SWERTIA CHIRAYITA: A LIVELIHOOD OPTION, A CASE STUDY FROM MAIPOKHARI VDC, ILLAM, NEPAL

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LETTER OF RECOMMENDATION

This is to certify that **Ms. MERINA KHADKA** has completed this dissertation work entitled **"*SWERTIA CHIRAYITA*: A LIVELIHOOD OPTION, A CASE STUDY FROM MAIPOKHARI VDC, ILLAM, NEPAL"** for the partial fulfillment of the requirement for the completion of her Master's Degree in Environmental Science and she has completed the excellent work under my supervision and guidance. To my knowledge, this research reflects the researcher's own effort and has not been submitted for any other degree, anywhere else. I therefore recommend the dissertation for acceptance and approval.

_____

Dr. Krishna Prasad Oli

Supervisor

Regional Coordinator, ABS-EH

Biodiversity Conservation and Management

ICIMOD, Khumaltar, Lalitpur

TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF ENVIRONMENTAL SCIENCE

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LETTER OF APPROVAL

This is to certify that the dissertation entitled **"*SWERTIA CHIRAYITA*: A LIVELIHOOD OPTION, A CASE STUDY FROM MAIPOKHARI VDC, ILLAM, NEPAL"** prepared by Ms. Merina Khadka has been approved and accepted as a partial fulfillment of the requirements of Master's Degree in Environmental Science, Tribhuvan University

Evaluation Committee:

……

Dr. Kedar Rijal
Central Department of
Environmental Science, TU,
Kirtipur, Kathmandu, Nepal
Head of Department

……

Dr. Krishna Prasad Oli
Regional Coordinator, ABS-EH
Biodiversity Conservation and Management
ICIMOD, Khumaltar, Lalitpur
Thesis Supervisor

……

Mr. Suman Aryal
Central Department of
Environmental Science, TU,
Kirtipur, Kathmandu, Nepal
Internal Examiner

……

Prof. Dr. Ram Prasad Chaudhary
Central Department of Botany
TU, Kirtipur, Kathmandu, Nepal
External Examiner

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Merina Khadka
Central Department of Environmental Science
Tribhuvan University
Kirtipur, Kathmandu.

ABSTRACT

Swertia chirayita is one of the important MAPs of Nepal. It is a multipurpose medicinal plant categorized as vulnerable category of IUCN. *S.chirayita* favors northeast and northwest facing slopes, sandy soil enriched with organic matter and humus with pH 4.7-5.5 (acidic soil). A study was carried out in Maipokhari areas of Illam district in the Eastern Nepal where chirayito cultivation is common between 1800 to 2220masl.

Questionnaire survey was carried out to generate the primary data and literatures were reviewed to get secondary data. Stratified sampling was undertaken for the ecological study of *S.chirayita*. Soil parameters and bitter principle test were analyzed in the laboratory.

Cultivated *S. chirayita* showed high density and high productivity too. Very scanty distribution of chirayito was observed in community forest especially at 1800m altitude due to unavailability of sufficient space to grow chirayito. The density as well as production of *S.chirayita* has been increased with increasing altitude. Bitter principle test showed the high value in chirayito collected from wild than cultivated site which is accordance to the value suggested in Pharmacopoeia of India (1982). However, student's t-test showed no significance difference in bitter principle between wild and cultivated chirayito. Mostly positive correlation was observed between soil parameters and bitter principle. This implies that with increase in soil parameters values (nitrate, phosphorous, potassium, percentage organic matter, percentage nitrogen); the bitterness of chirayito also increases. Thus in wild stage, the value of soil parameters is high as compared to cultivated sites so yield high bitterness too.

Almost all respondents cultivated chirayito in their private land. Over ninety percent of the local people are satisfied from the income generated through the trade of chirayito which they used for household expenditures (such as buy foods, medical expenses etc). This has improved their livelihood. Mostly all the people were satisfied from the prevailing price and they are planning to increase chirayito cultivation in their private land. Market survey showed no adulteration on chirayito during trade. Generally royalty/tax system does not exist for chirayito harvested from the private/cultivated land. However, farmers have to pay it to the traders indirectly and thus are getting lower price than the actual market price. There has been big price difference between harvesters and wholesalers. Cultivation on the private land showed higher income than harvesting from wild. It is because more amount of chirayito was harvested from the private land and traded too. Mainly legal trade network was observed

from the study area. The trade of NTFPs mainly chirayito towards Silugadi (India) is reported.

MAPs cultivation in the study area mainly includes Chirayito (*S. chirayita*), Lokta (Daphne bholua), Ok Aalu (Lilium nepalenises) in which chirayito showed high production (5587kg/bulb/plant) which was exported from the study area. Chirayito cultivation was carried out by uniformly showing seeds on the ploughed land. However, slash and burn method is also applied especially in the private forest. Harvesting of chirayito only after the seeds get mature and fall to the ground is highly recommended. Formation of NTFPs-based enterprises, Herbal processing units and market co-operatives should be initiated by the concerned organizations and stakeholders so that *S.chirayita* will be a better livelihood option in the study area.

Key words*: Bitterness, cultivation, Livelihood, MAPs, soil, Swertia chirayita, trade*

ABBREVIATIONS AND ACRONYMS

ANSAB	Asian Network for Small Scale agriculture and Bio-resources
CBS	Central Bureau of Statistics
CF	Community Forest
CFUGs	Community Forest User Groups
CSIR	Council of Scientific and Industrial Research
DFO	District Forest Office
DPR	Department of Plant Resources
Ha	hectare
HKH	Hindu Kush-Himalayan
ICIMOD	International Center for Integrated Mountain Development
IUCN	The World Conservation Union
KCAP	Kanchenjunga Conservation Area Project
MAPPA	Medicinal and Aromatic Plants Programme in Asia
MAPs	Medicinal and Aromatic Plants
MFSC	Ministry of Forests and Soil Conservation
NBS	Nepal Biodiversity Strategy
NEPAP	Nepal Environment Policy and Action Plan
NPC	Nepal Planning Commission
NTFPs	Non-Timber Forest Products
SADP	Special Area Development Program
SHAHGPI	Shree High Altitude Herbal Growers and Preservation Institute
VDC	Village Development Committee
WWF-NP	World Wide Fund for Nature – Nepal Programme
TMI	The Mountain Institute
USD	United States Dollar

