1. INTRODUCTION

1.1 Background

In Nepal, about 5160 species of higher plants have been enumerated by Hara and Williams (1979) and Hara *et al.* (1978, 1982) and 5833 by Koba *et al.* (1994). However more than 6,500 species of flowering plants have been recorded from Nepal (Press *et al.*, 2000; HMG Nepal, 2002) many of which have medicinal and aromatic properties. About 1,700 plant species are recorded to be medicinal and aromatic plants in Nepal (Shrestha *et al.*, 2000; Rawal, 2004; Sharma and Das, 2004; Baral and Kurmi, 2006). This comprises about 25% of the total number of flowering plants occurring in Nepal. More than 100 species of non timber forest products (NTFPs) are harvested from the middle hills and high mountains of Nepal (Regmi and Bista, 2002).

Rural communities are characterized by poor people with minimal infrastructural facilities. Independency on natural resources, particularly plants to meet livelihood needs is a part of local socio-economic system as plant resources have for long supported the life and practices of indigenous people in the form of various products. NTFPs play a crucial role in the economy as well as the livelihood of the rural communities as they are the integral part of their subsistence and most important component of income generation as well. Moreover MAPs are of special significance to the Nepalese economy because of their value to the local collectors, the small traders, Ayurvedic practitioners, Ayurvedic/Pharmaceutical companies and essential oil producing factories (Shrestha and Ghimire, 1996). Medicinal plants have played a significant role in rural health care as well. Medicinal plants collected for trade make an important contribution to household economies (Edwards, 1996; Olsen and Larsen, 2003).

Numerous endemic, threatened and endangered flora and fauna having high economic and ethno-botanical importance along with unique ancient cultural heritage is existed in Dolpa region (Lama *et al.* 2001).Shey Phoksundo National Park (SPNP) is one of the high Himalayan regions in northwest Nepal. SPNP and its teritory in Dolpa district is recognized for its importance for biodiversity, including medicinal plants, which are of high value in traditional health care in the context of Tibetan medical system practiced by *amchi* (Shrestha and Ghimire,

1996; Lama *et al.*, 2001). Some medicinal plants are heavily traded. Some 3,500 inhabitants mostly of Tibetan origin live inside the park, which largely depend on *amchi* medicine for health care. Collection for local health care purposes is not a major threat to populations of medicinal plants because of small quantities collected. However, plant resources inside the park are increasingly at risk from illegal harvesting for trade. Particularly, medicinal plants are highly threatened at the SPNP buffer zone, which is inhabited by over 10,000 inhabitants of diverse origin and ethnicity, due to over harvesting for trade without applying any sustainable practices. The trade of medicinal plants has considerably increased over the last few years to very large quantities (ANSAB, 1997; Shrestha *et al.* 1998). Figures available from the District forest office (DFO) shows that for a total of 5.47 t of raw dry products, collection and trade permission has been issued in 1992/1993 and this value increased to 36.73 t in 1997/98 and remained 28.67 and 22.51 t in 1998/99 and 1999/2000 respectively.

The major constraints and sustainability on plant resource use in Dolpa region are poverty and growing pressure of human activities, intensive harvesting practices and lack of a scientific resource management system. Local farmers and collectors have not generally practice cultivation of MAPS on private land and domestication in community forests due to lack of technical knowledge. The lack of proper management of MAPs and increasing market demands have resulted in a decrease in the diversity, quality and availability of MAPs in Dolpa district as well as in other Himalayan high hills, in general. The consequences are serious for the diversity of MAPs as well as for local harvesters who depend on the MAPs trade to meet their livelihoods. Very little efforts are done regarding wise management practices of MAPs in Nepal. Besides, some research projects about the growth of MAPs in different ecological conditions of high altitude medicinal plants especially, several technical information's regarding the MAPs are felt lacking for their wise practices in collection, cultivation and sustainability. Active participation of local users and farmers including collectors, traders, women and disadvantaged people as well should be expanded rapidly in the threatened areas of MAPs.

Valeriana jatamansi Jones is one of the most important MAPs of Nepal found in open as well as shady places of mountainous region. It is found globally from Afghanistan, Himalayas (Kasmir to Bhutan), Northeast India, Southeast China to Myanmar. Distribution of this plant in Nepal ranges from western to eastern regions with an altitude varying from 1300m to 3600m (IUCN, 2004). Government of Nepal banned this plant for export in unprocessed form outside the country under the Forest Act (1993). In Dolpa region, it is found commonly along the Juphal, Pahada, Tripurakot, Phoksundo and Majphal VDCs (Ghimire *et al.*, 1999b). The main constituent of this plant is 'valeportriate' which provides aromatic properties in the plant (Acharya, 2003). The local status of this plant in Dolpa region is highly vulnerable and threat of it is due to harvesting of rhizome for trade (Lama *et al.*, 2001). The trade of parts of this plant alone from Dolpa region was 2900 kg. (DoF, 2006). However, the amount was greater than this according to the traders information and other sources. Price of its rhizome varies from Rs.110/kg in Kathmandu to Rs.130/kg in Nepalgunj and Rs.144/kg in Tanakpur and Rs.176/kg in Delhi and Kolkata of India (ANSAB, 2007). The Royalty determined by government for the sale of this plant resource is Rs.15/kg under the forest act (1993).

Species Description of Sugandhawal

Valeriana jatamansi Jones (family: valerianceae) is one of the commonly harvested MAPs of Dolpa region. This plant is locally called 'Samayo' in Dolpali, 'Nakpoi' by *Amchi*s and 'Sughandhwal' in Nepali language. It is a perennial herb with aromatic root stocks and slender rootlets, dimorphic leaves, and grows up to 35-70cm in height. Radical leaves are persistent 3-8cm long, 1-3cm wide, deeply cordate-ovate-elliptic, and usually toothed. Cauline leaves are few, much smaller, entire or pinnate. The branches are erect and downy. It has thick, long and horizontal, nodular rhizomes, producing roots covered with fibers. Rootstock is 8-20mm thick and 2-3cm long while roots are 2-5cm long and 1-2mm thick. Flowers are dioecious, whitish or pinkish clustered in the axil of the upper leaves; fruits oblong, compressed, hairy or glabrous. Stem is tufted and divided into a number of shaggy, scaly crowns from which the leaves are produced.

1.2 Rationale

'Sugandhawal' is a plant entering global commerce (Fansworth and Soejarto, 1991). The Dolpa region has a rich natural base for plant resource of this plant that can potentially promote the rural development of the area. Sustainable utilization of such a common and easily accessible plant resource was found to be of not less economic importance than the rare as well as difficultly accessible plant resources of high value for the sustainable livelihoods in Himalayan communities like Dolpa region in long term basis. The collectors were found generally ignorant of the nature and implications of the proper season of harvest as well as post - harvest operations in the use of this plant resource. Unwise and unscientific harvest of the product of this plant keep this plant in dwindling condition thereby raising the question of its very existence. An immediate work of investigation of the plant through holistic approach was felt by the researcher as it keeps sound significance for formulating the sustainable conservational approach of its resource use. The present endeavor, even may be of small scale, is expected to be proved as a cornerstone to fulfill the research gap of scientific merits regarding the plant for exploring its resource potentialities and sustainability. This plant is selected for making the work more specific as well as holistic.

1.3 Literature Review

Very few research works have been carried out regarding the resource analysis and ecology of 'Sugandhawal' plant. Some works have included a few information regarding conservation status, botany and ecology of the plant (Ghimire *et al.*, 1999, 2000, Rawal *et al.*, 1999, Lama *et al.*, 2001, Kurumbang, 2003, Kunwar, 2006, Bhattarai, 2048 B.S., DPR, 2062 B.S., Rawat, 2061 B.S., Thapa, 2060 B.S.). But these works are found in more generalized form. Almost, no work was found specialized with regard to this species. The works regarding this species till now are confined to general description only and in some extent to its trade. A work of holistic approach through summing up the techniques of study from different disciplines such as from anthropology, ecology, economics, linguistics etc. was not found initiated before for this plant species.

1.3.1 General work on medicinal plant

The earliest publication on medicinal plants probably started with the work of Banerji (1955) who studied edible and medicinal plants from East Nepal.

Pandit Ghana Nath Devkota in the end of 19th century and the beginning of 20th Century compiled a hard written encyclopedia 'Bir Nighantu' with 750 colour plates of plants and its medicinal uses (Kanai, 1971). It has been published in 8 volumes and is probably the 1st effort in Nepal towards the compilation of medicinal plants of the country (Kanai, 1971).

Department of medicinal plants (Currently Department of Plant Resources) published for the 1st time "Medicinal plants of Nepal" in 1970 which has included information on 393 species of plant, their therapeutic uses and distribution (HMG Nepal, 1970). Later on, its supplementary volume with additional 178 species was published in 1984 (HMG Nepal, 1984)

Malla and Shakya (1984) have listed 630 species of plants of possible medicinal uses. Out of them, 120 are either exotic or indigenous.

Olsen (1998) described some wildly collected medicinal plants and their trade from Gorkha district of central Nepal to Delhi in Northern India. He found approximately 3700 people engaged in commercial collection of medicinal plant and 15.35% of poor households annual income was contributed by it.

Shrestha *et al.* (1998) studied the ecological distribution and status MAPs in the SPNP and its surrounding areas. They recorded a total of 205 species of MAPs out of which 88 species in Suligad-Jagdulla (Western part), 54 species in Suligad-Dho (Eastern part) and 63 species in Suligad-Perikapu (Central part) of the park. They also studied density and dominance of medicinal plants and its associates in the 9 different sites of SPNP. Result showed that medicinal plant species were dominant over its associates in most of the sampling site.

People and plant initiative in collaboration with WWF Nepal program under took a four year research project on "Conservation of plant resources, community development and training in applied ethno-botany at SPNP and its buffer Zone, Dolpa." It addressed the issues concerning ethno-ecology, ethno-botany local

health care and ecological status of MAPs in different pastures and sub pastures, and has also identified local knowledge pertaining to natural resource management and cultural relations with environmental components (Shrestha et al, 1998, Ghimire *et al.* 1999, 2000b).

Larsen (1999) studied the commercial collection of Jatamansi (*Nardostachys grandiflora*) in Chaudabise Valley, Jumla, Nepal. She observed the density, frequency and abundance of the Jatamansi along with its trade value.

Ghimire *et al.* (1999, 2000, 2001) studied the *amchis*' knowledge on the use of plants, folk taxonomy and folk-classification on Dolpa. They reported 407 plant species used by *Amchis*, lama and other healers for health care from SPNP and its buffer zone, Dolpa. They also reported about 23 different plant based medicinal and aromatic products traded from Dolpa at the time of their study and found that the area is exceptionally rich in ethno-medicine and indigenous knowledge.

MAPDON has listed 1,624 medicinal and aromatic plants (MAPs) either under cultivation or in wild form (Shrestha *et al.*, 2000)

Lama *et al.* (2001) gave an account of indigenous knowledge of *amchis* with regards to the use and types of diseases that prevailed in Doplo, ethno-ecological knowledge, folk-classification, folk taxonomy and the health status of the people.

Joshi and Joshi (2001) described 268 species of MAPs under the genetic heritage of MAPs in Nepal Himalaya. Baral and Kurmi (2006) complied 1,792 species of medicinal plants that are being used in Nepal in their book "Compendium of Medicinal plants in Nepal,"

Rokaya (2002) studied the ethnoecology of medicinal plants in Dho-Tarap area of Upper Dolpa, northwestern part of Nepal. He recorded altogether-274 plant species out of which 195 were documented as medicinal plants and 79 species were recorded as new medicinal plans. He also gathered some imported information about *Amchis* knowledge.

IUCN Nepal published a national register of medicinal plants in 2000 and revised and updated it in 2004 describing 185 species of medicinal plants (IUCN, 2004)

Watenabe *et al.* (2005) published "A Handbook of Medicinal plants" describing 108 important medicinal plants of Nepal along with their chemical constituents.

Department of plant resources revised the information about medicinal plants of Nepal in 2007 and has included information of 701 species of plants, their uses constituents and distribution (DPR, 2007).

Pokharel (2007) found the amount of essential oil of 'Sugandhawal' highest in the hairy roots produced in 0.5 mg/1NAA i.e. (0.80%). A total of 17 compounds were found present in the essential oil of 'Sugandhawal' by examining through gas chromatography coupled with mass spectroscopy (GC-MC).

Due to inaccessibility of the Dolpa region, very few organizations and researchers were found willing to carryout research work in this region. But due to high diversity of medicinal plants and interesting cultures of indigenous people, some reknowned institutions and organizations are making an attempt to explore the cultural and biodiversity virginity of this region. WWF Nepal program has performed and has also continuing several package program for the conservation of nature and culture in Dolpa region. The WWF Nepal program is also working in the direction of protecting indigenous knowledge of local people regarding the resource use and uplifting the livelihood of local people of the region. WWF Nepal program is launching the several programms in the name of Northern Mountain Conservation Program (NMCP) in this region. People and plants initiative (PPI), a combined effort of WWF, UNESCO and Royal Botanic Gardens, Kew has also worked there in local level with local people's participation for conservation and management of MAPs. PPI has explored the indigenous knowledge of traditional healers (*Amchis*) and documented the plant species used by them to cure different diseases established in the area. One good example is Gangchen Menkhang service center (*Amchis* Hospital) at Chunuwar, Phoksundo-5.

1.3.2 Conservation/Management of medicinal plant

The Himalayan medicinal plants appear to have been traded for millennia (Jacob and Jacob, 1993). Commercially traded Himalayan plant species have received

scientific attentions and their potential for contributing to rural livelihoods and their conservation consequences of harvest and trade are highly discussed.

Edwards (1996) reported that every year 10,000 to 15,000 t of NTFPs are harvesting from forest of mid hills and high mountains of Nepal and traded to India.

Olsen and Helles (1997) investigated the trade in MAP products from the rural area of Gorkha in Central Nepal to the wholesale markets in India over a two-year period. They found that approximately 98% of the products exported in unprocess form to India. They emphasized that the government should focus on provision of public goods such as dissemination of price information and developing physical infrastructure. They also felt the need of review of bans on collection and trade and a reconstructing of current approaches.

Niraula and Saiju (2000) carried out tissue culture of the 'Sugandhawal' from the young shoot tips as an explant cultured in Murashige and Skoog medium supplemented with Benzyl Amino Purine (BAP) 1mg/l and Napthalene Acetic Acid (NAA) 0.1mg/l. They successfully established these plants in the field well.

Lama *et al.* (2001) analyzed the concepts, approaches and result of developing a model for strengthening community based management of medicinal plants in Shey Phoksundo National Park and its buffer zone of Dolpa District. They found that integrating local indicators for the monitoring of ecological plant will benefit both communities and researches. They gave local and national status of highly potential medicinal plant species of Dolpa.

Ghimire *et al.* (2001) gave the abundance categories as rare, not so common, abundant and dominant for 407 medicinal plants recorded in Dolpa within 5 years time.

CAMP (2001) workshop held in Nepal organized by MAPPA and MOFSC, HMG, Nepal and assessed 51 species of medicinal plants based on IUCN threat category for their conservation status (versions 3.1). 3 were assigned as critically endangered (CR), 15 species endangered (ER), 23 vulnerable, 3 species rare, 1 species least concerned and 6 species as data deficient categories.

Regmi and Bista (2002) studied traditional management techniques, proper harvesting seasons, rotational system and domestication of high altitude MAPs in community forests and open agricultural field. They fed back to related stakeholders and recommended some suggestions for enterprise business development of MAPs. They studied 'Sugandhawal' and found survived better in the agricultural land and community forests in Jumla. A two year rotational practice of harvesting of 'Sugandhawal' was found best practice for regeneration and yield in natural habitat. The cultivated plant of 'Sugandhawal' gave higher percentage of oil content than that from natural habitat.

Shahi (2002) studied trade systems and feasibility of cultivation domestication of MAPs in the southern buffer zone of SPNP, Dolpa. He categorized 'Sugandhawal' as a regular MAP resource and being conserved due to huge collection pressure on seasonal and more expensive resources. He also found the more collective and unscented harvesting of regular MAPs resource making higher negative impacts on other sustainability. Development of local enterprises to process the 'Sugandhawal' resource was suggested feasible and reasonable to adding value of 'Sugandhawal' resource according to his study.

Vats et al (2002) studied net photosynthetic rate (P_N) of 'Sugandhawal' plants under nylon net shade or under different tree canopies and open growth plants able to photosynthesize at higher photosynthetic photon flux-density (PPFD). Plants grown under net shade had higher total chlorophyll content per unit area of leaf surface. However, chlorophyll a/b ratio was maximal in open grown plants but remained unchanged in plants grown in nylon net shade and under different tree canopies. Sun-grown plants had thicker leaves (higher leaf mass per leaf area unit), higher wax content, and higher P_N than shade grown plants.

Kurumbang (2003) studied ecology, harvesting and trade of five important medicinal plants in SPNP and its bufferzone including 'Sugandhawal' as well. *Nardostachys* showed highest overall density and IVI. The dry rhizome biomass values for 'Sugandhawal' was obtained 97.8kg/ha. 'Sugandhawal' along with *Nardostachys* were found some of the must preferred MAPs in trade. MAP resources were found at the verge of extinction due to over and unsustainable harvesting. He observed government regulations ineffective in the local level.

Shrestha (2003) reported that most of the traded species of medicinal plants in Nepal are collected in wild form. Over harvesting and destructive collection techniques have put many of the valuable herbs in the verge of extinction. He recommended the cultivation and domestication as the most effective solution for the conservation of these species.

Ghimire and Yumeerudy-Thomas (2005) analyzed the efforts of different harvesting patterns on the population ecology in two highly threatened himalayan medicinal plants, *Nardostachys grandiflora* and *Neopicrorhiza scrophulariiflora*, in SPNP and its bufferzone. They found a positive effect of low harvesting levels on plant density and a decreased survival rates with increasing harvesting level. They found that *Nardostachys grandiflora* is more vulnerable to harvesting than *Neopicrorhiza scrophulariiflora*.

Larsen (2005) conducted a survey in Gorkha district to explore the impacts of replanting on regeneration of *Nardostachys grandiflora*. He found that harvesting 100% of the plants in plots followed by replanting of upper part and 2cm of the rhizome provided the fastest regeneration and rhizome biomass growth.

Olsen (2005) studied trade levels and conservation of implications, of *Nardostachys grandiflora* and *Neopicrorhiza scrophulariiflora*. He emphasized the importance of applying a regional approach to conservation of the species. Also, the need for improved official trade monitoring by governments was indicated by him.

Sharma *et al.* (2005) studied the conservation and management efforts of MAPs in Nepal. They said that medicinal plants of commercial value are in a state of threat due to deforestation and over harvesting. They recommended activities such as threat assessment cultivation practices and system regularization for conservation, management and sustainable utilization of medicinal plants in Nepal.

Ghimire and Aumeeruddy-Thomas (2005) assessed the vulnerability of 35 species of highly traded medicinal plants in SPNP. They identified 20 species of MAPs as potentially vulnerable. Among these, 6 species including 'Sugandhawal' Jones fall under the high vulnerability category with threat scores equal or greater than 25.

