time. From May to November, fruits of 10-20 species were reported to be collected (with the peak in November), whereas in December only six were collected. However, differences were detected among the altitude zones. In the lowlands, no species were collected during the months January to March, but many in May and June as well as in November (Fig. 3). In the mid- and highlands, peak seasons were June, and September to November, but a few species were available even during the winter time from January to March. Homegarden species as a source for collecting fruits and nuts contributed particularly during early summer (May and June) and autumn (September and October), when five to six species were reported to be harvested from homegardens. A few fruit species such as *P. emblica*, *T. indica* or *Z. mauritiana* and all nuts were not only consumed fresh, but reported to be preserved in dry form to be available for home consumption and sale year round. Fruits of *C. axillaris* and *A. marmelos* were also processed to candies, juice, jam and fruit powder, particularly for income generation. Fruit and nut species with possibilities for preservation and a high market value are said to motivate local communities to conserve wild plant resources and could be candidate priority species for domestication (Leakey and Newton, 1994).

### Conservation Status

Out of the 54 fruit and nut species reported by the respondents, 40 were said to be decreasing in their abundance in the forests. In group discussions of local communities and key informants, a variety of reasons were mentioned for species' decrease such as logging forests, over-exploitation of species, unsustainable harvesting methods, land erosion and increase of agricultural land area. It was also mentioned that there is an increasing demand for exotic fruit species instead of indigenous ones. When the groups were asked to classify the abundance of the 54 species in four classes from abundant to endangered, 15 species were perceived as abundant, nine as rare, 28 as vulnerable and two as endangered. One of the species perceived as endangered, *C. axillaris*, is even classified as endangered in Nepal by IUCN's red list.

Indigenous fruit and nut species are so far neglected in regional and national policies and no conservation or domestication strategies are developed. Many of these species are threatened by genetic erosion, which will consequently hinder their future domestication because valuable intra-specific diversity may have been lost. Simultaneously with genetic erosion, the erosion of traditional knowledge on the respective species occurs, which will also negatively affect future domestication efforts. Strengthening and up-scaling the already existing Nepalese community forest user group



model and the involvement of the groups in forest management could be an important component of improving the conservation of biodiversity in Nepal.

### **Priority Ranking Based on Taste and Market Value**

Based on the interviews during participatory rural appraisals, 13 species were highly ranked with regard to taste; eight of these 13 species were preferred by at least three different ethnic groups. Most of the respondents preferred the sweet or sweet-sour tasting fruits of species such as *M. serrata*, *Rubus acuminatus* or *Z. mauritiana*. Eight of these 13 highly ranked species could be regarded as partly domesticated and were already cultivated in homegardens, e.g., *A. marmelos*, *D. butyracea* and *S. cumini*. However, five of the species were exclusively collected from forests, four of them (i.e., *Myrica esculenta*, *Rubus ellipticus*, *Terminalia bellirica* and *Ziziphus rugosa*) classified as ‘vulnerable’ by the respondents. With regard to market value, 16 fruit and nut species were rated to have a high market potential. Nine of these species were also rated highest with regard to their taste and 10 were cultivated in homegardens (Table 2). However, four of the species with highest market ranking (i.e., *Castanopsis indica*, *M. esculenta*, *T. bellirica* and *Terminalia chebula*) were collected only from forests and were classified as ‘vulnerable’ with regard to their decreasing abundance. For these species, the local communities lacked knowledge on their propagation and cultivation methods. Further reasons given for not planting these valuable species were lack of planting material, uncertain markets, low fruit prices, unknown nutritional value and the perception that these species are still abundant in the forests.

### **Selection of Priority Species**

Our approach for selection priority species was first to select only species highly ranked for either taste or sale, resulting in 19 species. Second, we included the following criteria: grown in homegardens (i.e., there is already some knowledge on species propagation and management), number of ethnic groups using the species, number of altitude zones where the species occurs, availability of fruits during the ‘lean’ season from December to April, level of threat (i.e., being vulnerable or endangered), fruits consumed by both children and adults and species’ suitability for storage and value adding. By summing up each of the values, we calculated a ‘priority index’ (Table 2). As a final step, we excluded six species for which improved cultivars exist in Nepal or neighbouring countries as in this case it would be more efficient to introduce these cultivars into the area than to start our own domestication programmes for them. Finally, we excluded two further species with low ranking and recommend the following 10 species for domestication in Makawanpur district: *C. indica*, *C. axillaris*, *C. operculatus*, *D. butyracea*, *J. regia* var. *kamaonia*, *M. esculenta*, *R. ellipticus*, *T. bellirica*, *T. chebula* and *Z. armatum*.