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CHAPTER-1

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Nepal has a natural gift of over 7000 species of higher plants out of which, over 700 species are medicinal herbs (GoN/IUCN, 1988; EFEA, 1999; Parajuli and Luitel, 2004) including about 250 species are endemic to the country. About 1624 species are of ethno botanical importance and 100 of them are commercially important for trade and marketing (Bhattacharya et al, 2003). About 90% of NTFPs are exported to India in raw form. Amala (*Imclica officinalis*). Chirayito (*Swertia chirayita)*. Tejpat (*Cinnamomum tamala*), Guchhi chyau (*Morchella esculenta*), Jatamasi (*Nardostachys grandiflora)*, Jhyau (*Parmelia nepalensis*), kutki (*Picrorhiza kurroa*), Pipla (*Exbucklandia populnea*), Ritha (*Sapindus emarginatus*), Sughandhawal *(Valeriana jatamansi)*. Sughandha kokila (*Cinnamomum glaucescens*) and Timur (*Zanthophylum alatum*) are the major MAPs in such trade to India (Poudel, 2007). Those are especially Medicinal and Aromatic Plants (MAPs). Among these, 12 MAPs are prioritized for cultivation and researches (MFSC, 2004). The Himalayas and high mountains are store of very high valued medicinal plants. In addition, it has been proven that not only the high mountain range of Nepal but also the middle hills and lowlands are endowed with many high valued medicinal plants (Malla, 1994). More than 75% Nepalese people still depend on the herbal plants as a local source of medicine for their primary health care (Karki 2000, Dutta and Devkota 2001). There are many endemic species and some are on the verge of extinction too. On the other hand, some species have been cultivated and is contributing to the national and local economy. The financial contribution made by NTFPs, especially medicinal plants, is much higher than the timber products (Karki, 2000).

MAPs are an important part of the Nepalese economy, and are exported to India, Hong Kong, Singapore, Japan, as well as France, Germany, Switzerland, Netherlands, the USA, and Canada. These plants have a potential for contributing to the local economy, subsistence health needs, and improved natural resource management, leading to the conservation of ecosystem and biodiversity of an area (Subedi, 1997). Nepal's ethnic diversity is also remarkable; so are the traditional medicinal practices. About 85% of total population inhabits in rural areas and many of them rely on traditional medicines, mostly prepared from plants for health care (GoN, 2002). The

majority of Nepal's population, especially the poor, tribal and ethnic groups, and mountain people, relies on traditional medical practices. A large number of products for such medical practices are derived from plants. The knowledge of such medical practices has been developed and tested through generations. In many cases this knowledge is transmitted orally from generation to generation and confined to certain people (Subedi, 2000).

MAPs have been important resources from human health care from prehistoric times to the present day. According to the World Health Organization (WHO), the majority of the world's human population especially in developing countries depends on traditional medicine based on MAPs. NTFPs, much more than timber, contribute in important ways to the livelihood and welfare of population by providing them with food, medicine other material inputs and a source of income and employment. About 80% of developing countries depend on NTFPs for the primary health and nutrition needs (Chandrasekharan, 1998). The significance of NTFPs in the rural economy and for subsistence has been revealed by a no. of studies (ANSAB 1999, Kanel 1999, Thapa et al.1993). In Nepal, in certain areas, NTFPs provide up to 50% of household income (Edwards *et. al.* 1993).

Besides, rural people are also getting employed in the collection and trade of medicinal plants, as collection and sale of medicinal plants and other NTFPs alone are considered to be one of the biggest sources of seasonal employment (three to four months in a year) to the mountain communities of the Hindu-Kush Himalayas (Karki, 2000). In the mountain regions of South Asia, MAPs play by far the most important role in providing livelihood security specially food and medicinal products and emergency cash (Karki 2000, Karki 2001; Karki *et.al.* 2003).

Poor, women and various ethnic groups form the bulk of the collectors and users of NTFPs/ MAPs for their livelihood support; these groups have increasingly been struggling with strong competition due to the growing market and interest of newcomers in MAPs collection (Sharma and Das, 2004).

MAPs and other biodiversity-based livelihoods can not only become poverty reducing they can also be made socially equitable and gender balanced. MAP-based livelihoods can be easily mainstreamed with other components to enhance human welfare, especially among the poor and marginalized communities (Bhattarai *et.al*.2003).

1.1.1 Introduction to *Swertia chirayita*

Swertia chirayita (Roxb. ex Fleming) H. Karst. is a medicinal plant indigenous to temperate Himalaya and belongs to Gentianaceae family. It is known as *S. chirayita*, Tite (Nepali); Khalu (Newari); Kirattikta, Kirat (Sanskrit); Chiretta (English) (IUCN 2004a). It is found at an altitude of 1200-3000m from Kashmir to Bhutan.

Chirayito is a biennial herb, which shows a rosette form in the first year whereas two years old plant has elongated stem with yellow flower. Distribution of Chiraito is not uniform; it depends upon the altitude and slope. It prefers to grow on north facing slopes. It grows in south facing slope between 1500m and3000m. In general, 2000maltitude is most preferable range (Bhattarai, 1996).

Chirayito prefers to grow in acidic soil condition with pH of 4.7 to 5.5 (Bhattarai & Shrestha, 1996). Chiraito is found being mixed with other species. The most common associates are: Bhuin Kaphal (*Fragaria indica*), Bukephool (*Anaphilis triplinervis*), Chari Amilo (*Oxalis corniculata*), Dubo (*Cynodon dactylon*), Ghans (*Digitaria adecendens*), *Desmodium oxyphyllum*, *Elsholtzia strobilifera*, Titepati (*Artemesia vulgaris*).

The natural regeneration of plant takes place by seeds, when the seeds become biologically mature having high potentiality of viability during November (Bhattarai, 1996). The viability of seeds is very low if seeds are collected before November. The seeds stored in bad condition have no viability at all. The viability decreases after next October. If seeds are collected after November and cleaned properly, the percentage of germination is reported to be up to 90% (Bhattarai, 1991).