Pant *et al.* (2005) developed a protocol for in vitro multiplication of 'Sugandhawal' by using nodal explants. This technique may be applied for the commercial production of this species through mass propagation *in vitro*.

Nepal and Sapkota (2005) made a study related to resource analysis and indigenous knowledge on plant use in Mimi VDC of Humla district of western Nepal. They found medicinal plants playing a considerable role for enhancing livelihood of rural people. 48 percent plants were found traditionally used by Aidy community of Mekhala village to treat 40 various diseases.

Kunwar and Duwadee (2006) studied MAPS in two mountainous districts Palpa and Jumla in mid western region and found several medicinal plants including 'Sugandhawal' indigenously used and potential for trade as well for medicinal purposes.

Identification and quantification of Valerenic acid through high performance thin layer chromatography (HPTLC) method in 'Sugandhawal' was carried on for the first time by Singh *et al.* (2006). Valerenic acid makes substantial contribution to the sedative and spasmolytic activity of the essential oil and extract of 'Sugandhawal' plants.

Adhikari *et al.* (2007) assessed NTFPs of Bubramadichaur, Jumla of mid western Nepal and found some species including 'Sugandhawal' most abundantly, found and prominently used by the local community for economic purposes.

Kunwar *et al.* (2007) studied indigenous use and ethno-pharmacology of some medicinal plants of far-western Nepal and found strong positive ethno pharmacological correlation with traditional knowledge.

1.4 Objectives

The present research work aims to explore how different environmental factors influence growth, distribution and production of "Sugandhawal". The specific objectives of this research work are:

i. To measure the potential yield of "Sugandhawal" in different habitat within study area.

ii. To study status of trade of the plant resources and socio-economic issues regarding its use.

iii. To recommend conservation strategies to ensure sustainable use of this plant.

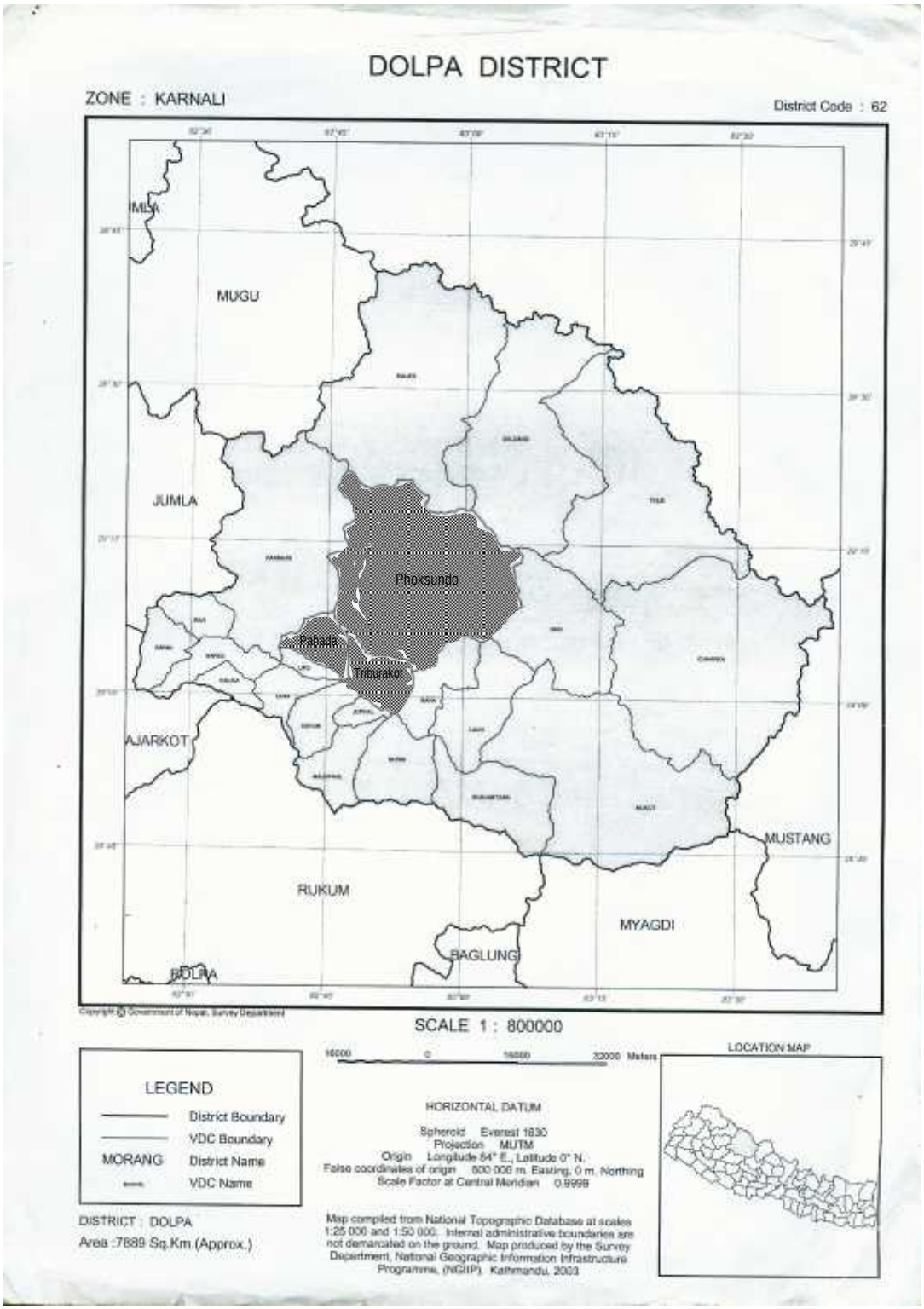
1.5 Limitations

The study area is one of the remotest areas of the country. The field visit was of short duration due to several technical constraints. The climatic condition during field trip was not sufficiently favourable to carryout field works smoothly without disturbances. The season was of collecting 'Yarsagumbu' (*Cordyceps sinensis*) and hence lack of sufficient informants was felt in some of the proposed areas especially in Raha and Phoksundo VDCs. Whole phenology of the plant could not be included in this study due to single field visit of the area.

2. MATERIALS AND METHODS

2.1 Study Area

The study area includes altogether 3 VDCs of Dolpa district. Phoksundo VDC was taken from the SPNP region and Tripuratkot and Pahada VDCs were taken from the southern bufferzone of SPNP.



2.1.1 Climate and Specificities

According to the records of department of Hydrology and Meterology, the five years average (2002 - 2006) maximum temperature of Dunai, the district headquarter of Dolpa, was seen in July i.e. 31.46°C. Similarly, the average minimum temperature of five years was seen in the month of January i.e. -0.92°C. The climatic data showed highest relative humidity (%) in the month of August and lowest in the month of March. The average of the five years data showed that the highest precipitation occurred in month of August and lowest precipitation in the month of December and March as well. The average total precipitation of the five years was 169.76mm per annum.

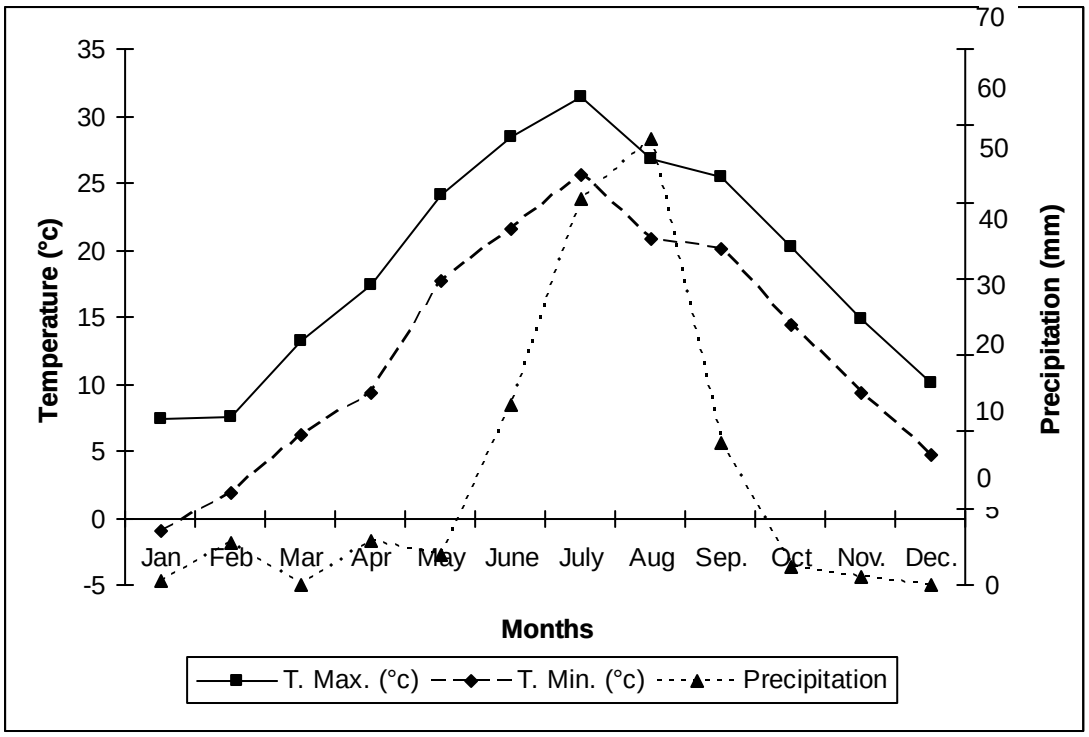


Figure 1.a:Ombrothermic Graph of Climatic Data of Dunai, Dolpa (2002 - 2006).

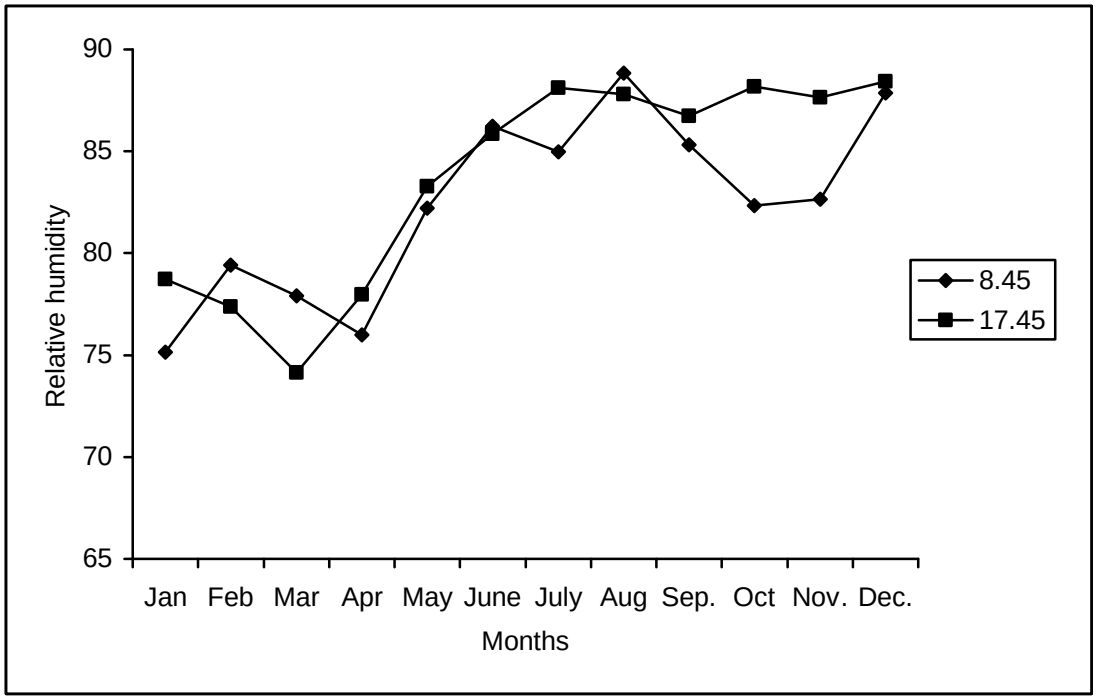


Figure 1.b : Relative humidity of Dunai, Dolpa

The main source of livelihood of the region is agriculture and animal husbandry. Trade of plant resources has also supported to the livelihood of local people in some extent. The exploitation of resources in this region is less explored and less scientific where explored. The people have, still, free access to larger part of the high altitude pastures for livestock grazing and commercial exploitation of the numerous plant resources.

This region is diverse culturally as well. The people of upper Dolpa follow the culture and religions of Tibet including Bon and Tibetan Buddhism, whereas the inhabitants of lower Dolpa have a mixed cultures from Tibeto Burmans (mainly Gurung and Magar) to Indo-Aryans (Brahamin, Thakuri, and Chhetri).
The district profile of Dolpa is given below in the box.

Box :1. District Profile of Dolpa

Area : 7889 sq. km.

Location : 28^0 24' - 29^0 43N latitude

82^0 24' - 83^0 38' E longitude

Elevation : 1225m - 7625m

Boundary:

East : Mustang and Myagdi District and Tibet (china)

West: Mugu, Jumla and Jajarkot Districts

North : Tibet (China)

South : Myagdi, Rukum and Jajarkot Districts

Major Mountain Peaks (>6000m)

1. Puttha Himchuli (7,035m)
2. Araniko chuli (6,584m)
3. Batuli Patan (6,969m)
4. Rigma (6,634m)

Main Rivers

1. Bheri, 2. Sangu (Panjang) 3. Sano Bheri
4. Suligadh 5. Jagdulla 6. Tamp khola etc.

Major Lakes and Ponds :

1. Phoksundo Lake 2. Jagdulla lake 3. Sun daha
4. Gamakundi daha 5. Rigma tal 6. Puttha tal
7. Pungma tal, etc.

Climate

Mild-temperate, cool - temperate, Alpine

Major Crops

Maize, Millet, Chino, Rice, Barley, Potato, Buckwheat, Wheat, Bean etc.

Major Vegetation

Temperate : Pine, Alnus etc.

Sub-alpine: Quercus, Betula, Rhododendron, Conifers etc.

Alpine : Alpine scrub/meadows.

Source: Nepal District Profile, 2002.

2.1.2 Shey Phoksundo National Park (SPNP)

SPNP is the biggest national park of Nepal extending in a core park area of 3,555 km^2. The park includes 286 species of plants of ethno-botanical importance (Ghimire *et al.*, 1999). A buffer zone of 449 km^2 area was established around the park in 1998 and increased again on the south and southeastern periphery to 1349 km^2 in 2002. Present study includes only 1 VDC of SPNP i.e. Phoksundo VDC. It is fairly cohesive as well as following the traditional resource management practices. However, owing to its contiguity with the southern buffer zone and to commercial collection of plant resources at the park border, the VDC was also found quite vulnerable to over exploitation and unscientific harvesting of the plant resources. Also, the indigenous knowledge of *Amchi*s regarding the use of plant resource was found more prominent in this site. Hence, this VDC of SPNP was selected for the present study purpose. The sulighad - Phoksundo Valley of this VDC was observed and studied.

2.1.3 South and South Western Bufferzone of SPNP

Bufferzone can be defined as an area designated around the national parks and reserves in order to provide facilities for the use of forest products on a regular basis to the local people. To date, there are 11 VDCs in the bufferzone of SPNP. Among them 9 VDCs come under Dolpa district. To manage and conduct people's activities in about 1349 sq. km area of buffer zone of SPNP, there are altogether 17 bufferzone management committees acting in this area. Out of them, 15 committees are in Dolpa district. Only 2 VDCs of the bufferzone area of SPNP in Dolpa were included by the present study i.e. Tripurakot VDC. from the southern periphery of SPNP and Pahada VDC from its south western periphery. Both the VDCs are found as higher rainfall receiving areas of the district. The population of these areas was also found relatively higher. People of these areas are mostly Hindu. Heavy amount of commercial exploitation of several species of medicinal plants are also being collected from these regions. Some signs of over harvesting of plant resources were also noticed in some of the areas of these VDCs as well.

2.2 Collection of Vegetational Data

Sampling was done in the natural habitat of 'Sugandhawal'. A technique of stratified random sampling was applied in which survey area is confined within 3 adjoining VDCs. From each site, six plots of 20m x 20m area was designated as major plots from 'Sugandhawal' rich sites and hence altogether 18 major plots were designated in total 3 VDCs of study purpose. Sampling sites were selected in such a way that a comparative study can be made in their status on the basis of disturbance factors and distance from the nearest village. Also the records of previous studies (Ghimire *et al.* 2000; Lama *et al.*, 2001) as well as local people's information were considered for the selection of the sampling sites for the study of the plant species.

The field notes regarding locality, longitude, latitude, altitude, aspect, slope, forest type and distance from the nearest village were recorded in each major plots of sampling. For recording altitudes, latitudes ad longitudes, global positioning system (GPS) was used where slope and aspect of the study area were taken by using clinometer.

Five plot will size of 2m × 2m were made with each major plot of study and hence altogether 30 such subplots were studied in 6 major plots of each site by making a grand total of 90 such subplots within 3 VDCs i.e. total study area. The number of individual ramet of 'Sugandhawal', their coverage and herbaceous species found associated with 'Sugandhawal' were recorded in each 2m x 2m subplot. 100g of soil samples were collected from each subplot from the depth of 30cm. Herbarium specimens were collected for unidentified plant specimens within each subplot with standard techniques described by 'Forman and Bridson (1992).

2.3 Collection of Environmental Data

Ecological and biological information were recorded in a standard data sheet (Appendix 1 and 2).

For the resource estimation, the rhizomes of 'Sugandhawal' present inside one micro-plot of 0.5m × 0.5m area within one subplot of each major plot selected randomly, were completely harvested and collected separately. Altogether 18

such micro-plots were studied for the resource estimation purpose within whole study area.