### **CONCLUSIONS**

Wild fruit and nut species play a significant role in the nutrition and income generation of rural communities in Makawanpur district, Central Nepal. The presented approach can help to prioritise those species with the highest need and the highest potential for domestication by integrating ethno-botanical, socio-economic and bio-physical information into the decisions. However, more research is needed to fine-tune the approach, for example studies on nutritional value of the many fruit and nut species for which information on this is still missing. Possibilities for up-scaling our approach need to be tested in other regions of Nepal and beyond.

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## **Tables**

Table 1. Number of respondents, total population size, altitude, level of urbanization and main ethnic groups of the selected 11 study sites in Makawanpur district, Central Nepal.

Study site	No. of respondents	Total population	Altitude (m a.s.l.)	Level of urbanization	Main ethnic groups
Hetauda	4	51,689	500	Urban	Newar/Chhetri
Handikhola	5	84	400-630	Rural	Bankaria
Harnamadi	2	6684	400	Rural	Tamang/Chhetri
Churiamai	4	13,730	630	Rural	Tamang
Daman	1	8158	2100	Rural	Tamang
Aghor	2	9375	2000-2130	Rural	Tamang
Simbhanjyang	1	About 150	2300	Rural	Tamang
Chisapani	6	3854	1800	Rural	Tamang
Tistung	5	6749	1800	Rural	Newar
Bhimphedi	2	6198	1100	Rural	Newar
Bhainse	2	6867	1000	Rural	Tamang

Source: District Development Committee Profile, 2000.

Table 2. Characteristics of potential priority fruit and nut species in Makawanpur district, Central Nepal, and their rankings after calculating the priority index and excluding species already domesticated elsewhere.

Species name	Priority for taste (3=high)	Priority for sale (3=high)	Found in HG (1=yes)	Ethnic groups collecting it (no.)	Altitude zones (no.)	Avail. Dec-Apr (1=yes)	Vulnerable or endangered (1=yes)	Eaten by children+ adults (1=yes)	Value adding/ storage possible (1=yes)	Priority index	Domesticated elsewhere	Rank for domestication
<i>Aegle marmelos</i>	3	3	1	4	1		1	1	1	<b>14</b>	x	
<i>Artocarpus heterophyllus</i>	3	3	1	2	1			1		<b>11</b>	x	
<i>Castanopsis indica</i>	2	3		3	3		1	1		<b>13</b>		3
<i>Choerospondias axillaris</i>	2	3	1	3	2	1	1		1	<b>14</b>		2
<i>Cleistocalyx operculatus</i>	3	0	1	4	1		1	1		<b>11</b>		5
<i>Diploknema butyracea</i>	3	3	1	3	1		1	1		<b>13</b>		3
<i>Juglans regia</i> var. <i>kamaonia</i>	3	3	1	3	2			1	1	<b>14</b>		2
<i>Morus serrata</i>	3	0	1	1	1		1	1		<b>8</b>		
<i>Myrica esculenta</i>	3	3		3	2		1	1		<b>13</b>		3
<i>Phyllanthus emblica</i>	2	3	1	3	1	1	1		1	<b>13</b>	x	
<i>Rubus acuminatus</i>	3	0		1	2					<b>6</b>		
<i>Rubus ellipticus</i>	3	3		3	3	1	1	1		<b>15</b>		1
<i>Syzygium cumini</i>	3	3	1	4	1		1	1		<b>14</b>	x	
<i>Tamarindus indica</i>	2	3	1	2	1			1	1	<b>11</b>	x	
<i>Terminalia bellirica</i>	3	3		4	1		1		1	<b>13</b>		3
<i>Terminalia chebula</i>	1	3		4	1		1		1	<b>11</b>		5
<i>Zanthoxylum armatum</i>	1	3	1	3	2		1		1	<b>12</b>		4
<i>Ziziphus mauritiana</i>	3	3	1	2	1	1	1	1	1	<b>14</b>	x	
<i>Ziziphus rugosa</i>	3	0		1	1		1			<b>6</b>		