The trade name of *S. chirayita* is chiretta. The plant is a native of temperate Himalayas, found at an altitude of 1200–3000 m (4000 to 10,000 ft), from Kashmir to Bhutan, and in the Khasi hills at 1200–1500 m (4000 to 5000 ft). It can be grown in sub-temperate regions between 1500 and 2100 m altitudes. The genus *Swertia* Linn. consists of annual and perennial herbs. There is no consistency in the literature citing the habit of *S. chirayita*. Some authors have described Chiretta as an annual and others as biennial or pluri-annual. It is not clear whether the plant behaves differently due to climatic conditions or varying genotypes. The plant can be grown in a variety of soils with sandy loam rich in carbon and humus. It is also found in open ground and recently slash-and-burnt forests. *S. chirayita* has an erect, about 2–3 ft long stem, the middle portion is

round, while the upper is four-angled, with a prominent decurrent line at each angle. The stems are orange brown or purplish in colour, and contain large continuous yellowish pith. The root is simple, tapering and stout, short, almost 7 cm long and usually half an inch thick (Joshi and Dhawan, 2005).

Cytological work done on the species is poor. Khoshoo and Tondon, 1963, used pollen-mother cells for cytological studies in some Himalayan species of *Swertia*. The authors counted thirteen bivalents at metaphase I, and observed that one of them was bigger than the rest. Flowering in *S. chirayita* is in the form of numerous small, axillary, opposite, lax cymes arranged as short branches and the whole inflorescence is 2 ft long. Flowers are small, stalked, green-yellow, tinged with purple colour, rotate and tetramerous (Basu *et.al*. 1984). The corolla is twice as long as the calyx and divided near the base into four ovate–lanceoate segments. The upper surface of the petal has a pair of nectaries covered with oblong scales and ending as fringes. Fruit is a small, one-celled capsule with a transparent yellowish pericarp. It dehisces from above, septicidally into two valves. Seeds are numerous, minute, many-sided and angular. Floral characteristics such as colorful corolla and presence of nectaries support crosspollination in the species. Generally, bees (Apoidae, Hymenoptera) are the pollinators of *S. chirayita.*

The plant is harvested for the drug industry when it sets into flowering in July–September. Seed setting commences around October–November and seeds germinate immediately after shedding. Only a few scattered reports in the literature suggest germination studies and nursery practices of *S. chirayita*. Ninety-one per cent seed germination was reported after 3°C chilling treatment for fifteen days. An observation at the post-germination growth stage revealed that *S. chirayita* is a slow-growing species (Basnet, 2001). Low germination percentage and viability of the seeds, long gestation periods and delicate field-handling are some of the factors which discourage commercial cultivation of the plant (Badola et.al.2002).

Shrestha and Joshi, 1996 has put *S. chirayita* in vulnerable category. A taxon is vulnerable when the best available evidence indicates that it meets any of the criteria: reduction in population size (>50 %); small range (extent of occurrence) <20,000 km2; small range (area of occupancy) <2000 km2; small and declining in population (<10,000); very small population (<1000); very small range (<20 km2 or <5 locations) (IUCN, 2001). In list of 20 Non-Timber Forest Products (NTFPs) contributing revenue to the government, *S. chirayita* ranks fifth. *S. chirayita* is

important NTFPs of mid-hills of eastern and central development region (Oli and Nepal 2003). Among 12 medicinal plants, *S. chirayita* has been emphasized as one of the plant for cultivation and research (GoN, 2005).

1.1.2 Hypothesis of the study

Null hypothesis (H_0) was set in this way:

H_0: there is no significant difference in bitter principle between wild and cultivated *S. chirayita.*

and alternate hypothesis (H_1) as:

H_1: there is significant difference in bitter principle between wild and cultivated *S. chirayita.*

1.2 Justification of the study

Maipokhari area is very rich in biodiversity. Most of the local people are involved in agriculture, animal husbandry, collection of NTFP's for their living. In recent years, the cultivation and collection of MAPs have been increasing to support the livelihood of the people in the area. Among the number of NTFP's, *S.chirayita* has been reported a common medicinal plant in the study area. The scientific analysis on the quality of *S.chirayita*, the condition under which it is grown and cultivated has not been documented. In order to ascertain this, a study has been undertaken.

Ongoing research has attempted to find out about current distribution of *S.chirayita* both in community forest and cultivated fields. *Comparative studies on the quality of chirayito found in Situ and Cultivation has been scanty*. Also the study has aimed to find the relationship between the bitter principle of chirayito and soil parameters *in situ and under cultivation.* For the improvement of livelihood of the community in the area, NTFPs is important. This requires to understand the potential of the area for chirayito production so that the socio-economic condition of the local community can be improved. This requires understanding the benefits derived from chirayito.

1.3 Research Questions

The present study has attempted to answer the following questions:

1. What is the current status of S.chirayita in the study area?
2. What is the suitable condition for chirayito to grow both in wild and cultivated field?

3. Is there any significant difference in bitter principle of chirayito collected from wild and cultivated field?
4. What is the relationship between soil parameters and bitter principle of chirayito?
5. Do the local people highly depend on collection and trade of *S. chirayita* for their livelihood?

1.4 Research Objectives

Trade of NTFPs plays an important role in improving the livelihood of the local people. *Swertia chirayita* is one of the common and potential medicinal herb in the study area which highly influence the livelihood of local communities. Thus, the broad objective of the study is to analyze the impact of chirayito on the local people's livelihood.

The specific objective includes:

- To study distribution (density) of *S. chirayita* in community forest and cultivated field
- To study the relationship between soil parameters and bitter principle of *S. chirayita*
- To study the impact of *S.chirayita* on livelihood and its market potentiality in the study area.

1.5 Overview of Contents

Chapter 1 includes the introductory part that covers Background (introduction and hypothesis testing), Justification, Research questions and Objectives of the study. Chapter 2 describes about literature reviews, various literature on MAPs especially focused on *S.chirayita* have been reviewed. Chapter 3 includes methodologies adopted to undertake the research work. It consists of study area, research design, data collection methods and methods of data analysis. Chapter 4 describes about the research findings. The ecological study of *S.chirayita*, socio-economic impact, trade differences, history of chirayito cultivation and existing market channel of chirayito are included in the result section. Chapter 5 contains the discussions of the results obtained so far. Chapter 6 includes the conclusion and recommendations regarding the study.