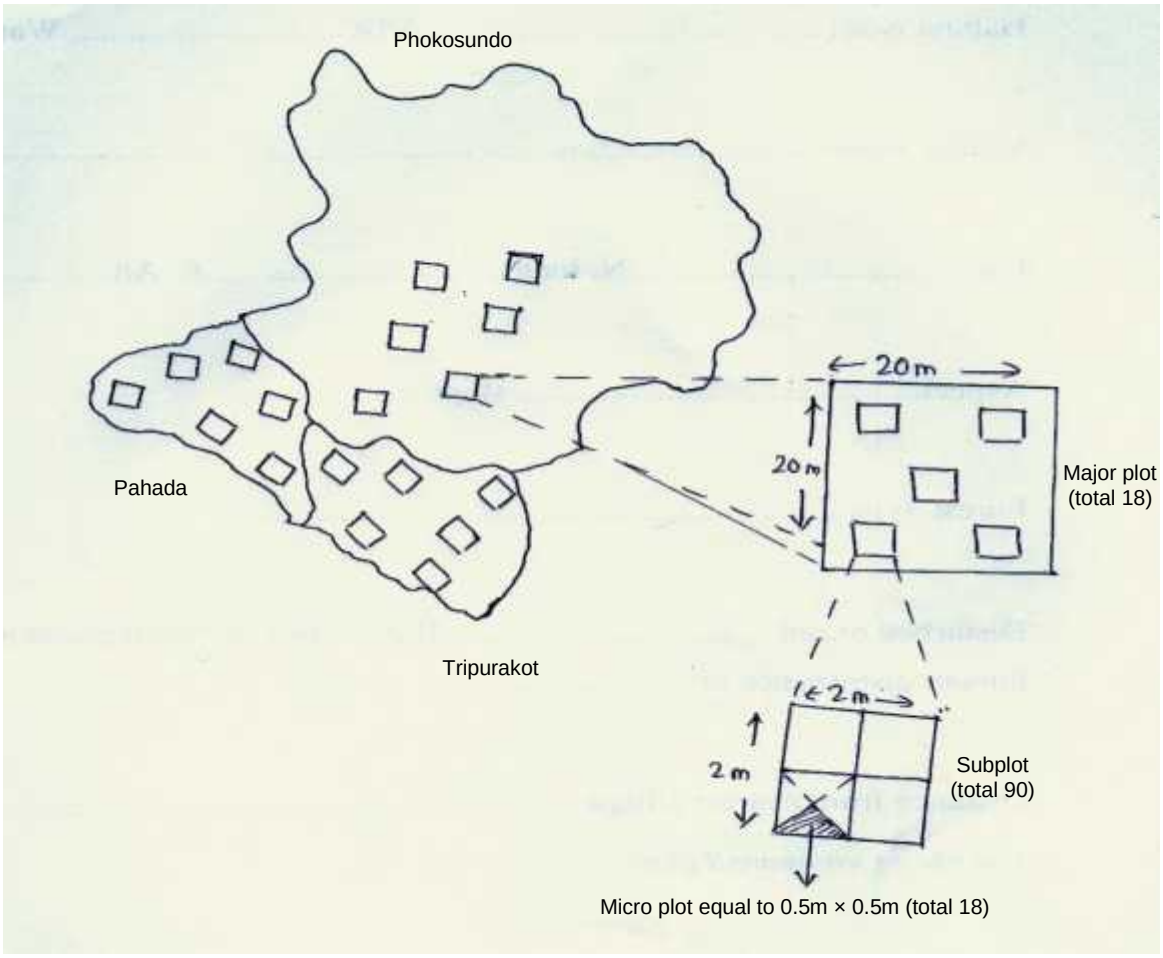


Figure 2 : Sampling Design

Various tools were used to gather environmental informations regarding the plant resource. Participatory methods such as Rapid Rural Appraisal (RRA), Participatory Observation, Focused Group's Discussion and Key Informant Interviews were employed. PRA and semi-structured interviews were conducted with *amchi*s, *Lamas*, local residents and teachers. Key informant interviews and the focused group's discussion were also conducted with local people of the area for collecting environment data regarding "Sugandhawal'' plant.

The participatory assessment was conducted through a group discussion with the people from different localities. During that process, the people were provided with different agenda related to the aim of the study. Similarly, different questions related to use, distribution and habitat of the plant were also asked to the people.

Exceptionally few people were reluctant to given information in detail during the time of data collection. For such respondents, questions were indirectly asked through informal discussion instead of using structured questionnaire. Determination of threat value of 'Sugandhawal' was made by 'Ranking method' by the scoring system and interpretation of 'Perring and Farewell (1997)' and modified by Ghimire and Yumeerudy-Thomas (2006).

Traditional herbal healers and faith healers, experienced and aged persons were prioritized while taking informations through asking questions and each information was validated authentic only after confirming by at least 3 other informants. View of villagers about problems, opportunities and management of resource use as well as dreams of people of the study area were also recorded. Trade of the plant resources from the district, population, climatic data and several other secondary informations desired for the study were gathered from concerned offices and organizations in Dolpa district.

2.4 Analysis of Data

Frequency

Occurrence of herbaceous plant species within each major plots of study area were recorded to assess their distribution pattern in 'Sugandhawal' occurring areas. Then, frequencies of these species were obtained by using following formula (Zobel *et al.*, 1987).

Frequency of associated species (%) =

$$\frac{\text{Number of quadrats in which species occur}}{\text{Total number of quadrats}} \times 100$$

Cover

The 'Sugandhawal' cover (%) in each subplot was recorded through visual estimation on the basis of following scale (Daubeumire, 1968).

Table 1 : Scale value, range and mid - point value for the plant cover estimation

Scale Value	Range of Coverage (%)	Mid -point value
1	0-5	2.5
2	5-25	15.0
3	25-50	37.5
4	50-75	62.5
5	75-95	85.0
6	95-100	97.5

Density

Density of only 'Sugandhawal' plant within each sub plot was determined by using following formula (Zobel *et al.*, 1987).

$$\text{Density (Plants/m}^2\text{)} = \frac{\text{Number of individual of Valeriana within subplot}}{\text{Area of sub plot (4)}}$$

[$\therefore$ Studied sub plot was of $4m^2$ area]

Relative Radiation Index (RRI)

RRI was calculated by using formula given by Oke (1987) i.e.

$$RRI = \text{Cos}\,(180^0\text{-}\Omega)\,\text{Sin}\beta.\,\sin\phi + \cos\beta.\cos\phi$$

Where Ω is aspect, β is the slope and ϕ is the latitude of each subplot. Hence, it is the composite value of the measurements of slope, aspect and latitudes. It gives a relative value of how much solar radiation a particular spot receives at noon at equinox. Its value ranges from +1 to -1.

2.4.1 Laboratory Analysis of Soil

Soil Analysis

Soil sample were air dried in shade and analyzed for pH, texture (%), total nitrogen (%) and total organic matter (OM)% at laboratory of Central Department of Botany, Tribhuvan University, Kirtipur.

pH

Soil pH was determined by the potentiometric method (Gupta, 2000) using a pH meter (Digital pH meter, 802, systronics (89-92) Naroda Industrial Area, Ahmeda Bad, India). Before pH measurement, the electrode of the pH meter was dipped for 24 hours in tap water. Then, buffer solutions of pH tablet 7.0 and 4.0 were prepared freshly. The pH meter was warmed up for 15 minutes before starting pH measurement. 10g of air dried fine soil was mixed in 100ml of distilled water and stirred well by the help of glass rod. Then, the mixture of soil and water was left for decantation about half an hour and hence solution of soil sample was made ready for pH measurement. Now, the pH meter was callibrated through buffer solution of p_H 4.0 and 7.0 and p_H measurement was taken for each solution of soil sample. Electrode of pH meter was flushed by distilled water and wiped by cotton each and every time before dipping it from anyone solution either buffer or of soil sample to next.

Texture (%)

At first, organic debrises of each air dried soil samples were removed and the soil samples about 50g was passed along the top shelf of sieve and lid of sieve was closed. The sieve was then shaken well. Then the soil through sieving in different shelves of sieve were collected in 3 groups on the basis of the pore diameter of the meshes of the sieve as follows:

Table 2 : Texture of Soil

Name of the Particle	Diameter range (mm)
Sand and gravel	> 2.0
Coarse Sand	0.20 - 2.0
Fine sand + Silt + clay	< 0.20

Now, the soil collected in each textural group was weighed separately and their individual weights were again added to get percentage of each textural group in soil sample.

Total Nitrogen (%)

The total nitrogen (%) of soil was determined by microkjeldahl method with techniques described by Gupta (2000). This method includes following 3 steps:

Digestion

1 g of air dried and fine soil (passed through 0.425 mm sieve) was taken in a dry kjeldahl digestion flask of 300ml. Then 3.5g potassium sulphate and 0.4g copper sulphate (i.e. catalysts) were added to the flask containing soil. Now, 6ml of conc. H_2SO_4 was added to the mixture of soil and catalyst in flask and shaken gently.

The flask was then placed on the preheated (30°C) heating mantle for digestion. Temperature was raised to about 310^0C after the bubbles started disappear on the contents of the flask. The end of digestion process was known as the colour changed from black to brownish and ultimately greenish. Then the flask was removed immediately from the mantle and allowed to cool down for 30 minutes. To the digest, 50ml of distilled water was added and the mixture was shaken well. A blank without soil sample was also run for each batch of soil samples digested through this process.

Distillation

The diluted digest of Kjeldahl digestion flask was now transferred to Kjeldahl distillation flask. A beaker of 100ml capacity with 10ml of boric acid indicator was placed below the nozzle of the condenser in such a way that the end of the nozzle dipped into the indicator. After the digest become warm, 30mL of 40 percent NaOH solution was added and mouth of distillation flask was closed with cork making the system air tight. The temperature of the mantle was now raised to about 310^0C. The distillate eveporated through distillation flask began to condense and the colour of boric acid indicator changed from pink to green. The distillation was continued until the volume of distillate in beaker reached to about 50 ml.

Titration

The distillate removed out from distillation plant was titrated with 0.1N HCL. The volume of HCL consumed in titrating distillate was recorded. The volume of acid consumed by both blank and soil samples were noted and on the basis of which the total nitrogen content (N%) of the soil sample was calculated by using following formula.

$$\text{Soil N (\%)} = \frac{14 \times N \times (S - B) \times 100}{M}$$

Where, N = normality of HCL

S = Volume of HCL consumed with soil sample (mL)

B = Volume of HCL consumed with blank (mL)

M = Mass of soil taken (mg)

Total organic Matter Content (OM) %

Soil OM (%) was determined by Walkely and Black rapid titration method as described in Gupta (2000).

In this method, 0.5g air dried soil was taken in a clean and dry 500ml conical flask. Then 5ml of $1N K_2Cr_2O_7$ was pipetted in and swirled gently. 10mL of conc. H_2SO_4 was added and swirled again two to three times. The flask was then allowed to cool down for 30 minutes and then 100 ml distilled water was added on it. After that 5 ml of orthophosphoric acid (pure) was added and then 0.5ml of diphenylamine indicator was added in the conical flask containing the mixture of soil and reagents. The colur of the solution of the flask was obtained blue violet. Now the content was titrated with 0.5N ferrous ammounium sulphate till the colour changed from blue violet to green. A blank was also run simultaneously for each batch of soil samples tested for OM%. In some samples, the 0.5g soil couldn't be able to be completely digested to give the estimation of OM%. In such cases, the soil samples taken for OM% analysis were reduced to 0.25g to even 0.20 g in some case and same procedure was followed for other steps and hence, a successful digestion of OM giving rise to blue violet colour of content obtained at

the end of each and every sample under test. Now, the soil organic carbon (%) of the sample was determined by using following formula.

$$\text{Soil organic carbon estimated (\%)} = \frac{0.003 \times 10\ (\text{Blank reading} - \text{Titration reading})}{\text{Blank reading} \times \text{Mass of soil (g)}} \text{x}100$$

The organic carbon (%) obtained by above formula was multiplied by a factor 1.3 (based on the assumption that there is incomplete oxidation of the organic matter in this procedure and only 77% recovery occurs through this method).

Hence, organic carbon (%) = organic carbon estimated (%) x 1.3

Now, to determine organic matter content (%) of soil, this value of organic carbon (%) was multiplied by Van Bemmelen factor of 1.724 (because organic matter is assumed to contain 58% organic carbon).

Hence, organic matter content (%) = organic carbon (%) x 1.724

2.4.2 Statistical Analysis

Hypothesis: Cover and density of 'Sugandhawal', soil characteristics and RRI in all 3 sites are alike.

Pearson's correlation coefficients were determined among above variables from a pooled data of 3 VDCs. Linear regression analyses were carried on to establish relations among each and every variables. The relevant and significant relations obtained by regression analyses were elaborated in the results. All statistical analyses were done using statistical programme for social science (SPSS, 2001) version 11.5.

2.4.3 Laboratory Analysis for Resource Estimation

Rhizomes harvested and collected separately from each micro plot of each major plot were air dried in dim light of sun for one week. After a week, dried biomass of the rhizomes was weighed and recorded in gram per 0.25m^2. Each value, thus obtained, was then multiplied by 40 to estimate the potential yield of 'Sugandhawal' rhizome (kg/ha.) in each major plot. These samples after taking

dried biomass were then treated separately turn by turn in Clevenger's Apparatus for steam distillation of the essential oil content in the rhizome. The essential oil was extracted by hydro-distillation in Clevenger's Apparatus by taking rhizome sample (g) and distilled water (mL) in 1:10 ratio in the distillation flask of apparatus and heating the flask in mantle for about 12 hours. The crude essential oil content was collected and measured after each batch of steam distillation and its percentage to the total mass of sample was calculated. Same procedure was followed for each and every sample. Specific gravity value was calculated for the crude oil extract to convert mL into g units.

2.5 Identification of associated plant species of 'Sugandhawal'

Species found associated with 'Sugandhawal' in each subplots were treated with experts, TUCH and National herbarium, Godavari for identification on the basis of their herbarium specimens collected during field trip as well as photographs taken in the field visit. Standard literatures such as Polunin and Stainton, 1987; Malla *et al.*, 1976; Press *et al.*, 2000 were also consulted along with different plant experts of Tribhuvan University, Kathmandu.

2.6 Social Survey

Social survey was performed through interview method with the help of semi-structured questionnaires. At first, all key informants were selected and on the basis of their information, other informants were selected.

2.6.1 Selection of Key Informants

Some renowned persons of the villages such as village representatives, political leaders, *Mukhiyas, Amchi*s and teachers were included as key informants. Then, these informants were asked for knowing who of the villagers were involved in the plant cultivation, collection, trade and other activities. Key persons interviewed are enlisted in Appendix 5. On the basis of their information other informants were taken.

2.6.2 Selection of Other Informants

Informants other than key informants were cultivators, collectors and traders of the plant resource, herders, farmers, porters and house constructors.

2.6.3 Interview

A semi-structured questionnaire was used for the interview with informants. Interview was undertaken mainly to know socio-economic status, plant's threat value index, harvesting pattern, cultivation practice, the amount of resource collection and trade, place of collection and the place of selling of the plant species. The questionnaire applied for these purposes are included by Appendices 3 and 4.

Most of the interviews were taken by visiting individual person whereas one group discussion was conducted in each VDC by involving collectors, traders, cultivators and other persons as well.

2.6.4 Informal talks

Informations were gathered also through informal talks with officers of District offices, SPNP Headquarters, Range Posts, VDC offices and village offices as well as from other concerned authorities.

2.7 Scoring and Interpretation System of Threat Value

The threat value was analyzed by following scoring and interpretation system of Ghimire and Yumeeruddy-Thomas (2006). Scoring system of threat value of sugandhawal resource is better illustrated in the following table.

Table 3 : Scoring system of threat value

S.N.	Name of Locality	No. of localities known			Remoteness *			Resource use			Trade			Subjective assessment by local people			Conservation index **
		decreasing	constant	increasing	< 3 hrs	3-10hrs	> 10hrs	H	H + FL	H + NL	N	S	L	NA	MA	HA	(W, X, Y or Z)

** To reach resource site* *** % localities of that species in nature resources or sanctuaries*

N = No trade S = Small trade L = Large trade NA = Not attractive MA = Moderately attractive HA = Highly attractive

H = Only by healer H + FL = header + few local people H + NL = healer + numerous local people

W = > 66% X = (33 - 66)% Y = < 33% Z = <M 33% and these sites are subject to exceptional threat

Interpretation for scoring system of threat value is as follows:

a) The number of localities known :

Score	Number of localities known
0	Increasing
1	Constant
2	Decreasing

b) Remoteness to reach resource site :

Score	Time taken (hrs.)
0	> 10
1	3 - 10
2	< 3

c) Resource use :

Score	Users
0	Only by healer
1	Healer + few local people
2	Healer + Numerous local people

d) Trade

Score	Amount
0	No trade
1	Small trade
2	Large trade

e) Subjective assessment of resource utilization of local people

Score	Response of local people
0	resource not attractive
1	resource moderately attractive
2	resource highly attractive

f) Conservation index (% localities of the species in nature resources or sanctuaries)

Score	% localities of the species in nature resources or sanctuaries
0	> 66%
1	(33 - 66)%
2	< 33%
3	< 33% and sites subject to exceptional threat

Remarks: The score exceeding 5.0 is considered under threat as per the values. The maximum threat value is 13.

3. RESULTS

3.1 Analysis of Data

3.1.1 Associated species of 'Sugandhawal' and their frequencies

The herbs and seedling of flowering plants found associatively growing in 'Sugandhawal' flourishing zones are summarized in following tables along with their frequencies (%) as well.