**Figures**

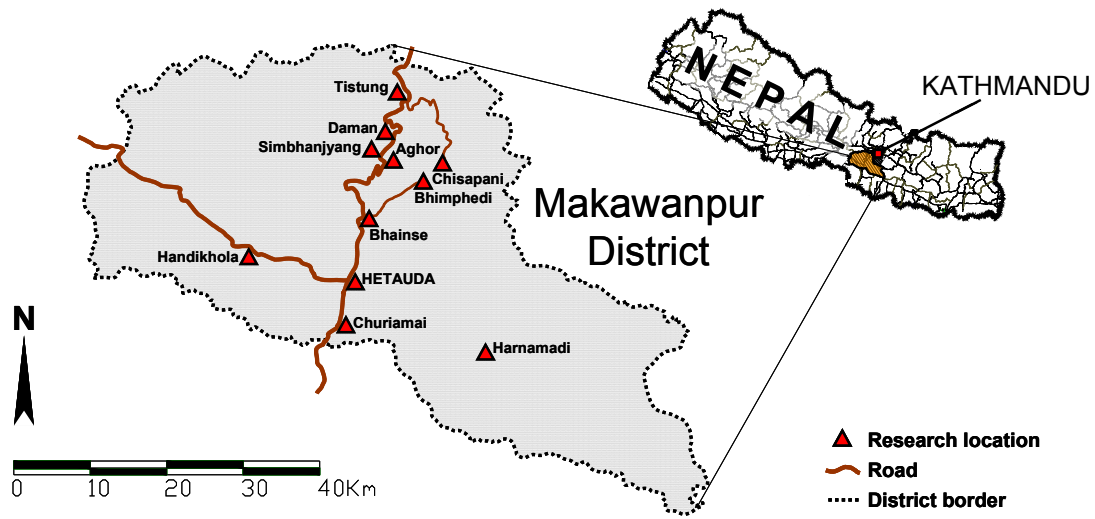


Fig. 1. Map of Makawanpur district, Central Nepal, and the locations of the 11 selected study sites, covering lowlands, midlands and highlands.

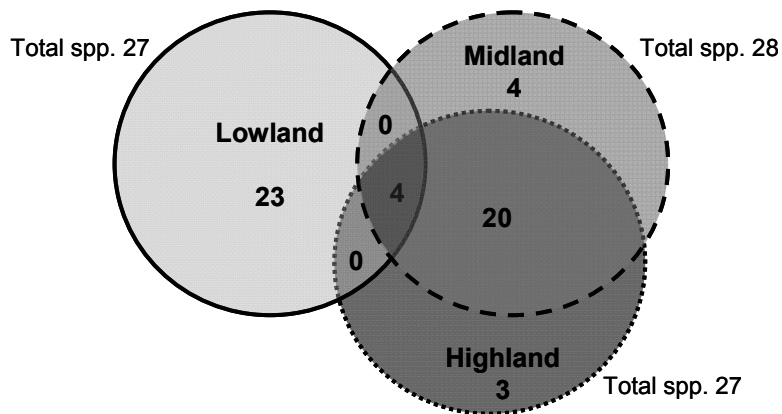


Fig. 2. Number of species that were reported to be collected in all altitude zones in Makawanpur district, Central Nepal (inner circle), and in only two or one altitude zones (outer circle segments); next to the main circles, the total number of species mentioned in this altitude zone is given (note: size of circles are not proportional to species numbers).

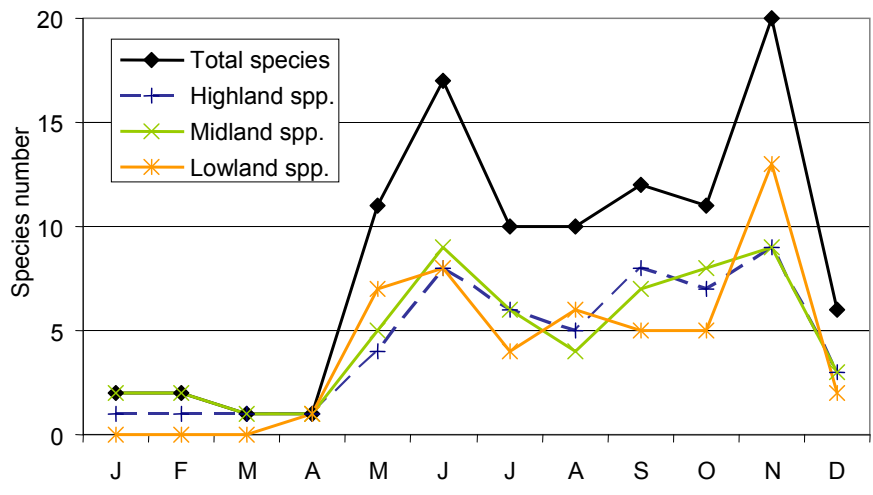


Fig. 3. Availability of fruit and nut species in Makawanpur district, Central Nepal, during the year according to the respondents separately for all species, species in the highlands, the midlands and the lowlands.