CHAPTER-2

LITERATURE REVIEWS

2.1 Status and Importance of Non-timber Forest Products in Nepal

Forest products other than timber, fuel wood and fodder which are useful for trade, industry and human lives are NTFPs (Chandrasekharan, 1995, Hamro Ban 2004/2005). Among NTFPs, MAPs; sub-sector of NTFPs, are of special significance to the Nepalese economy because of their value to the local collectors the small traders, herb dealer, Ayurvedic practitioner, Ayurvedic/Pharmaceuticals companies and essential oil producing factories (Shrestha and Ghimire, 1996). In Nepal, NTFPs are especially important for study since they have the potential to contribute to the local economy; local health needs of remote communities, and also to conservation of ecosystems and biodiversity (Subedi, 1998).

Nepal has rich biodiversity per unit area, and this is mainly attributed to the wide network of protected areas (GoN, 2002). About 150 km of North-South and 800 km of East-West expanse of the country hosts a wide range of geographic, climatic, floral and faunal variations. There are more than 700 plant species that have.40 medicinal values, of which 238 are in active use and 100 are traded. The government has identified 30 species in priority list, of which 12 are for commercial cultivation and market promotion (AEC/FNCCI, 2004; Subedi, 2006; Shrestha and Das, 2008). NTFPs are increasingly gaining popularity in national and international markets as they have been used as medicines and as important ingredients to several consumer items, such as cosmetics, tea, and food. It is widely agreed that NTFPs could be a very important commodity in Nepalese economy.

Nepal has significantly diverse ecosystems (Chaudhary, 1998; Subedi, 2000, 2004), producing a wide range of unique and valuable medicinal plant resources. Representing only 0.01% of earth's land area, Nepal is gifted by nature with 2.6% of all flowering plants, 9.3% birds, and 4.5% of mammals of the world. Out of an estimated 9,000 species found in the eastern Himalaya as a whole, 39% are endemic to this mountain range (Myers 1988; Myers 1990; Bajracharya *et al.* 1998; IUCN 2000). Nearly 7,000 species of higher plants are found in Nepal, of which 5% are endemic to Nepal and 10% are medicinal and aromatic plants. With 75 vegetation types ranging

from dense tropical forests to alpine vegetation that covers over 50% of the total geographical area of the country forms the land resource base for the provision of MAPs.

Pandey (1961) for the first time reported 73 MAPs. Then, Department of Medicinal Plants (DMP, 1970) reported 483 species; Malla and Shakya (1984-85) compiled a list 630 species of MAPs from Nepal, out of these 510 species are indigenous i.e. they occur in wild and 120 species are either exotic or indigenous that are naturalized or cultivated since long. However, approximately 1000 species of MAPs have been estimated to occur in Nepal (Chaudhary, 1998). These plants occur throughout the country from tropical forests (<100m) to alpine meadows (>4000m). The work of Malla and Shakya (1984-85) revealed the presence of maximum number of medicinal plants species, 540 (i.e.85%) from the central Nepal. The numbers from western and eastern regions are 424 (67.3%) and 512 (81.27%) respectively. Manandhar (2002) has reported ethno-botanical information of 1,500 plant species, majority of them have medicinal value.

2.2 Markets and marketing of MAPs from Nepal

Medicinal plant trade is one of the oldest trades of Nepal. The Himalayan medicinal plants from Nepal have been in high demand throughout the South Asian region since ancient times. It is reported that more than 80% of the rural Nepalese people depend on traditional remedies that involve the use of local plants in various forms and combinations (Rajbhandary & Bajracharya, 1994). Many important traditional practices of Eastern medicine including Ayurveda, Unani, Siddha, Chinese and Tibetan medicine (*Sowa Rigpa*) are practiced in Nepal (Phoboo *et al.* 2008). There are 1792 medicinal plants in Nepal (Baral & Kurmi, 2006) out of which 49% are herbs, 29% trees, 14% shrubs, 8% climbers (Bhattarai & Ghimire, 2006). Owing to their high demand, these plants have provided a supplementary source of income for the local population and in some villages of high mountains of Nepal, almost 50% of the population engages in collection and trade of medicinal and aromatic plants (MAPs) (Olsen & Helles 1997).Medicinal plants from Nepal were traded to the borders to Tibet as early as 600 A.D (Sung and Yiming, 1998). Presently over 90% of the total export every year from Nepal is to India and mostly in crude form (Bhattarai, 1997). Conservative estimates of the annual Nepalese alpine and sub-alpine Medicinal plants vary from 480-2500 tons with a total harvest of US $ 0.8-3.3 million (Olsen and Larsen, 2003). *Nardostachys grandiflora, Swertia chirayita, Neopicrorhiza scrophulariflora,*

Zanthophyllum armatum and Sapindus mukorosi are the top five species of NTFPs currently in trade (Olsen, 2005).

About 11,694 tons of air dried herbs were collected for trade in Nepal in 19993/1994 as compared to 3448 in 1989/1990 (Bhattarai, 1997). In Gorkha district, Nepal, about 25-100% of households in a given village participates in commercial collection of MAPs. About 15-35% of the income of poor households in the northern and central parts of this district comes from sale of MAPs (Olsen, 1998). Over 90% of the total export is to India and mostly in crude form (Bhattarai, 1997). From India, products are re-exported to other countries either in crude form or after primary processing, in addition to being used in the Indian Ayurvedic pharmaceutical and aromatic industries (Edwards 1996, Bhattarai 1997, Olsen 1997). It is estimated that approximately 20 thousand tons of MAPs are exported from Nepal annually and more than 90% of them are exported in crude form as raw materials for Ayurvedic companies (Parajuli, 2003).

A survey of NTFPs producers, traders and processers from the eastern border of Nepal to the mid-western town of Nepalgunj shows that a total of 100 entrepreneurs handled 42 thousand tons of over 100 different NTFPs items, equivalent to USD 26 million (Subedi, 1997). It is estimated that about 10,000 to 15,000 tons of plant products of more than 100 species are exported to India annually, and it comprises 90 percent of total NTFPs trade (Edwards, 1996).