Table 4 : Associated Species of 'Sugandhawal' in Pahada VDC

S.N.	Botanical name of the plant species	Family	Frequency (%)
1	*Fagopyrum dibotrys* (D. Don) Hara	Polygonaceae	20.0
2	*Rosa brunonii* Lind.	Rosaceae	6.67
3	*Asparagus filicinus* Buch-Ham. ex D. Don	Liliaceae	6.67
4	*Trifolium repens* L.	Fabaceae	16.67
5	*Artemisia dubia* Wallich ex Besser	Asteraceae	40.0
6	*Rumex nepalensis* Spreng.	Polygonaceae	33.34
7	*Oxalis corniculata* L.	Oxalidaceae	36.67
8	*Cannabis sativa* L.	Cannabaceae	10.0
9	*Artemisia indica* Willd.	Asteraceae	30.0
10	*Geranium pratense* L.	Geraniaceae	36.67
11	*Erysimum melicentae* Dunn	Brassicaceae	43.34
12	*Ranunculus hirtellus* Royle ex D. Don	Ranunculaceae	46.67
13	*Persicaria capitata* (Buch. -Ham.) H. Gross	Polygonaceae	33.34
14	*Desmodium elegans* DC.	Fabaceae	10.0
15	*Deutzia compacta* Craib	Hydrangaceae	13.34
16	*Galinsoga parviflora* Cav.	Asteraceae	16.67
17	*Galium aparine* L.	Rubiaceae	30.0
18	*Stellaria* sp.	Caryophyllaceae	23.34
19	*Anemone rivularis* Buch.-Ham.exDC.	Ranunculaceae	40.0
20	*Pedicularis scullyana* Prain ex Maxim	Scrophulariaceae	30.0
21	*Caltha palustris var. himalensis* (D. don)Mukerjee	Ranunculaceae	33.34
22	*Gnaphalium affine* D. Don	Asteraceae	23.34
23	*Berberis lycium* Royle	Berberidaceae	6.67
24	*Chenopodium album* L.	Chenopodiaceae	43.34
25	*Thalaspi arvens* L.	Brassicaceae	13.34
26	*Capsella bursa-pastoris* (L.) Medikus	Brassicaceae	13.34
27	*Selinum tenuifolium* Wallich ex C.B. clarke	Umbelliferae	10.0
28	*Taraxacum officinale* Webber	Asteraceae	16.67
29	*Medicago falcata* L.	Fabaceae	6.67
30	Unidentified-I	Poaceae	23.34
31	Unidentified-II	Umbelliferae	13.34

32	Unidentified-III	Labiatae	13.34

Table 5: Associated Species of 'Sugandhawal' in Phoksundo VDC

S.N.	Botanical name of the plants species	Family	Frequency (%)
1	*Polygonatum cirrhifolium* (wallich) Royle	Liliaceae	6.67
2	*Jasminum humile* L.	Oleaceae	10.0
3	*Androsace strigillosa* Franchet	Primulaceae	10.0
4	*Berberis lycium* Royle	Berberidaceae	13.34
5	*Abelia triflora* R. Br. ex. Wallich	Caprifoliaceae	10.0
6	*Prunus nepaulensis* (ser.) steud.	Rosaceae	6.67
7	Unidentified I	Labiatae	10.0
8	*Selinum tenuifolium* Wallich ex. C.B. clarke	Umbelliferae	13.34
9	*Parnassia nubicola* Wallich ex Royle	Parnassiaceae	10.0
10	*Thallictrum cultarum* Wall.	Ranunculaceae	16.67
11	*Bistorta amplexicaulis* (D. Don) Greene	Polygonaceae	3.34
12	*Polygala sibirica* L.	Polygalaceae	10.0
13	*Lecanthus peduncularis* (Royle) Wedd	Utricaceae	10.0
14	*Gentiana pedicellata* (D. Don.) Griseb.	Gentianaceae	13.34
15	*Anaphalis controta* (D. Don.) Hook f.	Asteraceae	16.67
16	*Hemiphragma heterophyllum* Wallich	Scrophulariaceae	13.34
17	*Satyrium nepalense* D. Don	Orchidaceae	3.34
18	*Delphinium* sp.	Ranunculaceae	6.67
19	*Swertia angustifolia* Buch-Ham-ex D. Don	Gentianaceae	6.67
20	*Selenium Wallichianum* (DC.) Raiza and Saxena	Umbelliferae	6.67
21	*Smilax rigida* wallich ex Kunth	Liliaceae	3.34
22	*Artemisia indica* willd	Asteraceae	6.67
23	*Origanum vulgare* L.	Labiatae	10.0
24	*Lonicera anguistifolia* Wallich ex. DC.	Caprifoliaceae	13.31
25	*Caragana brevispina* Royle	Fabaceae	10.0
26	*Taraxacum officinale* webber	Asteraceae	6.67
27	*Plantago indica*	Plantaginaceae	6.67
28	*Medicago falcata* L.	Fabaceae	6.67
29	*Roscoea alpina* Royle	Poaceae	10.0
30	Unidentified IV	Oleaceae	13.31
31	*Ligularia fischeri* (Ledeb.) Turcz	Asteraceae	13.34
32	*Epipactis royleana* Lindl	Orchidaceae	6.67
33	*Rosa sericea* Lindl	Rosaceae	16.67
34	*Populus cilliata* Wall. ex Royle	Salicaceae	10.0
35	*Ribes alpestre* (Wallich ex Decne)	Grossulariaceae	10.0
36	*Acer* sp.	Aceraceae	6.67
37	*Salvia hians* Royle ex. Benth	Labiatae	6.67
38	*Desmodium multiflorum* DC.	Fabaceae	10.0

39	*Carum carvi* L.	Umbelliferae	6.67

Table 6 : Associated Species of 'Sugandhawal' in Tripurakot VDC

S.N.	Botanical name of the plants species	Family	Frequency (%)
1	*Berberis lycium* Royle	Berberidaceae	6.67
2	*Oxalis corniculata* L.	Oxalidaceae	16.67
3	*Rubus nepalensis* (Hook. f.) kuntze	Rosaceae	13.34
4	*Rumex nepalensis* spreng.	Polygonaceae	16.67
5	*Punica grantum* L.	Punicaceae	6.67
6	*Taraxacum officinale* webber	Asteraceae	10.0
7	*Rubia manjith* Roxb. ex fleming	Rubiaceae	13.34
8	*Urtica diocia* L.	Urticaceae	10.0
9	*Rosa brunonii* Lind.	Rosaceae	6.67
10	*Ranunculus hirtellus* Royle ex. D. Don	Ranunculaceae	13.34
11	*Plantago indica*	Plantaginaceae	16.67
12	*Artemisia gmelinii* weber ex steckm	Asteraceae	10.0
13	*Wikstroemia canescens* Meisn	Thymelaeaceae	13.34
14	Unidentified - I	Poaceae	10.0
15	*Rumex hastatus* D. Don	Polygonaceae	13.34
16	*Carex cruciata* Wahlenb	Cyperaceae	10.0
17	*Coriaria nepalensis* wall	Coriariaceae	6.67
18	*Geranium pratense* L.	Geraniaceae	10.0
19	*Erysimum melicentae* Dunn	Brassicaceae	13.34
20	*Desmodium elegans* Dc.	Fabaceae	16.67
21	*Anemone rivularis* Buch. Ham ex. Dc.	Ranunculaceae	13.34
22	*Deutzia compacta* Craib	Hydrangaceae	13.34
23	*Ephedra gerardiana* Wall.ex Stapf.	Ephedraceae	10.0
24	*Allium oreoprasum* Schrenk	Amaryllidaceae	6.67
25	*Arisaema tortousum* (Wall.) Schott	Araceae	13.34
26	*Berberis mucrifolia* Ahrendt	Berberidaceae	6.67
27	*Cyanoglossem zeylanicum* (Vahl ex. Hornem) Thunb. ex. Lehm.	Boraginaceae	6.67
28	*Gentiana capitata* Buch- Ham ex. D. Don	Gentianaceae	16.67
29	*Crysopogon gryllus* (L.) Trin	Poaceae	16.67
30	*Bistorta amplexicaulis* (D. Don) Greene	Polygonaceae	10.0
31	*Clematis tibetana* kuntze	Ranunculaceae	13.34
32	*Viola biflora* L.	Violaceae	10.0

3.1.2 Plant attributes

The density of 'Sugandhawal' was significantly differed in all sites of study area. Among 3 major sites, Phoksundo VDC showed least average value of density (plants/m^2) i.e. 3.69 ± 0.84. However, in Tripurakot VDC, the density of 'Sugandhawal' was found comparatively moderate i.e. 6.52 ± 1.93 and that in

Pahada was found highest i.e. 8.87 ± 1.34. The total average density of plant in study area was obtained 6.36 ± 2.56.

The cover of 'Sugandhawal' also differed significantly in all 3 major sites of study area. The pattern of its distribution followed the same path as that of density because density and cover are attributes dependent to each other. The highest average cover value was obtained in Pahada (50.00 ± 12.71)%, moderate in Tripurakot (33.08 ± 11.12)% and lowest in comparison was found in Phoksundo (21.67 ± 10.37)%. The total average cover of the plant in study area was found (34.92 ± 16.28)%.

Table 7 : Descriptive table of ecological variables

	Site	Mean (± SD)
Density	1	8.87±1.34c
	2	3.69±0.839a
	3	6.52±1.93b
	Total	6.36 ± 2.56
Cover	1	50.00 ± 12.71c
	2	21.67 ± 10.37a
	3	33.08 ± 11.12b
	Total	34.92 ± 16.28
Soil N.	1	1.38b ± 1.01b
	2	0.79a ± 0.53a
	3	0.81a ± 0.34a
	Total	1.00 ± 0.73
Soil OM	1	18.98 ± 4.13b
	2	19.30 ± 7.93b
	3	9.70 ± 2.27a
	Total	15.99 ± 6.91
P^H	1	6.43 ± 0.18a
	2	6.93 ± 0.49b
	3	6.88 ± 0.52b
	Total	6.74 ± 0.48
SSC	1	26.23 ± 7.57b
	2	46.42 ± 17.04a
	3	23.73 ± 18.73c
	Total	32.13 ± 18.21
RRI	1	0.90 ± 0.04a
	2	0.94 ± 0.03b
	3	0.88 ± 0.07a
	Total	0.91 ± 0.05

Site : 1 = Pahada 2 = Phoksundo 3 = Tripurakot

3.1.3 Soil variables

Soil of 'Sugandhawal' occurring region was found acidic in all sites of study area. However, the mean soil pH value for Pahada VDC was obtained comparatively more acidic which was found 6.43± 0.18 while those values for Phoksundo and Tripurakot were found more or less similar i.e. 6.93 ± 0.49 and 6.88 ± 0.52 respectively. The total mean value of pH in 'Sugandhawal' occurring sites of study area was obtained 6.75 ± 0.48.

The mean soil total nitrogen content (%) of Pahada VDC was 1.39 ± 1.01 which was higher than that of Phoksundo and Tripurakot which were 0.79 ± 0.53 and 0.82 ± 0.34 respectively. However, the total average soil nitrogen content (%) of 'Sugandhawal' occurring sites of study area was obtained 1.00 ± 0.73. Similarly, the average organic matter content (%) in soil of the Tripurakot was obtained 9.70 ± 2.27 which was lower than that of Pahada (18.98 ± 4.13) and Phoksundo (19.30 ± 7.93). The total average value for the total organic matter (%) of 'Sugandhawal' occurring sites of study area was found 16.00 ± 6.91.

The mean of fine sand + silt + clay (%) of all 3 sites were significantly differed from 23.73 ± 18.73 (lowest) in Tripurakot to 26.23 ± 7.57 (moderate) in Pahada and then 46.42 ± 17.04 (highest) in Phoksundo. Total mean value of fine sand + silt + clay (%) in 'Sugandhawal' occurring sites of study area was obtained 32.13 ± 18.22.

3.1.4 Relative radiation index (RRI)

The mean RRI value among 3 major sites of study area was obtained higher in Phoksundo VDC i.e. 0.94 ± 0.03 whereas in Pahada and Tripurakot VDCs, it was found more or less similar i.e. 0.90 ± 0.41 and 0.89 ± 0.67 respectively. The total mean RRI of 'Sugandhawal' occurring sites of study area was obtained 0.91 ± 0.53.

3.1.5 Relations of Plant ('Sugandhawal') abundance with soil attributes

Table 8 : Pearson's Correlations between different attributes

	DENSITY	COVER (%)	SOIL N (%)	SOIL OM (%)	pH	SSC (%)
COVER (%)	0.62**					
SOILN (%)	0.26*	0.28**				
SOILOM (%)	-0.05	0.06	0.49**			
pH	-0.21*	-0.38**	-0.17	-0.16		
SSC (%)	-0.41**	-0.22*	-0.19	0.13	0.35**	
RRI	-0.18	-0.19	-0.01	0.24*	0.09	0.09

*** Correlation is significant at the 0.01 level (2-tailed). N = Nitrogen, OM = Organic Matter*

** Correlation is significant at the 0.05 level (2-tailed). SSC = Fine Sand + silt + Clay*

n = 90

The Pearson's correlations were found significant in between following attributes.

1. Density of 'Sugandhawal' was found positively correlated with total nitrogen content (%) (i.e. r = 0.262, P = 0.01) but negatively with that of pH (r = -0.211, P = 0.01) of the soil of its occurring sites. The corresponding estimated linear regression lines for these relationship is as shown in figures.

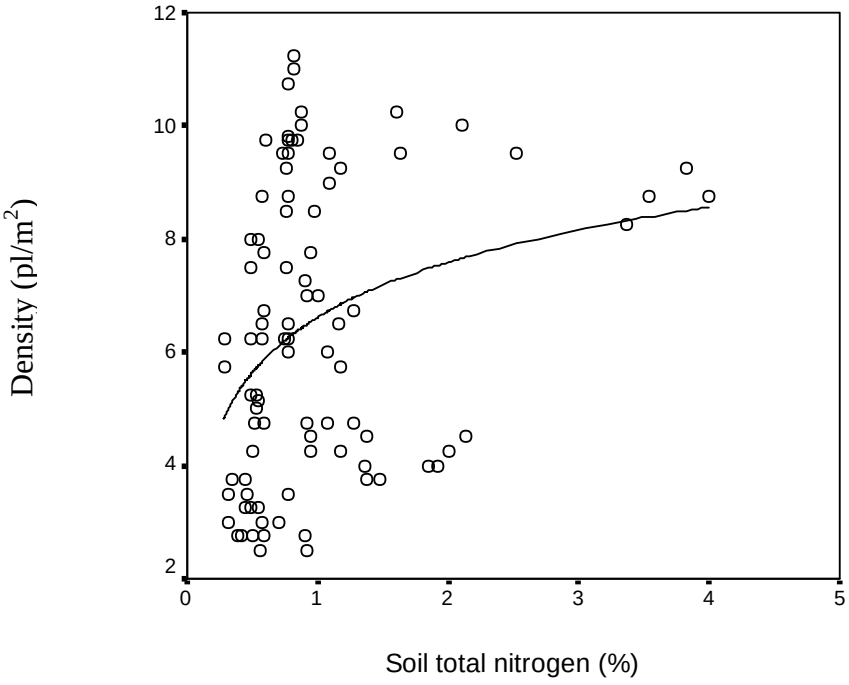


Figure 3 : Relationship between 'Sugandhawal' density and total nitrogen of soil

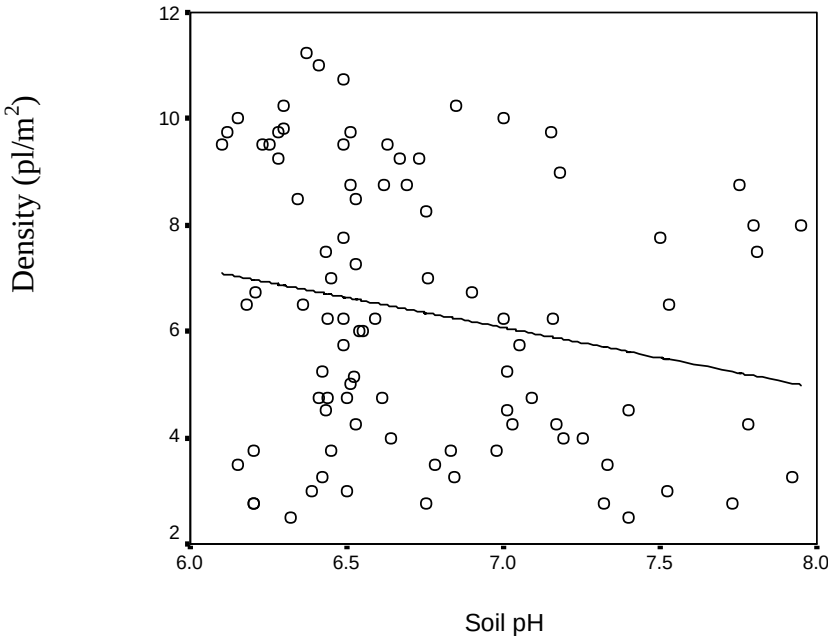


Figure 4 : Relationship between 'Sugandhawal' density and Soil pH

2. Density of 'Sugandhawal' was also obtained negatively correlated with fine sand + silt + clay (%) (i.e. r = -0.407, P = 0.05). Estimated linear regression line for this relationship is as shown in figure:

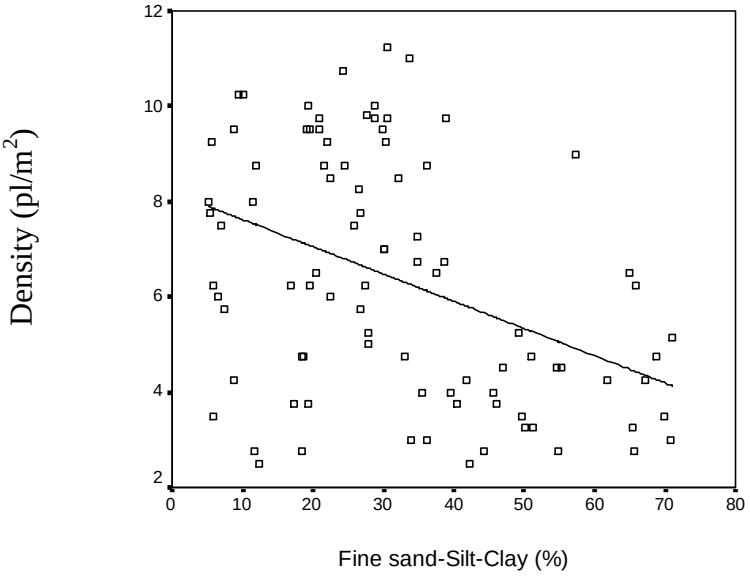


Figure 5 : Relationship between plant density and fine sand + silt + clay (%)

3. Coverage of the 'Sugandhawal' was found negatively correlated with pH (i.e. r = -0.384, P = 0.05) of the soil of 'Sugandhawal' in its natural habitat. Estimated linear regression line for this relationship is as shown in figures:

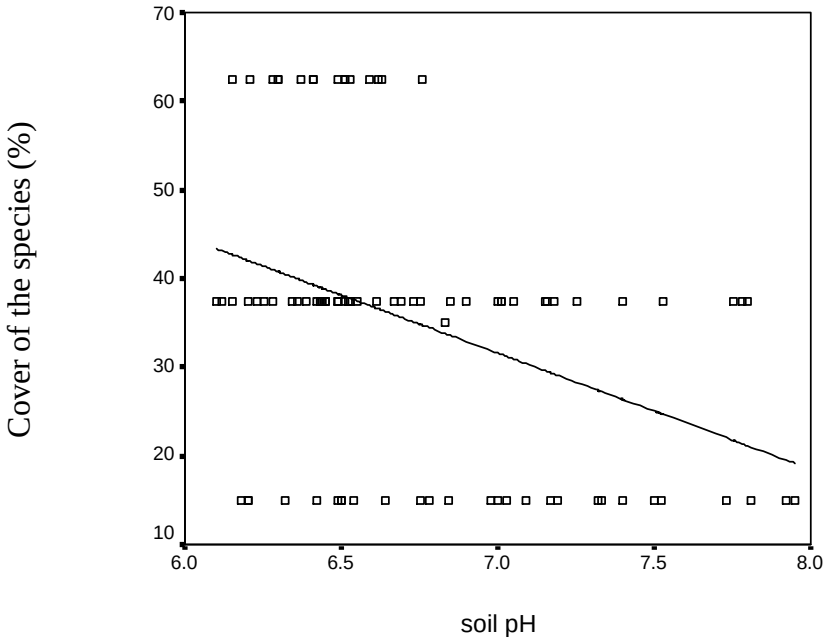


Figure 6: Relationship between 'Sugandhawal' cover and soil pH

3.1.6 Relations of Plant nutrient with RRI

Significant positive correlation was obtained with total organic matter content (%) of soil with RRI value of 'Sugandhawal' occurring sites (i.e. r = 0.244, P = 0.01). Estimated linear regression line for this relationship is as shown in figure.