2.3 Non-Timber Forest Products and Livelihood Perspectives

The main principle of National Biodiversity Strategy (NBS) for poverty alleviation, economic and social development is to develop an effective mechanism for the sustainable use of Biological resources and conservation of biodiversity in rural areas of Nepal. The forest products have to be utilized in forest-based enterprises without depleting the forest in relation to biodiversity conservation and sustainable resource management (GoN, 2002).

Shrestha *et.al*. (2003) revealed that NTFPs can play a crucial role in improvement of livelihood of the people through their trade. For trade, bulk production is needed which cannot be fulfilled without appropriate management of existing NTFPs and cultivation of potential species. Gautam (1999) carried out a study on the promotion of NTFPs in Sindhupalchowk district. He found out that the annual cash earnings from NTFPs account for 17% of the collectors annual income. This income contributed substantially to strengthen their household economy. He further mentioned that of the 15 NTFPs species identified, *S. chirayita*, *Rubia sikkimensis*, *Lycopodium clavatum*

Linn. and *Valeriana jatamansi* were collected for marketing purpose. Uprety (2008) has also studied the status of *Swertia chirayita* in Kanchenjunga Conservation Area which emphasized on its cultivation in private land to get benefits. He had concluded that its trade had played a vital role on local people livelihood.

NTFPs are being increasingly recognized for their role in rural livelihoods, biodiversity conservation and export values. The market of NTFPs is expanding and this is an opportunity and a challenge for a more sustainable, efficient and equitable use of NTFPs resources. But unsustainable harvesting, inequitable benefits distribution and overall economic inefficiencies are the problems of current NTFPs practices (Ojha, 2000).

2.4 Status and distribution of *Swertia chirayita* in Nepal

S. chirayita is found in the temperate region throughout the Himalayan belt extending from Kashmir to Bhutan between the altitudes of 1200-3000 m (Bhargava *et.al* .2008). It is found in the subtropical (1200 m) to alpine zone (3000 m) throughout western, central and eastern regions of Nepal in more than 40 districts out of 75 in Nepal (Bhattarai & Acharya 1998). The chief *S. chirayita* supplying districts are Sankhuwasabha, Tehrathum, Dhankuta, Illam, Panchthar, Rasuwa, Solukhumbu, Taplejung, Ramechap, Dolakha, Sindhupalchok, Gorkha, Dolpa, Rolpa, Salyan, Sinduli, Accham, Doti and Makwanpur (Bhattarai & Acharya 1998). It grows well in moist, semi-shade temperate forests usually in sloping hillsides (Phoboo *et.al.* 2008). The plants are not abundant due to over-exploitation and open grazing, and are becoming increasingly difficult to find in the wild conditions (Phoboo *et al.* 2008). *S. chirayita* is usually found growing with other species of plant like *Anaphalis* spp., *Bidens* spp., *Eupatorium adenophorum, Centella asiatica, Viola* spp., *Polygonum amplexicaule*, and forest tree species such as *Rhododendron arboreum*, *Quercus* spp. and *Acer* spp. (Phoboo *et.al.*2008).

2.5 Medicinal Importances

In Ayurveda, *S chirayita* is described as bitter (*tikta*) in taste and its thermal action defined as cooling (*shita*), easily digestible (*laghu*) and dry (*ruksha*) (Joshi & Dhawan 2005). The whole plant is extremely bitter and is used for chronic fever, malaria, anemia, bronchial asthma, liver disorders, hepatitis, gastritis, constipation, dyspepsia, skin diseases, worms, epilepsy, ulcer, scanty urine, hypertension, melancholia and certain type of mental disorder, secretion of bile, blood purification and diabetes and anti-inflammatory (Banerjee *et al.* 2000, Karan *et al.* 1999,

Rai 2003, Saha *et al.* 2004). It has been found to possess antitumor (Balasundari *et al.* 2005), hypoglycemic (Saxena *et. al.* 1993), anti-helmintic, hepatoprotective (Chakravarty *et al.* 1994), anti-pyretic properties (Bhargava *et al.* 2008), antiviral (Verma *et al.* 2008), anti-hepatotoxic (Karan *et al.* 1999),and anti-diabetic (Suryawanshi *et al.* 2006) properties. It is also used in Ayurvedic industry as a constituent in an anti-cancer medication and in the skin tonic 'Safi' as well as in skin soaps and cosmetic products. This medicinal plant is usually administered as concentrated infusion, tincture or as powder and fluid extract (Joshi 2008, Phoboo *et al.* 2008).

2.6 Cultivation of *Swertia chirayita* in Nepal

Barakoti (2002) developed a scheme for commercial cultivation of *S. chirayita*. The commercial cultivation of chirayito has been initiated on farmland in eastern and central Nepal. However, in western part, commercial production has not yet initiated. Chirayito is well grown in N-facing slopes. The nursery practices starts from March to April. Seeds are small, therefore, they are sown mixed with sand and need very intensive care to sow Seed is matured during November to December and it is sown in February to March (Barakoti, 2002).

The natural regeneration of plant takes place by seeds, when the seeds become biologically mature having high potentiality of viability during November (Bhattarai, 1996). The viability of seeds is very low if seeds are collected before November. The seeds stored in bad condition have no viability at all. The viability decreases after next October. If seeds are collected after November and cleaned properly, the percentage of germination is reported to be up to 90% (Bhattarai, 1991).

The plant can be grown in a variety of soils with sandy loam rich in carbon and humus in temperate climate. It is also found in open ground and recently slash-and-burnt forests (Edward 1993; Joshi and Dhawan, 2005). Chirayito favors north facing moderate and moist slope with temperate climate. Sandy soil rich in humus and organic matter with pH 4.5-5.5 is suitable for growth (Barakoti, 2002). It can be grown in less productive food crop fields, degraded and marginalized lands slash and burn area and community forests of high hill (Barakoti, 2007).