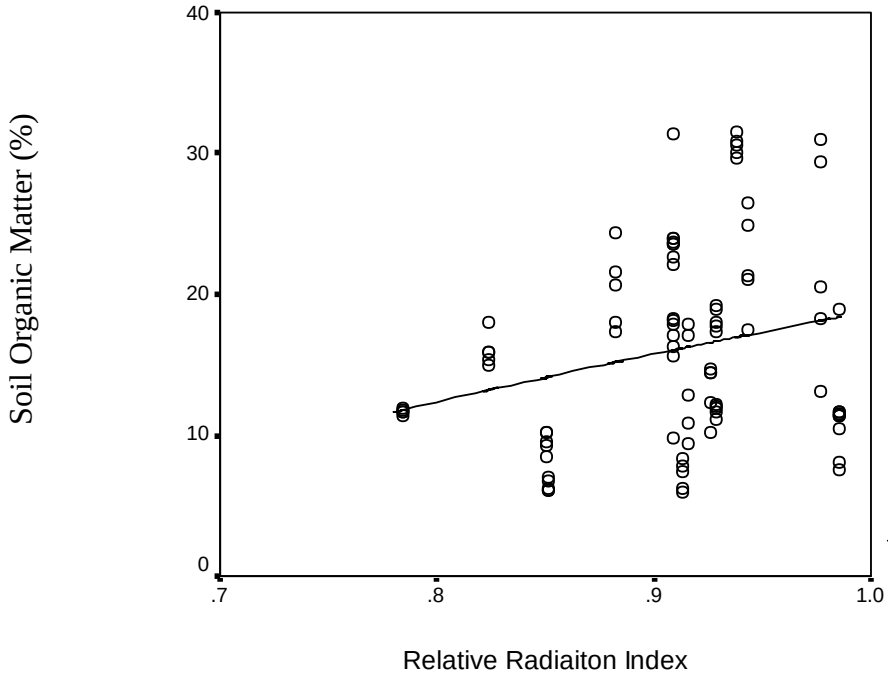


Figure 7: Relationship between soil organic mater and RRI

3.1.7 Relationship of Different Variables

Analysis of variances (ANOVA) for the different attributes under study showed that all of the attributes of study were significantly varied at $P \leq 0.001$. Hence, density and coverage of 'Sugandhawal' plant, RRI as well as soil attributes (i.e. total nitrogen content (%), total organic matter (%), pH and fine sand + silt + clay (%)) of 'Sugandhawal' occurring sites of study area showed significant variation in distribution pattern in terms of their values.

Table 9 : ANOVA table

Variables	Source of variations site	Sum of Squares	df	Mean Square	F	Sig. (P)
DENSITY	Between sites	402.450	2	201.225	96.254	0.000
	Within sites	181.879	87	2.091		
	Total	584.330	89			
COVER (%)	Between sites	12192.917	2	6096.458	46.576	0.000
	Within sites	11387.708	87	130.893		
	Total	23580.625	89			
SOILN (%)	Between sites	6.836	2	3.418	7.228	0.001
	Within sites	41.144	87	0.473		
	Total	47.980	89			
SOILOM (%)	Between sites	1784.651	2	892.326	31.432	0.000
	Within sites	2469.874	87	28.389		
	Total	4254.525	89			
pH	Between sites	4.571	2	2.286	12.598	0.000
	Within sites	15.784	87	0.181		
	Total	20.355	89			
SSC (%)	Between sites	9286.783	2	4643.391	19.948	0.000
	Within sites	20251.328	87	232.774		
	Total	29538.110	89			
RRI	Between sites	0.045	2	0.023	9.660	0.000
	Within sites	0.204	87	0.002		
	Total	0.249	89			

3.2 Estimation of 'Sugandhawal' Resource

3.2.1 Estimation of Number of plants

The number of individual plants/hactare was estimated by multiplying density/m^2 by conversion factor 10000. The average number of plants per hectare of 'Sugandhawal' occurring areas for 3 major sites of study area was found as follows:

Table 10: Estimation of number of 'Sugandhawal' with in study area

S.N	VDC	number of plants/hectare (± S.D.)	Remarks
1	Pahada	88,700 ± 13,400	highest
2	Phoksundo	36,900 ± 8,400	lowest
3	Tripurakot	65,200 ± 19,300	moderate

3.2.2 Estimation of rhizome yield

The yield was estimated on the basis of air dried mass of rhizome. The total average rhizome yield (g) of 0.5×0.5m micro plot was multiplied by conversion factor 40 for converting the yield into kg/ha as follows:

Table 11: Estimation of rhizome yield of 'Sugandhawal'

VDC	Microplot No.	Air dried mass of rhizome (g)	Average	Resources yield (kg/ha)
Pahada	Q_1	64.516		
	Q_2	55.642		
	Q_3	49.370	52.629	2105.17
	Q_4	42.234		
	Q_5	49.032		
	Q_6	54.981		
Phoksundo	Q_1	18.571		
	Q_2	17.257		
	Q_3	19.678		
	Q_4	14.875	16.791	671.64
	Q_5	14.135		
	Q_6	16.231		
Tripurakot	Q_1	31.614		
	Q_2	48.062		
	Q_3	35.300	37.785	1511.40
	Q_4	43.572		
	Q_5	32.262		
	Q_6	35.900		

3.2.3 Estimation of Essential Oil Content of the 'Sugandhawal' Rhizome

The crude essential oil content (%) of the plant resource was estimated through the extraction of essential oil from air dried mass of rhizome collected from each micro plot. The crude oil was extracted through the steam-distillation of dried rhizome through Clevenger's Apparatus and recorded in mL. Then the amount of mL was multiplied by the specific gravity of crude oil (0.9510 at 19°C) to calculate percentage.

Table 12: Estimation of essential oil content of the 'Sugandhawal' rhizome

VDC	Quadrat No.	Mass of rhizome taken	Oil content (mL)	Oil content (g)	Oil content (%) (mL is taken equivalent to gram) (%)	Average oil yield of microplot $(0.5\times0.5)m^2$	Average oil yield (kg/ha)
Pahada	Q_1	64.516	0.41	0.39	0.60	0.37	14.8
	Q_2	55.642	0.39	0.37	0.66		
	Q_3	49.370	0.38	0.36	0.73		
	Q_4	42.234	0.36	0.34	0.81		
	Q_5	49.032	0.37	0.35	0.71		
	Q_6	54.982	0.40	0.38	0.69		
Phoksundo	Q_1	18.571	0.49	0.47	0.08	0.08	3.2
	Q_2	17.257					
	Q_3	19.678					
	Q_4	14.875					
	Q_5	14.135					
	Q_6	16.231					
Tripurakot	Q_1	31.614	0.25	0.24	0.76	0.24	9.6
	Q_2	48.062	0.26	0.25	0.52		
	Q_3	35.300	0.25	0.24	0.68		
	Q_4	43.572	0.27	0.26	0.60		
	Q_5	32.262	0.24	0.23	0.71		
	Q_6	35.900	0.21	0.20	0.56		

3.3 Socio economic issues of 'Sugandhawal'

3.3.1 Collection of 'Sugandhawal'

Purpose of plant collection

The collection 'Sugandhawal' in Dolpa district within study area was found mainly for livelihoods purpose. Out of total respondents (56) interviewed about 45% stated that MAPs are collected for livelihood activity. 25% of the respondents collect MAPs to generate income in leisure time and about 11% take MAPs collection as a side activity of cattle grazing at pasture to generate pocket money or extra money for them. Remaining about 20% of the people, including local healers collect MAPs including 'Sugandhawal' for medicinal purposes. Hence, a total of 80% respondents were found to be collecting MAPs for commercial purpose in the study area.

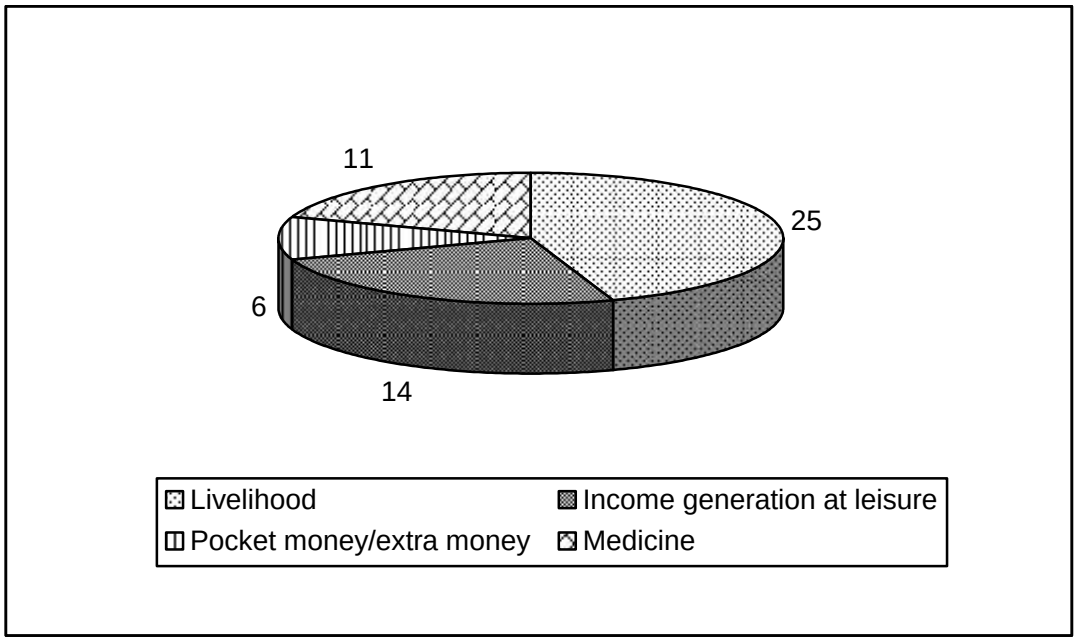


Figure 8: Purpose of collection of 'Sugandhawal'

Regarding the season of collection, out of 56 respondents, 71.43% collect in autumn, 16.07% in spring and 12.5% in both the seasons. Hence, majority of rhizome collection of 'Sugandhawal' was found during autumn.

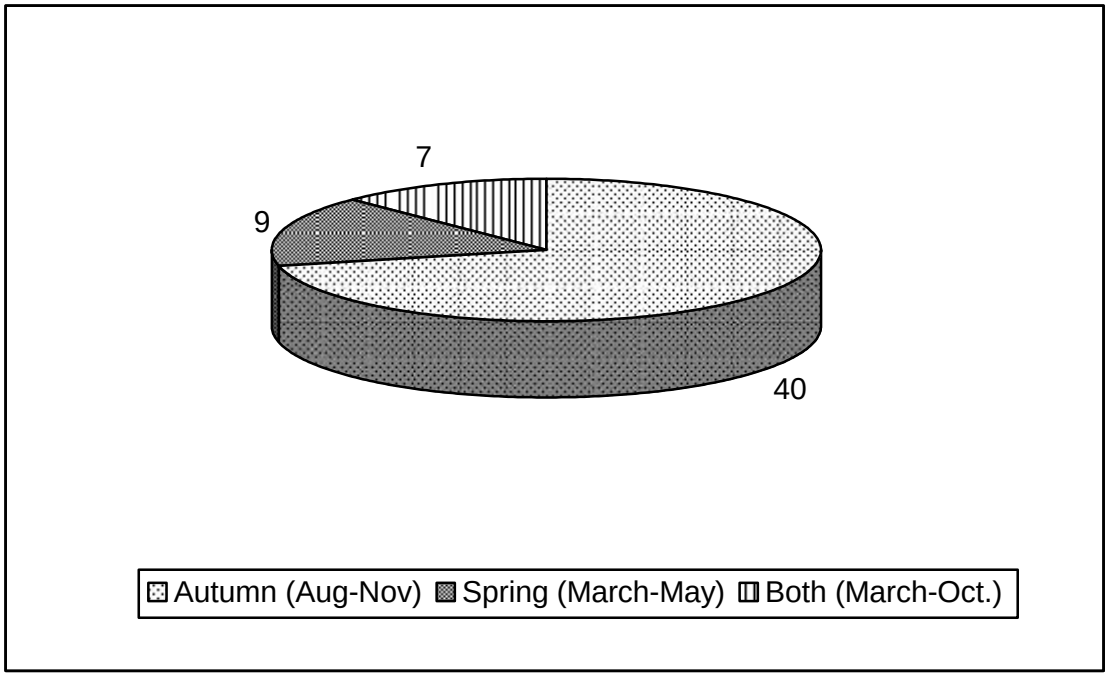


Figure 9 : Season of collection of 'Sugandhawal'

Out of total respondents interviewed, only about 20% of the respondents were found to follow the rotational basis of more than two years of rhizome collection of 'Sugandhawal'. Remaining about 45% respondents were found to be collecting it in every year and about 36% in every two year.

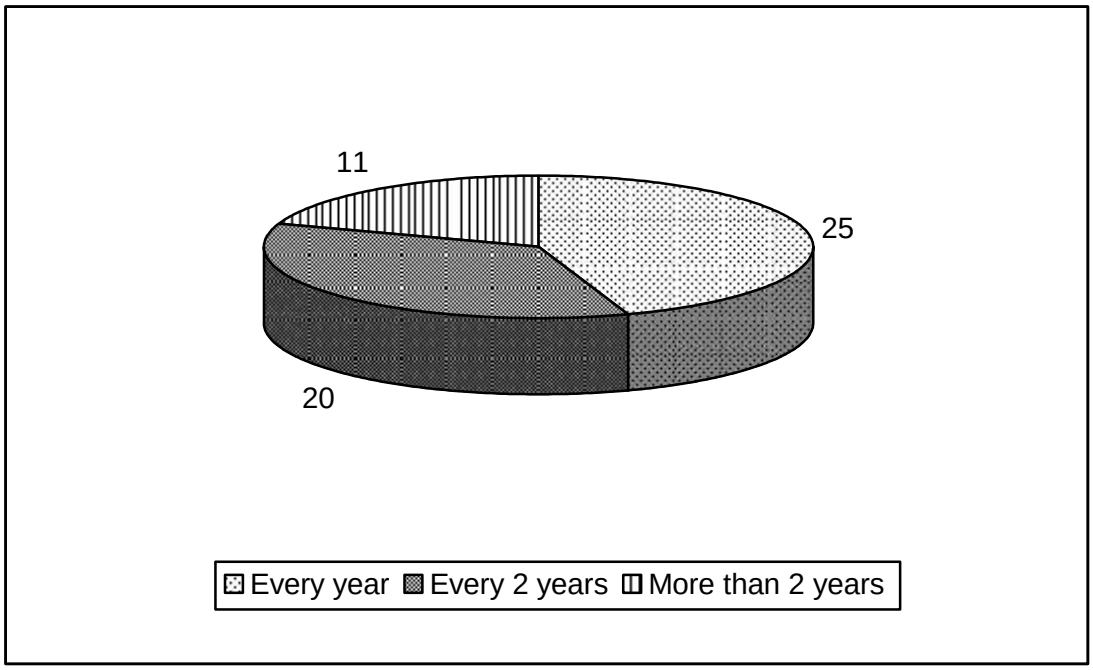


Figure 10 : Interval of 'Sugandhawal' Collection

3.3.2 Harvesting of 'Sugandhawal'

'Sugandhawal' was found harvested for its underground rhizomes. Aerial parts was found removed when harvested. After collecting 'Sugandhawal' rhizomes were found dried and made lighter and easier to carry to market. Sun drying was found commonly used for drying purposes. After sufficient drying, rhizomes are packed on jute sacks or bambo baskets (*doko*).

The 'Sugandhawal' plant was found within 2000 m to 3100 m altitude on study area where the snowfall is not regular. 'Sugandhawal' starts to flower in March and continues until August but the maximum flowering takes place in April-May and maturation of seeds takes place in August-September. Seeds can be harvested in October-November.

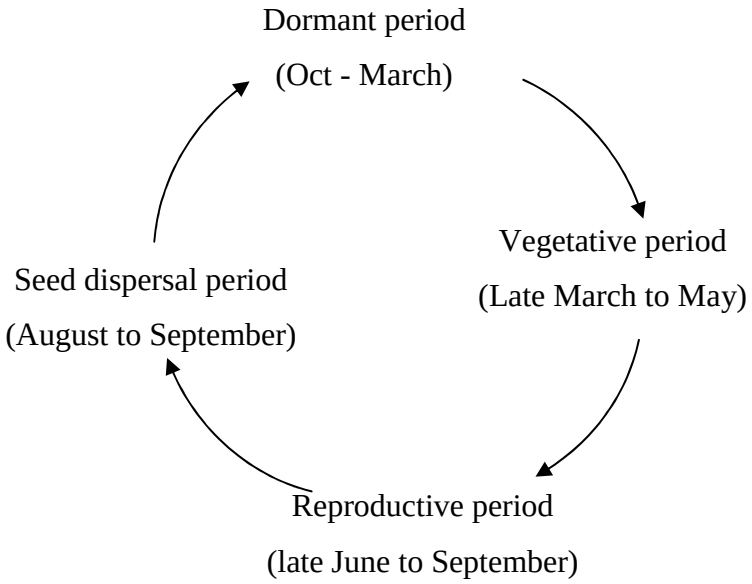


Figure 11 : Life cycle of 'Sugandhawal' plant

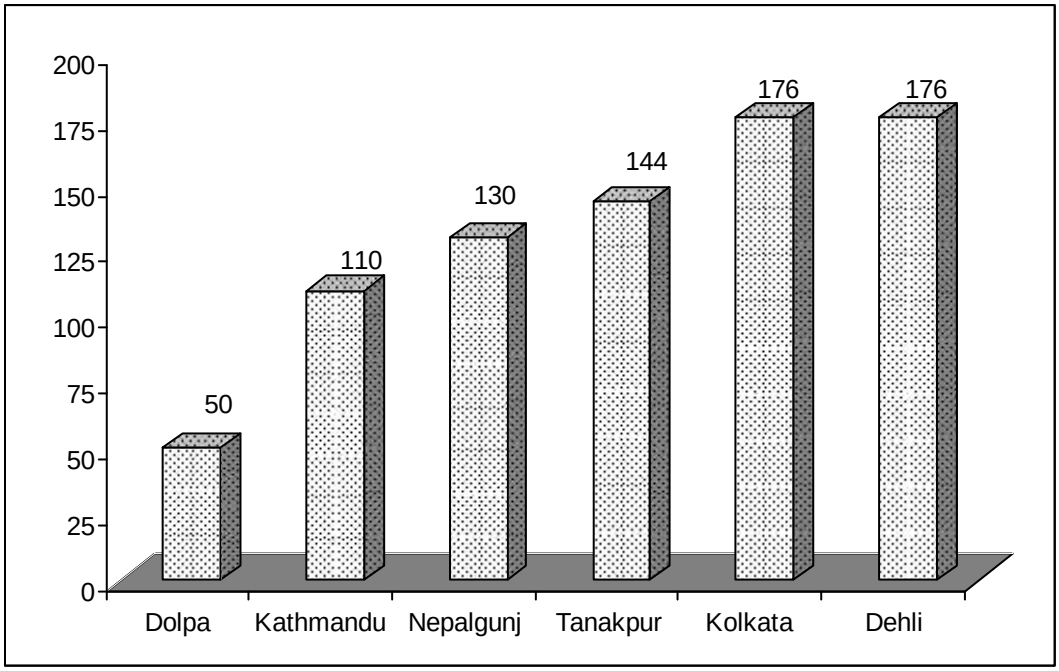
3.3.3 Analysis of Threat Value of 'Sugandhawal'

Table 13: Analysis of threat value of 'Sugandhawal' plant

VDC	Station	Total Sum of Score	Mean	Interpretation
Pahada	Devkotabara	9		
	Racchapani	10		
	Rawatbara	9	8.67	Highly threatened
	Bajabari	7		
	Likhudhunga	9		
	Pahenlekhola	8		
Phoksundo	Sungtung	5		
	Chunuwar	5		
	Amchis Hospital	5		
	Rachi	6	5.50	Negligibly threatened
	Kunasa	5		
	Chhepka	7		
Tripurakot	Karelikanda	8		
	Temple area	9		
	Tripukotgaun	10	9.33	Highly threatened
	Ralli	9		
	Maddu	10		
	Ruma	10		

3.3.4 Trade and Market Channel

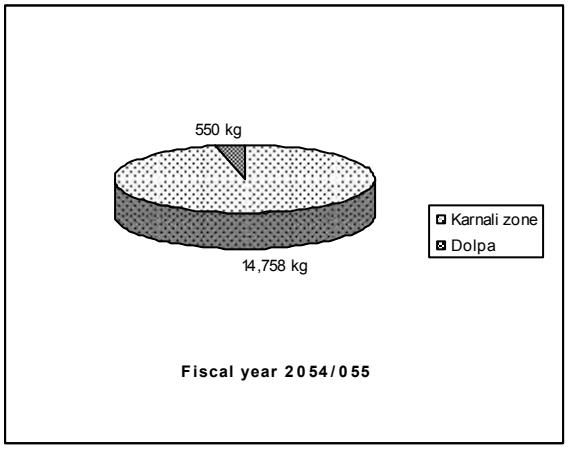
The trade of 'Sugandhawal' extends from Nepal to India as well as other overseas countries. The oil price varies from NRs.15,000 to 20,000 per kg. An average of 100 tons of 'Sugandhawal' is exported from the country legally after collecting and processing inside the country (NEPHA, 2005). The main commercial centers of 'Sugandhawal' in Nepal are Kathmandu, Dang, Krishnanagar and Nepalgunj. The market price of 'Sugandhawal' resource varies from place to place which is presented in fig. 12.

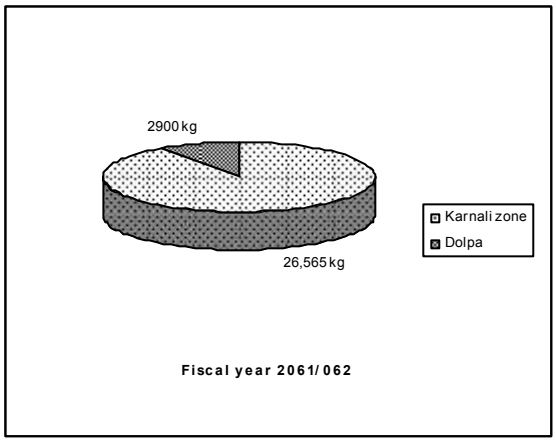


Source: ANSAB (April, 2007)

Figure 12 : The price of 'Sugandhawal' in different markets

The government royalty for 'Sugandhawal' was NRs 15/kg. The amounts of trade of 'Sugandhawal' rhizome from Karnali zone and Dolpa district are presented in fig.13.





Source: DFO, Dolpa. *Source: DFO, Dolpa.*

Figure 13 : The amount of trade of 'Sugandhawal' from Karnali zone and Dolpa district

Table 14: The amount of trade of 'Sugandhawal' based on DFO's records and trader's information

Amount (kg) based on DFO's records		Amount (kg) based on trader's information	
1997/98	1998/99	1997/98	1998/99
550	1465	17075	2600

1. HMGN, 1999 DFO, Dunai
2. Traders information based on EFEA (1999 a,b)

Market Channel

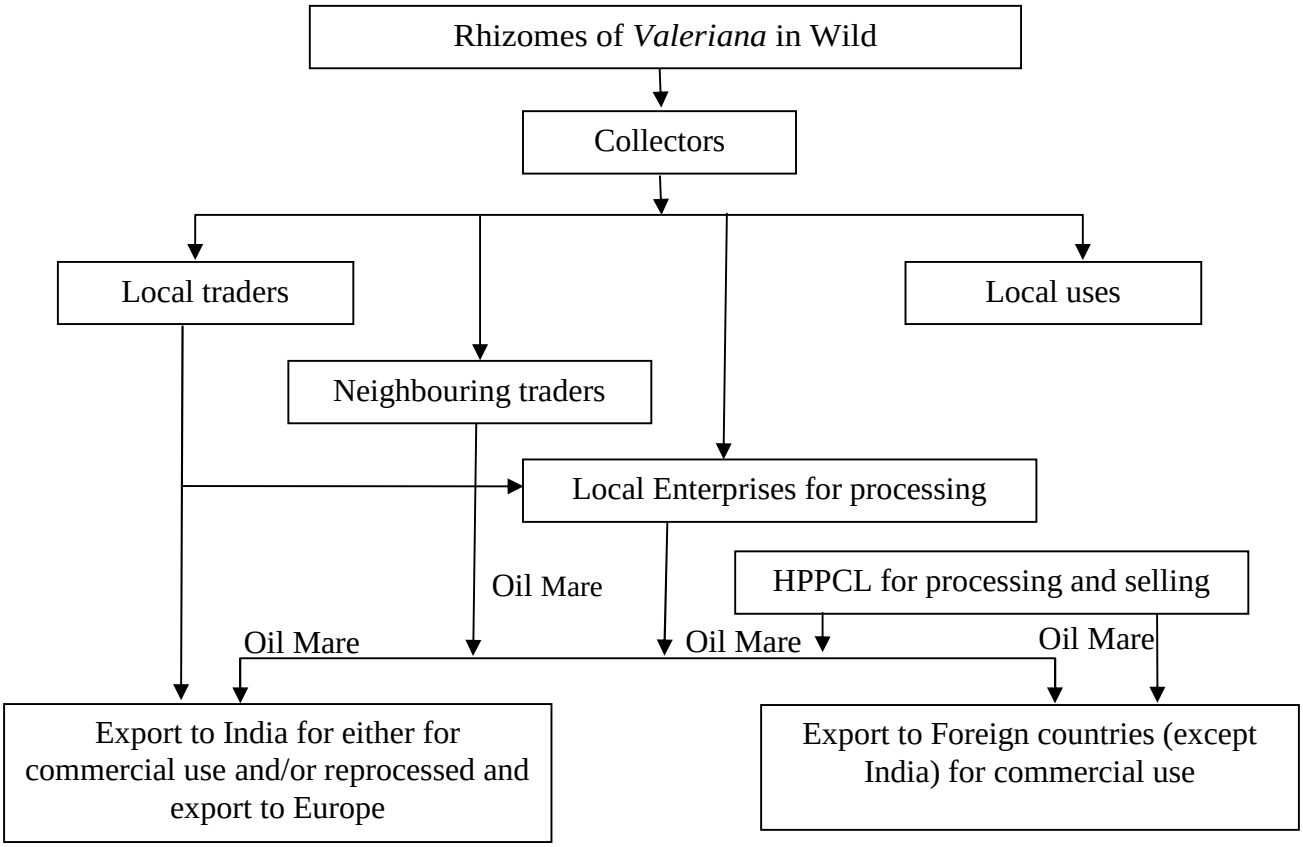


Figure 14 : Market Channel of 'Sugandhawal': Wild collection to the international market

Determinants of income

Determinants of income as suggested by Rodrik and Subarmanian (2003) was found relevant to the context of 'Sugandhawal' as it is originated from rural areas (study area) and is also nature based.

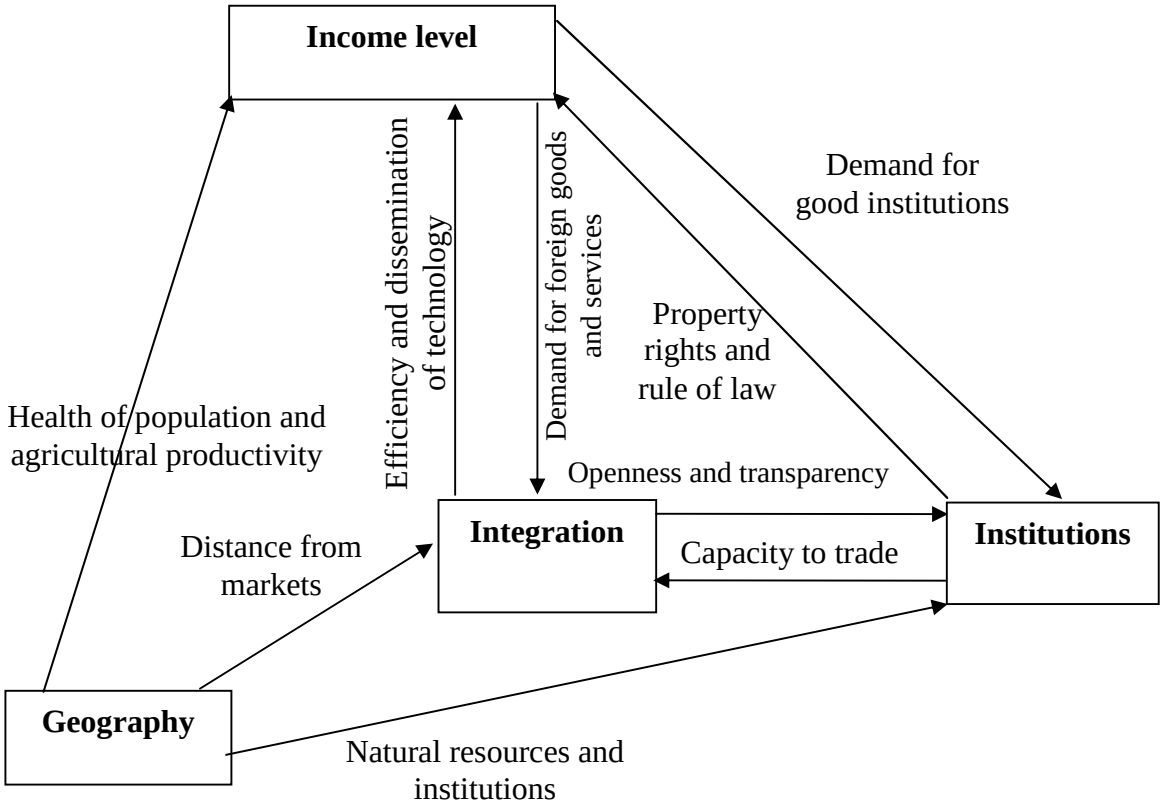


Figure 15 : The Deep determinants' of income, Rodrik and Subramanian (2003)

This plant species has been included as protected species under the category II by government i.e. this plant is banned for export on unprocessed form outside the country without the permission of DPR, Thapathali, and HPPCL, Koteshwor, Kathmandu. Conservation Assessment and Management plan (CAMP) has kept this plant in list of vulnerable plants.

However, this species was also known to be traded illegally from the study area.

Table 15 : Existing selling price of 'Sugandhawal' in study area

S.N.	Status	Price NRs/kg
1	Collectors to primary traders	50
2	Primary traders to secondary traders	70
3	Secondary traders to whole salers*	130

** Whole salers of Nepalgunj*

Information regarding amount of 'Sugandhawal' collection from Dolpa region is very poor. A total of only 10 kg of 'Sugandhawal' was collected from Pahada VDC in 1997/98 (DFO, 1999) and that of 38kg in 1998/99 (DFO, 2000). However as like of that of other MAP, the actual information about the trade of 'Sugandhawal' was very difficult to obtain because only those amount which is traded by permit of DFO was taken into account however the large quantity of resources were traded illegally also due to overburden rules and numerous place of examination of resources. The royalty of the plant was found comparatively higher in accordance with its market price. Hence, many evidences of illegal collection were found to be occurred which had not any records in the DFO office. Potential plant resource available for trade was found far more and some of these were found also hidden in DFO records of traded quantity. Hence, actual figure was found to be obtained only when the data of trade would be collected through the field level.

4. DISCUSSION

4.1 Associated species of 'Sugandhawal'

In three sites of study area, variation in the associated species and their frquency of occurence was observed. This indicates that the 'Sugandhawal' plant doesnot have its specific plant communities itself.

4.2 Ecological variables

'Sugandhawal' plant is rhizome bearing perennial herbs which reproduce through seeds as well as through vegetative means. Ghimire and Aumeeruddy-Thomas (2005) enlisted 'Sugandhawal' in top six species with highest scores of vulnerability in their research of Dolpa region.

The average density and coverage of the 'Sugandhawal' were found significantly ($p \geq 0.01$)varying in all 3 major sites of study area (Table 6). The effect of geophysical setting and ecological factors were found significant to affect growth, distribution and abundance of this plant within study area. The least density and coverage value of this plant in average was obtained for Phoksundo VDC. It might be due to the influence of cool temperate climate with long snow stand in the habitat and low intensity of rainfall and solar radiation in the area. The upper Dolpa (north and northeast part of the district) receives comparatively low annual precipitation (200 - 400mm) than lower part of Dolpa and western periphery of lower Dolpa receives comparatively higher precipitation (700-1000m) of the region (Ghimire, 2005). Average density and cover of 'Sugandhawal' of Pahada and Tripurakot VDCs were obtained higher where warm temperate climate with comparatively higher receive of precipitation and solar radiation were prevailed in majority of the studied sites. In Pahada the condition for flourishing 'Sugandhawal' were met better than Tripurakot as well.

Through soil analysis, it was found that 'Sugandhawal' prefers mild acidic soil of pH value around 6.75±0.48. Comparatively, mean soil pH of 'Sugandhawal' occurring areas of Pahada was found highly acidic than other two sites. Also, in Pahada the total nitrogen content (%), organic matter (%) of the soil were obtained higher in comparison with other (Table 6). All these factors might be responsible for higher density and cover of 'Sugandhawal' in Pahada VDC than

other two. However, a moderate percentage of fine sand+sill+clay were found in soil of Pahada suggesting sandy loam soil would be suitable for growth and abundance of 'Sugandhawal' plant.

All of the variables of the present study were varied significant through the study area as shown by ANOVA (Table 8). It might be governed by a significant variation in geophysical as well as ecological conditions within the study area. Wide altitudinal gradient and variation in topography of the land might be responsible for creating diverse microclimatic regime within study area thereby creating significant variation of habitat for the same plant ('Sugandhawal') as well. Hence, a significant variation was obtained in plant attributes, soil attributes of 'Sugandhawal' occurring region and RRI. Also this plant can acclimate to full sunlight by altering its leaf anatomy (Vats *et al.*, 2002; Pandey and Kushwaha, 2005).

4.3 Estimation of 'Sugandhawal' Resource

Dolpa provide a unique habitat for a number of commercially important and high valued MAPs. Poor people are more dependent upon medicinal and aromatic plants for their health and economy (Olsen and Larsen, 2003). Therefore, the loss of the medicinal and aromatic plant species are directly related to poor rural communities. Although local people have little understanding and almost no say about decisions taken at higher levels, policies in particular as well as lack of opportunities for education and funding directly affects their medicinal plants related activities (Aumeeruddy-Thomas, 2006).

Kurumbang (2003) obtained underground dried biomass of 'Sugandhawal' 97.8kg/ha in his study of Pahada VDC of Dolpa district which is far less than that of our value. He found this plant as the one of the top five traded species of medicinal plants. Larsen (1999) also found the same type of result in her study in Chaudhabise valley, Jumla district.

The average number of individual plants/hectare was found highest in Pahada, followed by Tripurakot and Phoksundo VDC. It might be due to the variation in ecological conditions of these sites. It shows that very cold weather with comparatively longer annual stay of snow on land of higher altitude is less

favorable for this plant species to grow and regenerate. Also, the soil of more xeric nature and nitrogen poor condition was found less supportive for abundance of this plant species. Hence, Pahada and then Tripurakot were found more potential for the higher resource yield of 'Sugandhawal'. The estimated resource yields of 'Sugandhawal' of Pahada and Tripurakot VDC were far higher than that for Phoksundo. In Pahada, the resource yield per hectare of resource yielding land was obtained 2105.17 kg of 'Sugandhawal'. Through the extraction of essential oil also, the resource potentiality of the Pahada was found best among three sites as average oil yield of 'Sugandhawal' for this VDC was estimated 14.8kg/ha. However, oil yield of Tripurakot i.e. 9.6kg/ha is also of optimistic value for the utilization of resource to raise local economy of the area. However, the Phoksundo VDC with a low estimated value of resource yield (i.e. 3.2kg/ha crude essential oil and 671.64kg/ha the dried rhizome) was found less potential for commercial utilization of 'Sugandhawal' for sustainable livelihood of the local people of the area.

Management of 'Sugandhawal' Resource

To conserve medicinal plants, locally its availability, abundance and threats should be concerned. Local health care systems and needs are of vital importance for the balancing use of medicinal plants. There should be national markets for medicinal plants and traditional health care system in national level and laws and regulations should be adequate and appropriate for the conservation of medicinal plants in both national as well as international level. Trade should be fair and the provisions of international certifications and labels should be made in international level for conserving and balancing the use of medicinal plant species (Aumeeruddy-Thomas and Karki, 2005).

The mountain specificities rely on the diversity of species, which often grow in small fragmented and highly diverse habitats, thus demanding a variety of approaches of management. The plant resources are crucial for sustainable livelihood as well as economy of local people of mountain. Modern health care infrastructures are often lacking in mountains and people are confronted to large scale collection for trade of MAPs which may endanger the resource base for local healers. Community based decision-making processes should also be

combined with policy and planning process at the national level to inform macro-level players of the local realities. To address the environmental challenges, both scientific and indigenous knowledge are necessary. An enterprise at Humla in Nepal provides a success story of conserving *Nardostachys jatamansi* and its habitat.

4.4 Analysis of Threat Value

Harvesting of underground plant parts can have important effects on plant population dynamics (Rock *et al.*, 2004). Ghimire and Yumeerudy (2005) in their works of ecological study of *Nardostachys* and *Neopicrorhiza* in Dolpo region found disturbance level progressively decreased with increasing distance from villages in the Bufferzone. In consequence, the density, frequency, cover and biomass of this species were found to be increased significantly with increasing remoteness in the bufferzone sites. However the effect was not found significant as there was no significant commercial collection.

An analysis of threat value of 'Sugandhawal' in different sites of study area suggested that threat to this plant was high due to accessibility, rhizome as the parts used as resource, use of resource by numerous people and the resource entering in global commerce. The highest threat value of it was found at Pahada VDC, followed by Tripurakot and the Phoksundo. The Phoksundo VDC was found fairly cohesive and secure for the sustainability of the resource. Ghimire and Aumeeruddy-Thomas (2005) kept six plant including 'Sugandhawal' under the high vulnerability category with threat scores equal or greater than 25. It might be due to the low commercial use of resource, low resource potential of the area as well as *amchis* participation on conservational use of resource in this VDC. The higher threat value in other two VDCs might be due to high commercial use, accessibility of resource and unwise collection and harvesting pattern of resource in these areas.

Socio-economy related to the plant

Local livelihoods combine agriculture, pastoralism and trans-Himalayan trade in an integrated management system based on communal regulatory system (Baver, 1999). Socio-economically, this plant resource was found to be significantly

important. However, in one hand unscientific exploitation was also found persisting in collection and harvesting of this resource and in other hand, the resource was found inadequately noticed and utilized for subsistence and livelihood purposes as well.