2.7 Bitter constituents of *Swertia chirayita* and its uses

The bitter principles are the main principle constituents in chirayito. Chiretta is reported to contain a yellow bitter acid, ophelic acid ($C_{15}H_{20}O_{13}$), two bitter glucosides, chiratin ($C_{26}H_{48}O_{15}$)

and amarogentin ($C_{32}H_{38}O_{16}$), gentiopicrin, two yellow crystalline phenols, a neutral, yellow crystalline compound and a new xanthone, swerchirin ($C_{25}H_{12}O_6$) which is also medically important xanthone. Amarogentin is one of the most bitter substances known. According to the pharmacopoeia, the drug should not contain less than 1.3 % of the bitter principles. It is usually administered as a bitter ingredient. It is also used in the liquor industry as bitter ingredients. (CSIR, 1976).

2.8 Trade of *Swertia chirayita* from Nepal

According to the Department of Forest (DOF 2009/2010), *S. chirayita* is traded in 61 out of 75 districts in Nepal. In Nepal, about 90% of the medicinal plants traded are collected from the wild (Phoboo *et al.* 2008). Chirayito is also mostly collected from the wild by the local collectors. The collected plants are then dried and bundled before they are sold to the local traders. The current market price (2010) of raw dried chirayito is Rs. 300 per kg while the local collectors are paid only Rs. 110 per kg and these are exported at a price of Rs. 400 per kg. The trade of chirayito usually consists of four levels of stakeholders, the local collectors, the local trader, road head trader and the wholesaler. The local collectors had been paid as much as Rs. 800 per kg in the past according to traders in Kathmandu (Phoboo *et al.* 2008). Nepal is reported to trade more than 45% of the world's total volume of chirayito (Saha 1999; Barakoti 2004,). Only about 1% of the chirayito is collected for local use, much of the local chirayito is exported to India for their Ayurvedic, Unani and Sidha medicinal market while some are exported to China, Malaysia, Singapore, Germany, Italy, France, Switzerland, Sri Lanka, Bangladesh, Pakistan, and USA (Phoboo *et al.* 2008). Almost all chirayito is harvested from the wild (Edwards, 1996). According to the data from the Ministry of Forests and Soil Conservation, Nepal traded only about 66.806 ton of chirayito in 2008-2009. The major trading centers of chirayito are Hille, Dharan, Basanatapur, Nepalgunj, Birtamod and Trisuli (Bhattarai & Acharya, 1998).

The highest volume of chirayito comes from East Nepal. In the last thirteen years, East Nepal contributed more than 50 % of the total chirayito traded in Nepal (Department of Forest, 1996/1997-2008/ 2009). The highest amount of chirayito in the last thirteen years came from Taplejung (263.572 ton) and Tehrathum (213.837 ton) districts of East Nepal. There has been a general decline in volume of chirayito traded from Nepal in the last twelve years (1997-2009) although there seems to be slight increase in total volume in the last two years). The total

revenue generated by the Department of Forest from the taxes and duties levied on MAPs in 2008/2009 was Rs. 38.9 million out of which the trade of chirayito generated Rs. 9.9 hundred thousand. At present, in some villages of high mountains, almost 50% of the population engages in collection and trade of MAPs (Olsen & Helles, 1997). Chirayito constituted 3% of the total medicinal plant traded in Nepal in 2008/2009.

Department of Plant Resources (DPR), has also identified chirayito as major medicinal plant that is traded. Thirty four districts of Nepal have been found to contribute in supply of chirayito traded. Total of 4,193 tons of chirayito has been estimated to trade during 1995/96. They identified the market channel as: collector-middleman/village trader-Road head trader-wholesaler-Industries (Bhattarai and Acharya, 1998).

2.9 Adulterants on *Swertia chirayita*

There are 31 species of Swertia found in Nepal (Joshi, 2008). Although *S. chirayita* plays a dominant role in trade since it is considered to be superior in its medicinal properties in comparison to other species of *Swertia* (Rijal, 2009), the trade of it is affected by adulterants. Species of *Swertia* other than *S. chirayita* are often mixed in with the bundled *S. chirayita* and sold. Locally many species of *Swertia* including *S. angustifolia* and *S. nervosa* are used as substitutes for *S. chirayita* in case of its unavailability but in trade, adulteration causes problematic trade issues and product devaluation. Some of the adulterants found along with true *S. chirayita* as listed by Joshi and Dhawan (2005) are *Andrographis paniculata* (green chirayita), *Exacum tetragonum* Roxb., *E. bicolor* Roxb., *E. pedunculatum* Linn., *Slevolgia orientalis* Griesb., *Swertia alata* Royle., *S. angustifolia* Buch.- Ham., *S. bimaculata* Hook. f. and Thoms., *S. ciliata* G. Don, *S. densifolia* Greisb., *S. elegans* Wight., *S. lawii* Burkill., *S. minor* Griesb., *S. paniculata* Wall., *S. multiflora* Dalzell.

2.10 Policies related to Marketing and Conservation of NTFPs/MAPs in Nepal

2.10.1 Forest Act (1993), Forestry Regulations (1995) with amendments

The Forest Act (1993), Forestry Regulations (1995) with amendments regulates NTFPs use by a licensing system for NTFPs removal, sale, transportation and export; a royalty system; controlling authority at the local district forest office; and severe punishment for NTFPs collectors who violates the law. Prior to the Forest Act 1993, collectors could harvest all the

MAPs, except Yarsagumba (*Cordiceps sinensis)* from the areas of north of Mahabharat Range without permit or license. The Forest Regulation of 1995 requiring license for their collection. The Forest Regulation 1995, enforced in accordance with the Forest Act, 1993, categorized a number of NTFPs requiring license for their collection.

2.10.2 Collection Permits

Collection permits have to be obtained from the District Forest Office (DFO) for the collection of NTFPs from the government forests. Transport/export permits of unprocessed NTFPs have to be obtained from the DFO.

2.10.3 Nepal Environment Policy and Action Plan, 1993

Nepal Environment Policy and Action Plan (NEPAP) aims to preserve endangered species and their habitats, promote private and public institutions for biological resource inventory and conservation. NEPAP, 1993 recommended that forestry research address the utilization of lesser-known forest species, which could include their use as a resource for NTFP. NEPAP II (1998) was the first policy document to recognize that non-government policy had more or less ignored the important role of NTFPs as a source of income in rural communities. NEPAP II (1998) and the Ninth Five Year Plan recommended that the community owned land is suitable for purposes other than forestry be utilized under the community management for the production of NTFPS especially, MAPs.