Despite of its accessibility and luxuriance, local people were found more inclined to the collection and trade of high value and rare medicinal plants such as 'Yarsagumba', 'Jatamansi', 'Kutki' etc. Majority of people were found collecting 'Sugandhawal' for commercial purposes and most of the collection of 'Sugandhawal' was found during autumn season which is a good indication of its sustainable utilization. Further study on the conservation status of this species can be recommended, including determining distribution and coverage in existing protected area networks and main threat factors.

Collection and Harvesting

No exact procedure was found adopted by collectors for collection interval. Commercial collectors of 'Sugandhawal' were found less aware in harvesting this plant in a sustainable basis. They were found less selective and more commercial as they were found harvesting more rapidly and broadly irrespective of the sustainability of the plant resources. However, *amchis* were found quite supportive and well aware about the sustainability of the plant while harvesting its resource.

The harvesting techniques used by local people and *amchis* are uprooting, cutting, picking and collecting various parts which are also the common techniques in other parts of the Himalaya (Ghimire *et al.*, 1999). 15-20% portion of total population is left knowingly or unknowningly. Such type of response was also found by Larsen (1999) in Chaudabise valley of Jumla district.

Combination of livestock (generally sheep, goats) farming and MAPs collection was found as a common practice in the study area. People, generally take their herds of sheep goats, horses etc. to the high pasture for about 3-4 months (June - Sept.) and during this period they collect MAPs also. When they return with their herds they also take the collected MAPs to the village and sell. They also collect MAPs including 'Sugandhawal' in their free time i.e. before and after cropping

season. The regular collectors have noticed the phenological stages and habits/habitats of MAPs; and they use to collect must of the MAPs after flowering. For the local use also they consider that the chemical constituent is higher during early winter and regarding the habitat the species found on rocky substratum are more effective than on common forest.

Sometimes the collectors dug out all rhizome of 'Sugandhawal' without leaving even any sign of 'Sugandhawal' there. Such activity has led this plant under a great threat. Lack of proper monitoring has fostered illegal and unsustainable harvesting of high-altitude medicinal plants in the area.

The wide range of variation was observed in the life cycle of 'Sugandhawal' plant. It might be due to variation in microclimate of their habitat. In Pahada and Tripurakot, maturation of plant was found quite earlier than in Phoksundo. The higher amount of solar radiation and precipitation which are found supportive with the growth and maturation of the plant species (Barbour *et al*., 1999).

Numerous constraints were found for the adequate popularization of 'Sugandhawal' trade and utilization of its trade for raising local economy. The government's legislation and unnecessary rules, license system as well as comparatively high royalty of government for its resource were found causal factors for declining interest of the local people on this resource utilization for economic purposes. Marketing channel was also felt uneasy and inappropriate for this resource as the local processing and value adding processes were found lacking for this resource. Preparation of resource was also found more time and labour demanding for which its trade couldn't be found adequately paid for the collectors. Cleaning, processing and packing of the resource was found more time consuming and also significant loss of weight of resource in drying process was experienced. However, other resources like 'Yarsagumba', 'Jatamansi', 'Kutki' etc. were found comparatively more cash yielding though their collection would be more risky and difficult to access. Local people were found avoiding such accessible resource ('Sugandhawal') and found inclined to high value plant resources, due to their poor economy. Hence, despite of entrance of the 'Sugandhawal' resource in global commerce, its adequate popularization and value addition in local level in study area was found lacking and the charm of its

utilization for sustainable livelihood was found decreasing. Lack of international channel for the trade of this resource, fluctuating price, lack of price raising activities etc. were found responsible for the comparatively low and unreasonable price of 'Sugandhawal' resource in the local level including study area. Inadequate relation with collector and trader was also experienced for 'Sugandhawal' trade.

Amount of 'Sugandhawal' collection from study area was also found very poor through the analysis of secondary data related with it. Records of DFO showed the trade of this resource very poor. However, according to local people and based on information collected from field level, actual figure of the 'Sugandhawal' trade was greater than the records. This reflects the unpopularity of government legislation and overburdening systems of licensing to collect resource and examining system of the resource for the name of its conservation.

Trade and Market channel

In general, data derived from local trader interviews have higher validity than that obtained through wholesalers interviews as the former have fewer incentives to underestimate traded amounts (Olsen, 2005).

Dolpa district is not connected by road till now and hence from any of the districts market of MAPs, transportation of MAPs to outside wholesalers is one of the major issue in this area. Though the district is connected by air transportation, it is also quite irregular, weather dependent and comparatively more expensive.

A local enterprise named Ban Udhyam was known to be existed in Tripurakot in the recent past which was used to process some MAPs including 'Sugandhawal' *jatamansi*. Even, this was found not running at the time of this research carried out. The Udhyam used to buy raw materials from local collector as well as trader and used to sell refined oil produced from it to the traders of Juphal and to the wholesalers of Nepalgunj.

Trade in medicinal plants from Nepal is huge and important to a large number of rural collectors. Also, there is considerable scope for improving the trade to the benefit of collectors (Olsen, 1998). Illegal trade was also found occurred. The herders and traders from the adjoining districts invade the park during post

monsoon seasons and harvest medicinal plants from the area. Trade data and household level information keeps prime importance in order to design effective conservation policies. Official trade monitoring should be significantly improved by government.

Indigenous knowledge about plant resource

Communities living in Phoksundo VDC of Dolpa were found managing plant resources far before than the creation of National Park. They were found provided with sound traditional knowledge systems and experiences in managing resources for developing community based management systems of MAPs. The *amchis* of Dolpa region were found key actors in the field of community health care. *Amchis* were found quite helpful for implementing the management of medicinal plants at the level of community. Hence, supporting the profession of *amchis* was also found to be appeared as key issues for sustainable management of medicinal plants in Dolpa region. A good knowledge of ethno-medicinal practices was found still survived in Dolpa. The people of the Pahada and Tripurakot VDC were also found rich in traditional knowledge regarding the use of plant resources.

The use of indigenous knowledge and perception of local resource users was realized very precious for developing management guidelines for the medicinal plants including 'Sugandhawal' and for overall conservation approaches.

Exploring indigenous knowledge of the resource users with the highest level of knowledge is most likely for contributing best management of resource and hence was found of major importance to develop conservation practices. The vast knowledge of the *amchis, dhamis*, local healers as well as local people was realized of very great implications not only for local health care but also for the conservation and sustainable use of the resource as well.

CONCLUSION

- The 'Sugandhawal' plant was found better adopting acidic soil of mild acidity with rich nitrogen (%) and humus content (%) and moderate sandy. Also, good amount of radiation was found better for the abundance of 'Sugandhawal' plant.
- The favourable ecological conditions and geo-physical setting for the high potentiality of resource yield (crude oil as well as dried resource) of 'Sugandhawal' among study area was obtained in Pahada VDC, followed by Tripurakot and then Phoksundo.
- Study area was found as a good center for the collection and trade of 'Sugandhawal'. No standard procedure was found adopted for collecting rotation and season of 'Sugandhawal' collection.
- The commercial practice of harvesting 'Sugandhawal' i.e. usually starting before the seed shedding season and uprooting of all the plants was found harmful to the regeneration of 'Sugandhawal'.
- 'Sugandhawal' was found adjusting easily the prevailed environmental conditions of the soil of Pahada and Tripurakot VDC of Dolpa district.
- Constraints of popularity of 'Sugandhawal' collection, cultivation and use of its resource for raising local economy might be low price of its resource, lack of financial support in its cultivation, insecure market, unnecessarily excess checking of this resource collection and trade by government agencies from collecting spots to country's boundary with India, legitimacy problem of government, time consuming preparation of resource and so on.

RECOMMENDATIONS

- Rotational harvesting system of the resources should be adopted for harvesting this plant resource as its parts used as resource (rhizome) is most important part required for its regeneration.
- The processing of resource should be in local level. Oil extracting machines for 'Sugandhawal' oil should be installed at local level and trade channels should be improved.
- Value adding process should be enhanced for this resource e.g. decreasing royalty, increasing local processing systems proper legislation and policy for resource use.
- Financial and technical support for 'Sugandhawal' cultivation should be provided for its cultivators to initiate modeling of its cultivation. The price should achieve at least more than that of price of agricultural products for its cultivation in agricultural land for commercial purpose.
- The Royalty taken by government for resource use should be invested in the same community from where it is collected and price should be made fixed and reasonable.

REFERENCES

Abbasi, M.K.; M. Zafar and S.R. Khan. 2007. Nutrient Cycling in Agroesystems Journal. **78**(1) : 97 -100.

Acharya, R.P. 2003. *Assessment of Management Options for Economically Important NTFPs A Case Study from mid and High hills of Nepal* post master dissertation in Natural Resource Management: Indian Institute of Forest Management, Neharu Nagar, Bhopal (M.P.).

Adhikari, S.N., K.P. Khanal and A.K. Joshi. 2007. Assessment of Non-Timber Forest Products for the Livelihood of Local People A Study from Bumra Madichaur, Jumla District, Nepal Abstract : *National Seminar on Sustainable Use of Biological Resources* April 22 - 23, 2007, Pokhara, Nepal.

ANSAB, 2007. *Forest Products Market/Enterprise Option Study*. Final Report, Asia Network for Small Scale Agricultural Bioresources (ANSAB), Kathmandu, Nepal.

ANSAB. 1997. *Forest Products Market/Enterprise Option Study*. Final Report, Asia Network for Small Scale Agricultural Bio-resources (ANSAB), Kathmandu, Nepal, pp. 107.

Aumeeruddy-Thomas, Y. 2000. *Concept Showing Interactions Across Local and Global Scales in the HMAPs sector*. Presented at the People and Plants Annual Meeting, WWF-UK, May 2000.

Banerjee, M.L. 1955. Some Edible and Medicinal Plants from East Nepal. *J. Bomb. Nat. Hist. Soc.* **53** : 153 - 155.

Baral, S.R. and P.P. Kurmi. 2006. *A Compendium of Medicinal Plants in Nepal*. Rachana Sharma, Maijubahal, Kathmandu, Nepal.

Barbour, M.G., J.H. Burk, W.D. Pitts, F.S. Gilliam and M.W. Schwartz. 1999. *Terrestrial Plant Ecology*. 3rd ed. California : Benjamin/Cummings, an imprint of Adison Wesley Longman, Inc. 649p.

Bauer, K.M. 1999. *Stewards of the land : Pastoralists and Rangeland Management in Dolpa, West Nepal*. Master's Dissertation submitted to University of California, Berkeley.

Bhattarai, K.R. 2048 B.S. *Medicinal plant: Cultivation and Collection* Gorkha Ayurved Company Pvt. Ltd., Kathmandu, Nepal.

Brochure of *Shey Phoksundo National Park* 2004. Department of National Park and Wildlife Resources, Kathmandu, Nepal.

CAMP, 2001. *Conservation Assessment and Management Prioritization Report*. International Development Research Center (IDRC), Canada/Ministry of Forest and Soil Conservation, HMG, Nepal.

Chapman, J.L. and M.J. Reiss. 1995. *Ecology : Principles and Applications*. Cambridge University Press, p.294.

Chaudhary, R.P. 1998. *Biodiversity in Nepal (Status and Conservation)* S. Devi, Saharanpur, India and Tec press Books, Bangkok, Thailand.

Chhetri, R.B. 2005. *Sacred Himalayan Landscape Nepal : A Socio-Economic Assessment* A Report Submitted to WWF, Nepal, pp. 17-23.

Cunningham, A.B. 2001. *Applied Ethnobotany : People, Wild Plants use and Conservation* A people and plants conservation manual, Chapman and Hall, London.

Das, P.K. 2005. *Status of Non-Timber Forest Products and Policy Initiatives in Nepal*. Synthesis of Seminar on Herbs, Herbal Products and Species, Nepalgunj, CECI, Kathmandu.

Daubeumire, R. 1968. *Plant Communities - A Text Book of Plant Synecology*. Harper and Row, New York, pp.120-123 .

Department of Forest, Ministry of Forest and Soil Conservation. *Hamro Ban* 2006. (ed.) R. Shrestha, Kathmandu, Nepal.

Department of Plant Resource. 2062 B.S. *Kheti Tatha Anusandhan Ko Lagi Prathamikatako Kramma Pareka Jadibutiharuko Janakari*, Thapathali, Kathmandu.

Edwards, D.M. 1996. *Non-Timer Forest Products from Nepal : Aspect of the Trade in Medicinal and Aromatic Plants.* FORESC Monograph 1/96 Forest Research and Survey Center, Babarmahal, Kathmandu, Nepal.

Fansworth, N.R. and D.D. Soejarto. 1991. Global Importance of Medicinal Plants. In : Akerele, O., Heywood, V. and Synge, H. (eds.) *The Conservation of Medicinal Plants*. Cambridge University Press, Cambridge, U.K., pp. 25-51.

Ghimire, S.K. 2005. The Endemic Flora in Dolpa, North-west Nepal : Distribution Patterns, Life Forms, Habitat Specificity and Conservation Status. *Botanica Orientalis*. **5** : 30-39.

Ghimire, S.K. and B.K. Nepal 2006. *Community Based Management of NTFPs in Kanchenjunga Conservation Area: Participatory NTFP Inventory* A Report submitted to WWF Nepal Program.

Ghimire, S.K. and Y. Aummeruddy-Thomas. 2005. Approach to *in-situ* Conservation of Threatened Himalayan medicinal plants: A Case Study from Shey Phoksundo National Park, Dolpa. In : Aumeeruddy-Thomas, Y. Karki, M., Parajuli, D. and Gurung, K. (eds.) *Himalayan Medicinal and Aromatic Plants, Balancing Use and Conservation.* WWF-UNESCO, People and Plant Imitative/WWF Nepal/IDRG, Kathmandu, Nepal, pp. 209 - 234.

Ghimire, S.K., D. Mckey and Aumeeruddy-Thomas. 2005. Conservation of Himalayan Medicinal Plants : Harvesting Patterns and Ecology of Two Threatened Species, *Nardostachys Grandflora* DC and *Neopicrorhiza Scrophulariflora* (Pennell) Hong. *Biological Conservation*. **124** : 463 - 475 .

Ghimire, S.K., D.B. Parajuli, *Amchi* T.N. Gurung, Y.C. Lama and Y. Aumeeruddy-Thomas. 1999a. *Conservation of Plant Resources, Community Development and Training in Applied Ethnobotany at Shey Phoksundo National Park and Its Buffer Zone, Dolpa*. Second Phase WWF/Nepal Program Report Series No. **38** WWF Nepal Program Balwatar, Kathmandu, Nepal.

Ghimire, S.K., K.K., Shrestha, D.B. Parajuli, Y.C. Lama and Y. Aumeeruddy - Thomas. 1999b. Plant Resource Uses and Community Management Practice in Shey Phoksundo National Park, Dolpa, Nepal In : *Proceeding of 3rd National Conference on Science and Technology*, RONAST, Kathmandu, Nepal.

Ghimire, S.K., Y. Aumeeruddy-Thomas, S. Schmitt and P.K. Jha. 2002. Ethnoecology, Participatory Assessment, Botancial Sampling and Stock Assessment for Sustainable Harvest of Plant Resources In : *Ethnobotanical Research : Laboratory and Field Methods* a National Training Workshop Organized by ESON.

Ghimire, S.K., Y.C. Lama, Amchi T.N. Gurung and Y. Aumeeruddy-Thomas. 2000b. *Conservation of Plant Resources, Community Development and Training in Applied Ethnobotany at Shey Phoksundo National Park, Dolpa* 3rd WWF Nepal Program Report Series No. **40** WWF Nepal Program, Kathmandu, Nepal.

Ghimire, S.K., Y.C. Lama, G.R. Tripathi, S. Susanne and Y. Aumeeruddy-Thomas. 2001. *Conservation of Plant Resources, Community Development and Training in Applied Ethnobotany at Shey Phoksundo National Park and Its Bufferzone, Dolpa* Report Series No. **41** WWF Nepal Program and People and Plants Initiative, Kathmandu, Nepal.

Gupta, P.K. 2000. *Method in Environmental Analysis*. Agro Bios, India.

Hara, H. and L.H.J. Williams. 1979. *Enumeration of Flowering Plants of Nepal*. Vol. 2. British Museum (Natural History) London.

Hara, H., A.O. Chater and L.H.J. Williams. 1982. *An Enumeration of flowering plants of Nepal*. Vol. 1. British Museum (Natural History) London.

Hara, H., W.T. Stearn and L.H.J. Williams. 1978. *An Enumeration of Flowering Plants of Nepal*. Vol. 1. British Museum (Natural History) London.

HMG Nepal. 1970. *Medicinal Plants of Nepal*. Department of Medicinal Plants, Thapathali, Kathmandu, Nepal.

HMG Nepal. 1984. *Medicinal Plants of Nepal*. Department of Medicinal Plants, Thapathali, Kathmandu, Nepal.

HMG Nepal. 2002. *Nepal Biodiversity Strategy*. Ministry of Forests and Soil Conservation, Singha Durbar, Kathmandu.

IUCN Nepal. 2000. *National Register of Medicinal Plants*. IUCN- The World Conservation Union, Kathmandu, Nepal.

IUCN. 2004. *National Register of Medicinal and Aromatic Plants* (*Revised and Updated*) IUCN-The World Conservation Union, Kathmandu, Nepal

Jaceb, I. and W. Jacob. 1993. *The Healing Past : Pharmaceuticals in the Biblical and Rabbinic World*. E.J. Brill, Leiden.

Jillaka Gabish Stariya Tathayanka Ra Naxaharu, Dolpa. 2003. A Joint Venture of Oxfam-Nepal, Lalitpur and NLA, Kathmandu.

Joshi, K.K. and S.D. Joshi. 2001. *Genetic Heritage of Medicinal and Aromatic Plants of Nepal Himalayas*. Buddha Academic Publishers and Distributors Pvt. Ltd., Kathmandu, Nepal.

Kala, C.P. 2000. Status and Conservation of Rare and Endangered Medicinal Plants in the Indian Trans-Himalayan. *Biological Conservation*. **93** : 371 - 379.

Kanai, H. 1971. 'Bir Nighantu', A Nepalese Herbal Encylopedia. *J. Jap* **46** : 347 - 377.

Kandel, D.R. 2007. *Vegetation Structure and Regeneration of Sal in Community Managed Sal Forests of Inner Terai, Central Nepal* M.Sc. Dissertation, Central Department of Botany, T.U., Kirtipur, Kathmandu, Nepal.

Koba, H., S. Akiyama, Z. Endo and H. Onba. 1994. *Name List of the Flowering Plants and Gymnosperms of Nepal*. Vol. 1. The University Museum, University of Tokya, Japan.

Kunwar, R.M. 2006. *Non Timber Forest Products of Nepal,* International Tropical Timber Organization (ITTO), Japan and Centre for Biological Conservation (CBC), Nepal, pp. 446 - 157.

Kunwar, R.M. and N. P.S. Duwadee. 2006. Medicinal and Aromatic Plants in West Nepal In : *Environment and Plants : Glimpses of Research in South Asia*.