2.10.4 Jadibuti (Herbs) and Non-Timber Forest Products' Policy, 2061

The objectives of the policy is to encourage commercial cultivation of important jadibuties and NTFPs and national income and job opportunities will be increased through ex-situ conservation. Initial processing unit will be set up locally to collect the jadibuties of remote areas. Participatory approach should be incorporated participating local government. Trainings and Skill development centers must be developed. Local markets must be encouraged to reduce poverty.

2.11 Issues and Potentials of Medicinal and Aromatic Plants (MAPs)

High fluctuations of prices, seasonality, very few established markets, lack of certification and lack of region specific cultivation technology are few of the most important lacunae of this trade making the marketing of MAPs a very difficult and uncertain proposition. Even basic grading and cleaning operations tend to be centralized in major /Indian cities (Edwards, 1993).

Yadav (2008) in his study concluded that there was the high potential of cultivation of MAPs but no security for risks and uncertainty providing subsidy and facilities for cultivation and marketing so that cultivators always suffered from unavailability of markets and low price from MAPs.

The interpretation of regulations, both national as well as international, for collection and trade of MAPs is controlled by government officials. Even products from community forest and private forests are treated in the same way as wild resources. Thus the prospects of alleviating poverty of people in remote districts of Nepal through best use of their MAPs are overshadowed in the secretive and lucrative trade controlled by trans-border buyers and distant companies (Shrestha, 2001).

CHAPTER-3

RESEARCH METHODOLOGY

3.1 STUDY AREA

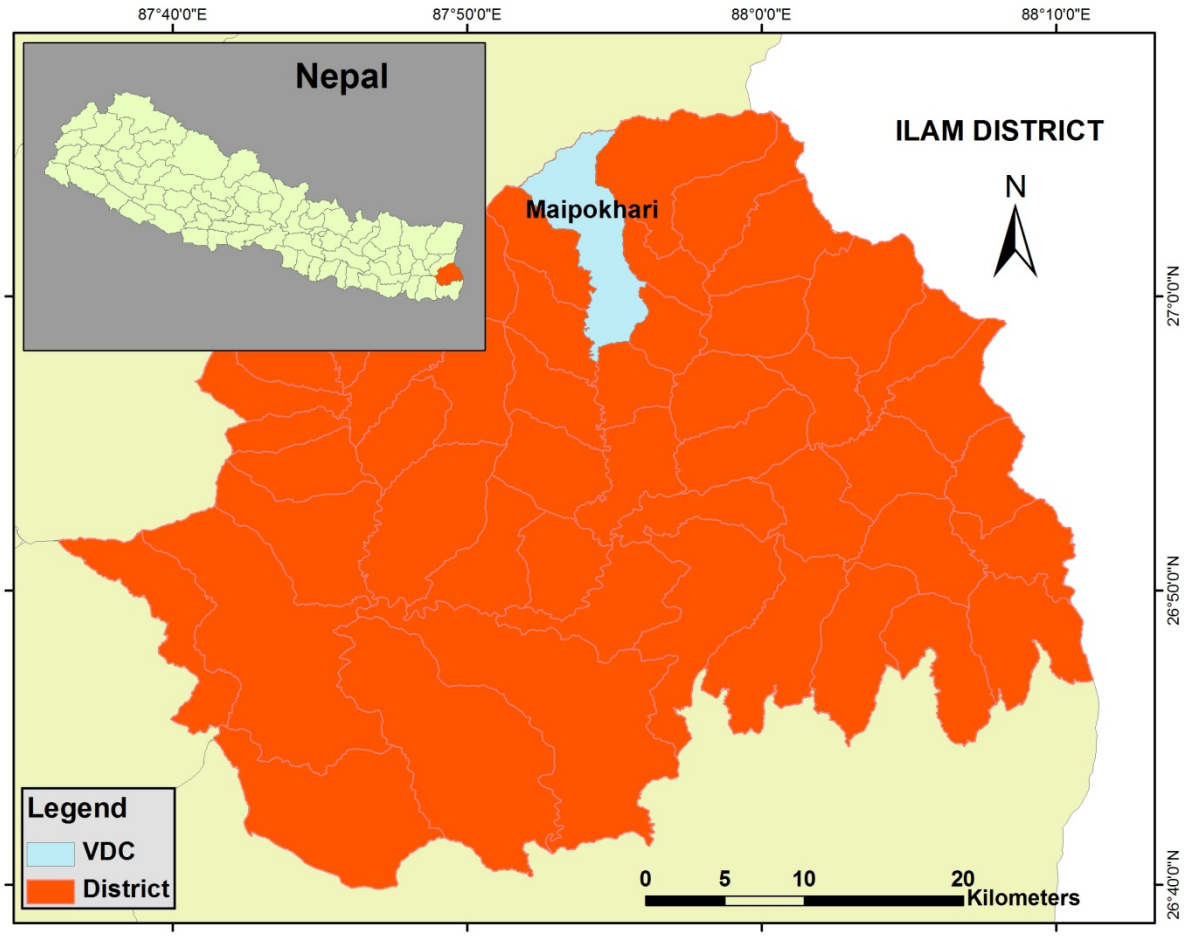


Fig 3.1: Map showing the study area

3.1.1 Geographical Location

The study area is Maipokhari VDC which is located at Illam district in Mechi zone. It lies about 5 miles north from Illam district headquarter. It covers an area of 41.60km^2 . It is bordered by Sumbek, Sulubung, and Maimajuwa VDC to east, Puwamajuwa and Sakhejung VDC to west, VDC of Panchthar district- Sidin, Lungrupa and Ranitar towards north and Barbote VDC towards south. The area has gentle slope. It is located between 26^{o}58'14"N-27^{o}06'09"N latitude and 87^{o}51'47"E-87^{o}56'09"E longitude. Altitude ranges from 995m to 3302m from the mean

above sea level and 2194 meter above sea level. In ancient time, the VDC was named as Malate Panchayat Village and in 2038 B.S; some portion of Sulubung VDC was added and renamed as Maipokhari VDC from Maipokhari pond. This VDC covers an area from Jallari Beshi of Puwakhola to Chhintapu. This VDC has its great importance due to highly rich in biological diversity and tourism.