(eds.) P.K. Jha, R.P. Chaudharya, S.B. Karmacharya and V. Prasad, Ecological Society (Ecos), Kathmandu, pp. 194 - 202.

Kunwar, R.M.; Y. Upreti, C. Burlakoti and C.L. Chaudhary. 2007. Indigenous use and Ethnopharmacology of Medicinal Plants of Far-west Nepal. Abstract : National Seminar on Sustainable Use of Biological Resources April 22 - 23, 2007, Pokhara, Nepal.

Kurumbang, N.P. 2003. *Ecological Study, Harvesting and Trade of Some Medicinal Plants in Shey Phoksundo National Park and It's Buffere Zone, Dolpa, Nepal* M.Sc. Dissertation, Central Department of Botany, Kirtipur, Kathmandu.

Lama, Y.C. and Y.A. Thomas. 2002. High Attitude Himalayan Medicinal Plants Conservation : Linkages with Health Care Development and Trade in Shey Phoksundo National Park, Dolpa, Nepal In: *Himalayan Medicinal and Aromatic Plants, Balancing Use and Conservation* (eds.) Aumeeruddy-Thomas, Y., M. Karki, K. Gurung and D. Parajuli MOFSC with support of WWF Nepal. pp.362-377.

Lama, Y.C., S.K. Ghimire and Y. Aumeeruddy-Thomas in Collaboration with the Amchis of Dolpa. 2001. *Medicinal Plants of Dolpa, Amchis Knowledge and Conservation* People and Plant initiatives, WWF Nepal Program, Kathmandu, Nepal, p. 150.

Larsen, H.O. 1999. *Commercial collection of Nardostachys grandiflora DC in Chaudabise Valley, Jumla, Nepal : Local Management Systems and Sustainability*. M.Sc. Dissertation Submitted to Unit of Forestry Department of Economics and Natural Resources, Royal Veterinary and Agricultural University, Denmark.

Larsen, H.O. 2005. Impact of Replanting on Regeneration of the Medicinal Plant Nadostachys grandflora DC. (Valerianaceae). *Economic Botany*. **59** (3) : 213 - 220.

Malla, S.B. and P.R. Shakya. 1984. Medicinal Plants In : Majupuria, T.C. (eds.) *Nepal Nature's Paradise*. White Lotus Co. Ltd., Bangkok, Thailand, pp. 261- 297.

Malla, S.B., Shrestha, A.B., Rajbhandari, S.B., Shrestha, T.B., Adhikari, P.M. and Adhikari, S.R. 1976. *Flora of Langtang and Cross Section Vegetation Survey*

(Central Zone). Bull., Dept. Med. Plants Nepal No. 6 Department of Medicinal Plants, Thapathali, Kathmandu, Nepal.

Manandhar, N.P. 2001. Ethnobotanical Studies in Nepal-Conservation of Economically Important Plants by Rural People In, Jain S.K. (ed.) *Ethnobiology in Human Welfare*. Deep Publications, India.

Martin, G.J. 1995. *Ethnobotany : A Methods Manual*: A People and Plants Conservation Manual, Chapman and Hall, London, U.K.

Medicinal Plants of Nepal (Revised) (eds.) Adhikari, M.K., D.M. Shakya, M. Kayastha, S.R. Baral and M.N. Subedi. *Bulletin of the Department of Plant Resources*. No. 28 Government of Nepal, Ministry of Forest and Soil Conservation, Department of Plant Resources, Thapathali, Kathmandu, Nepal

Nepal, B.K. and P.P. Sapkota. 2005. Resource Analysis and Indigenous Knowledge on Plants Use : A Case Study of Humla District, Nepal In : *Nepal Journal of Plant Sciences*. Vol. 1, Nepal Botanical Society, Kathmandu, Nepal.

Niraula, R. and H.K. Saiju. 2002. Micropropagation of *Valeriana jatamansi* Jones In : *Proceedings of Nepal-Japan Joint Symposium on Conservation and Utiliation of Himalayan Medicinal Resources (eds).* Watanabe, T.; A. Takano, M.S. Bista and H.K. Saiju, pp. 235-236.

Oke, T.R. 1984. *Bounary Layer Climates*. Metheun & Company, New York, pp.339 - 348.

Oli, B. R. and B.K. Nepal. 2003. *NTFPs from Kanchenjunga Conservation Area : Aspects of Trade and Market Opportunities* A Report Submitted to WWF, Nepal Programme.

Olsen, C.S. 1998. The Trade in Medicinal and Aromatic Plants from Central Nepal to Northern India. *Economic Botany*. **52** : 279 - 292 .

Olsen, C.S. 2005c. Trade and Conservation of Himalayan Medicinal Plants. *Nardostachys grandiflora* DC and *Neopicrorhiza scrophulariiflora* (Pennel) Hong. *Biological Conservation*. **125** : 505 - 514.

Olsen, C.S. and F. Helles. 1997. Medicinal Plants, Markets and Margins in the Nepal Himalaya : Trouble in Paradise. *Mountain Research and Development.* **17**(4) : 363-374.

Olsen, C.S. and H.O. Larsen. 2003. Alpine Medicinal Plant Trade and Himalayan Mountain Livelihood Strategies. *The Geographical Journal*. **169**(3): 243- 254.

Pant, B., S. Devkota and Y. Nepal. 2005. Micropropagation of 'Sugandhawal': *Nepal Journal of Plant sciences.* **1** : 69-73.

Paudel, D.R. 2003. *Survey and Mapping of Chiraito (Swertia Chiraita) in Kanchanjunga Conservation Area*. Report Submitted to WWF Nepal Program.

Pokharel, B.R. 2007. *Study on Essential oil of Valeriana jatamansi* Jones. M.Sc. Thesis, Central Department of Botany, Tribhuvan University, Kirtipur, Kathamndu, Nepal

Poluin, O. and A. Stainton. 1987. *Flowers of the Himalaya*. Oxford University Press, New Delhi.

Press, J.R., Shrestha, K.K. and Sutton, D.A. 2000. *Annotated Checklist of the Flowering Plants of Nepal*. The Natural History Museum, London.

Rastogi, A. 1999. *Method in Applied Ethnobotony Lessons from the Field*, ICIMOD- International Centre for Integrated Mountain Development, Kathmandu, Nepal.

Rawal, R.B. 2004. Marketing Nepal's Non-Timer Forest Products Challenges and Opportunities. In : Bhattari, N.K. and Karki, M. (eds.) *Local Experience Based National Strategy for Organic Production and Management of MAPs/NTFPs in Nepal*. HMG Nepal, MAPPA/IDRC, New Delhi and CCO, Kathmandu, pp.150-164.

Rawal, R.B., B. Bhatta and A. Paudyal. 1999. *NTFPs: Production, Collection and Trade in Mid-western, Nepal*; Ban Udyan BSB/New Era and Jadibuti Association of Nepal.

Rawat, M.B. 2061 B.S. Sughandhawal Cultivation in Jumla District, Nepal: Problems and Prospects *Kalpabrikshya*. **15** (162): 20-23.

Regmi, S and S. Bista. 2002. Wise Practices in Collection and Cultivation of Medicinal Plants for Sustainable Livelihoods in Himalayan Communities In: Aumeeruddy-Thomas, Y.A; M. Karki; K. Gurung and D. Parajuli (eds.) *Himalayan Medicinal and Aromatic Plants, Balancing Use and Conservation* Ministry of Forest and Soil Conservation and World Wide Fund for Nature, Nepal Program, pp. 152 - 173.

Rijal, D.P. 2007. *Plant Diversity and Environmental Justice of Resource Use in Upper Manang (Central Himalaya)* M. Sc. Dissertation, Central Department of Botany, T.U., Kirtipur, Kathmandu, Nepal.

Rock, J.H., B. Beckage and L.J. Gross. 2004. Population Recovery Following Differential Harvesting of *Allium tricoccum* Ait. in the Southern Appalachians. *Biological Conservation*. **116** : 227 - 234.

Rodrik, D. and Subramanian, A. 2003. The Primacy of Institutions and What This Does and Does not Mean. *Finance and Development*. **40** (2) : 31 - 34.

Rokaya, M.B. 2002. *Ethnoecology of Medicinal Plants in Dho-Tarap Area in Buffer Zone of Shey Phoksundo National Park, Dolpa, Nepal* M. Sc. Dissertation, Central Department of Botany, T.U., Kirtipur, Kathmandu, Nepal.

Shahi, D.P. 2005. Trade Systems and Feasibility of Cultivation/Domestication of MAPs in the Southern Bufferzone of Shey Phoksundo National Park, Dolpa In: Aumeeruddy-Thomas, Y.A; M. Karki; K. Gurung and D. Parajuli (eds.) *Himalayan Medicinal and Aromatic Plants, Balancing Use and Conservation* Ministry of Forest and Soil Conservation and World Wide Fund for Nature, Nepal Program, pp. 506 - 510.

Shakya, K. 1991. *Dolpa : The Hidden Paradise, A Journey to the Endangered Sanctuary of the Himalayan Kingdom of Nepal*. Nirala Publications, Jaipur, New Delhi.

Sharma, B.N. 2060 B.S. Sugandhawal Kheti *Kalpabrikshya*. **14** (150): 8-10.

Sharma, U.R. and P.K. Das. 2004. Reviewing Current Issues and Prospects of Non-Timber Forest Product (NTFPs) Sub-sector Development in Nepal. In : Bhattarai, N. and M. Karki. (eds.) *Local Experience Based National Strategy for*

Organic Production and Management of MAPs/NTFPs in Nepal. Proceedings of the National Workshop held at Kathmandu, Nepal, 27-28 February 2004. HMG Nepal, MAPPA/ IDRC, New Delhi and CCO, Kathmandu, pp. 87 - 96 .

Sharma, U.R., K.J. Malla and R.K. Uprety. 2005. Conservation and Management Efforts of Medicinal and Aromatic Plants in Nepal. *Banko Jankari*. **14** (2) : 3 - 11.

Sherpa, S. 2000. *The High Altitude Ethnobotany of the Walung People of Walangchung Gola VDC, Kanchenjunga Conservation Area, East Nepal* M. Sc. Dissertation, Central Department of Botany, T.U., Kirtipur, Kathmandu, Nepal.

Shey Phoksundo National Park and Buffer Zone : Baseline Study Report Published by WWF, Nepal Program.

Shey Phoksundo Rastriya Nikunj, Dolpa Ma Jadibuti Bebasthapan Tatha Swasthaya Sudhar. 2057 B.S. People and Plants Programme, WWF Nepal.

Shrestha, K.K. and S.K. Ghimire. 1996. *Diversity, Ethnobotany and Conservation Strategy of Some Potential Medicinal and Aromatic Plants of Taplejung* A Report Submitted to ANSAB, Kathmandu, Nepal.

Shrestha, K.K., N.N. Tiwari and S.K. Ghimire. 2000. MAPDON- Medicinal and Aromatic Plant Database of Nepal. In : Watanabe, T. (ed.), *Plants, Can They Save Us* ? Department of Plant Resources, HMG Nepal and Society for the Conservation and Development of Himalayan Medicinal Resources (SCDHMR) Japan, pp. 53 - 74.

Shrestha, K.K., S.K. Ghimire, T.N. Gurung, Y.C. Lama and Y. Aumeeruddy-Thomas. 1998. *Conservation of Plant Resources Community Development and Training in Applied Ethnobotany at Shey Phoksundo National Park and its Buffer Zone, Dolpa*. WWF Nepal Program, Report Series No. 33, WWF Nepal Program , Kathmandu.

Shrestha, N. 2007. *Assessment of Threatened Medicinal Plants in Langtang National Park, Central Nepal* M. Sc. Dissertation, Central Department of Botany, T.U., Kirtipur, Kathmandu, Nepal.

Shrestha, T.B. and R.M. Joshi. 1996. *Rare, Endemic and Endangered Plants of Nepal*. WWF Nepal Program, Kathmandu, Nepal.

Shrestha, U.B. 2003. Cultivation of Medicinal and Aromatic Plants (MAPs): Tools for Biodiversity Conservation. Annual Issue of *Botanica Orientalis* **3**(1) : 29-32.

Singh, N.; A.P. Gupta, B. Singh and V.K. Kaul. 2006. Quantification of Valerenic Acid in 'Sugandhawal' and *V. officinalis* by HPTLC *Chromatographia*. **63**(3-4) : 209 - 213.

Thapa, Y.B. 2060 B.S. Sugandhawal *Kalpabrikshya*. **14** (145):10-12.

The Herbarium Handbook. 1992 (eds.) Forman, L. and Bridson D. Royal Botanic Gardens, Kew.

Thomas, Y.A. and M. Karki. 2002. Himalayan Medicinal and Aromatic Plants; Perspectives for Balancing Use and Conservation In: *Himalayan Medicinal and Aromatic Plants*. Balancing Use and Conservation (eds.). Thoma, Y.A, M. Karki, K. Gurung and D. Parajuli MOFSC with Support of WWF Nepal. pp. 2-36.

Ukyab, T. and S. Adhikari. 2000. *The Nationalities of Nepal* His Majesty's Government of Nepal, Ministry of Local Development, National Committee for Development of Nationalities, Kathmandu, Nepal, pp.69.

Vats, S.K.; S. Pandey and P.K. Nagar. 2002. Photosynthetic Response to Irradiance in 'Sugandhawal', a Threaterned Understory Medicinal Herb of Western Himalaya. *Photosynthetica*. **40**(4) : 625- 628.

Watanabe, T., K.R. Rajbhandari, K.J. Malla and S. Yahara. 2005. *A Handbook of Medicinal Plants of Nepal.* AZURISEED, Life Environment Institute, Kamagawa, Japan.

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

Appendix 1

Ecological informations (for major plots only)

Date: ..... Q. No..... Q. Size .....

Habitat type : ..... VDC ..... Ward .....

Village name : .....

Lat ..... N, long ..... E Alt .....

Aspect ..... Slope .....

Forest type .....

Disturbed or not ..... If disturbed (trampling/grazing/ human disturbance or .....)

Distance from nearest village .....

Characters of Valeriana jatamansii plants (in each subplot)

Number of Valeriana : ..... Cover of Valeriana : .....

Tree canopy cover ..... Colour of soil sample collected : .....

Appendix 2

S.N.	Name of Sp.	Q_1					Q_2					Q_3					Q_4					Q_5					Q_6					Q_7					Q_8					Q_9					Q_{10}				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E

Appendix 3

Questionnaires to trader

Trader's name: Address:

1. What are NTFPs traded and its amount?

(In order of value) _____

NTFPs name	Parts in trade	Amount traded in last year	Rate of Purchasing	Rate of selling	Remarks

2. What are the catchments areas / Where do you get 'Sughandhawal'?
3. How do you get Sugandhawal? Yourself or through village trade or collectors?
4. Value adding process, if any?
5. How long do you store the products? Where?
6. Where do you sell it?
7. Who determines the price?
8. Factors responsible for the fluctuation of price?
9. What is the actual demand? Is the demand fulfilled or not?
10. From which sector is the demand?
    i) Pharmaceutical company ii) Herbal industries
    iii) Others (specify)
11. Any barrier in trading?
12. If yes, what is its impact on trade and royalty payment?
13. What could be done to reduce the current barriers?
14. How many foreigners annually come to harvest MAPs? From which country?
15. Which species do they mostly harvest?
16. How can the species be conserved sustainably?
17. What are the MAPs from which you make good income?

Appendix 4
Questionnaire for collectors:

1. Types and amount of species harvested (in terms of preference)

Local name	Past used	Amount of trade (kg)	Rate (Rs./kg)	Use purpose	Method of harvesting

2. Whom do you sell?
3. Where do it go (places of selling)?
4. Distribution (where) and availability/abundance of it?
5. Who is involved? (Division of labour among HH members)
6. Share of contribution (%) from sale of MAPs to HH economy?
7. What are the value addition process being made before their sale?
8. Income distribution among collectors and different level f traders.
9. Where do you go to collect (Private or government land)?
10. What are the regulatory barriers in transporting/selling materials.
11. Where do you store your materials before selling?
    i) modern ware house ii) Warehouse iii) Rough shed
12. What is the quantity and quality of loss in storage?
13. Which products are easy to collect and which are dificult? Why?
14. How long do these MAPs take during collection?
15. In your opinion what should be done to make the situation favourable to conserve and process the resource? How?
16. In your opinion, How the plant can be conserved?
17. Who are involved in the plant collection?
    - All the users can collect
    - Only Primary users
    - Distant people also
    - Interested people to whom the area/time is efficient
    - Foreigners
18. What types of NTFPs based industries are present in the area?
19. If not at present, what types of NTFPs based cotage industries have more potentialities in future?
20. Are you satisfied with the present management system? Yes or No? Why?
21. Do you want to cultivate the plant on your private land?
22. Are you sure that the plant may help to uplift the economic level ? How?
23. Who are more responsible to destroy/deplete the plant?
24. Trend of amount harvested since 5 years back? Decreasing or increasing? Why?
25. Do you follow conservation practices, if yes how? If no, what can be done?
26. Relationship between collectors and traders?
27. How do you sell the MAPs - Directly or indirectly why?

Appendix 5

Key persons interviewed

A. Dunai/Suligadh

1. Oli, Om Bahadur (ranger, DFO, Dunai)
2. Neupane, Man Datta (Asst. Warden, SPNP headquarter, Suligadh)

B. Phoksundo

1. Shree Lama (Head *Amchi, Amchi* Hospital, Phoksundo)
2. Norbu Lama (Asst. Amchi, *Amchi* Hospital, Phoksundo)
3. Ram Pd. Mahat (Teacher, Phoksundo)
4. Ujjal Dev Rawal (Teacher, Ringmo Village, Phoksundo)

C. Raha

1. Laxmi Man Karki (President, Devi BGUG, Raha)
2. Dharma Nepali (Local People, Raha Village)

D. Tripurakot

1. Dil Bahadur Bista (President, Tripurasundari BZUG, Tripurakot)
2. Nayananda Devkota (local People, Tripurakot)
3. Bishnu Rudra Upadhaya (Chief Priest, Tripurasundari Temple)
4. Kul Bdr. Khadka (Police, Tripurakot Police station)
5. Tirtha Bdr. Bista (Local People, Tripurakot)
6. Janak Bahadur Budha (Local People)
7. Bishnu Budha (Local Women)
8. Man Laxmi Thapa (local Women)
9. Laxmi Kathayat (Local Women)

E. Pahada

1. Bhairab Shahi (President, Tritha BZUG, Pahada)
2. Dil Bdr. Shahi (Local People, Pahada)
3. Hira Singh Rawal (trader of 'Samayo', Pahada)
4. Ujjal Rawal (Student, Pahada)

F. Karelikanda, Tripurakot

1. Sukh Bahadur Lama (Local People)
2. Karma Lama (Local People)

G. Rama, Tripurakot

1. Man Bahadur Budha (Local People, teacher, cultivator of Sugandhawal)
2. Biswa Bdr. Rokaya (Local People)
3. Bhim Bdr. Thapa (Local People)
4. Kabi Ram Thapa (Local People)