3.1.2 Climate

The climate of the area is found to be subtropical to cool temperate type. Diversity in climate is found due to geographical variation. The weather is warm at the lowland and nearby river. It is comparatively very cold at the highland especially in the winter season. Lowland temperature is found to be 25^{o}C in the northern area, the temperature decreases up to 0^{o}C. The average annual rainfall is 2500mm/yr.

3.1.3 Population

According to the population census 2001, the VDC has population of 4376, population growth rate 1.88%. According to household survey 2008, this VDC has population of 5029 and 890 HHs with 2.1% population growth rate and population density of 120.77km^2.

The VDC has forest coverage of 28.06km^2 which is 67.31% of the whole VDC. Forest management practices have been ongoing in most of the community forest. Due to the uncontrolled use of forest products, fire, ineffective forest management practices, forests are in degrading stages. (Source: Awadhik Digo Bikash Yojana, Maipokhari VDC, Illam, 2065).

3.1.4 Access:

The study site is located at 15kms to the north from Illam bazaar of Illam district. It takes 3-4 hrs to reach Maipokhari from Illam Bazar on foot. It is also connected towards eastern road and it takes one hour to reach by the road with vehicle. The road head is Deurali bazaar on the way to Maimajuwa and Aalubari VDCs.

3.1.5 Vedichowk Community Forest

For the study of the distribution of *Swertia chirayita* in the nearby community forest of Maipokhari VDC, Vedichowk Community Forest was selected. This community forest lies in Maipokhari VDC. It is bordered by Maipokhari thamdada to east, chameri khola kinar to west, Deurali bazar-way to change towards North and Kakar-way to change towards South. It covers

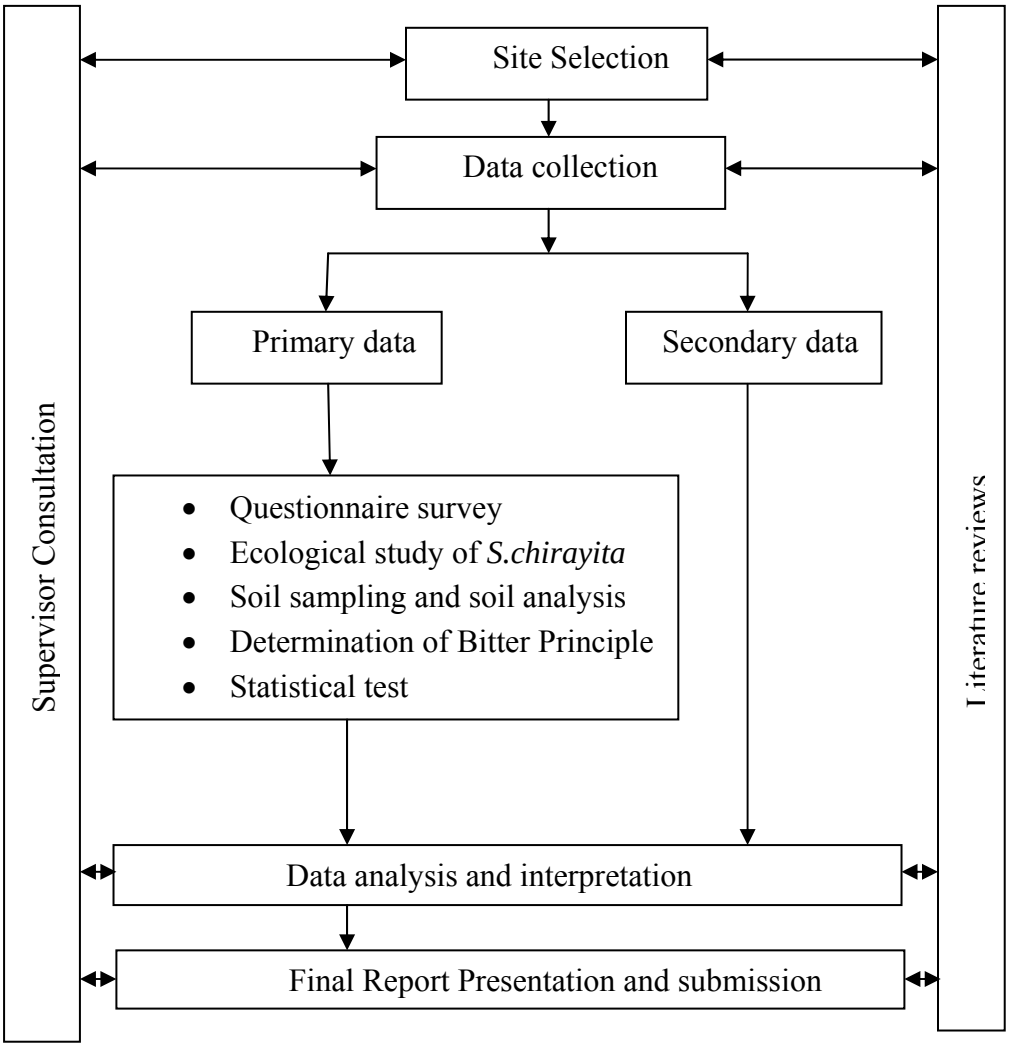
an area of 38.12ha (762.4ropani).This forest lies about 1800-2200m above the mean sea level. Slope is normal about 15^{o}-30^{o}. It is south west facing aspect Chameri khola, Deurali kholshi, Nikas kholshi, Kopche kholsi etc lie within this CF.

This forest is generally covered by naturally regenerated and planted plants. Species of Katus *(Castanopsis tribuloide*), Phalant (*Quercus oxyoden*), Kharane, Ashare, Utis (*Alnus nepalensis*), etc. are found in natural stage whereas planted Japanese Sal forest is highly dominant. The species of NTFPs found in this forest includes Jatamasi (*Nardostachys grandiflora*), Nagbeli (*Lycopodium clavatum*), Jhyau (*Parmelia nepalensis*), Orchid, Lokta (*Daphne bholua*) Chirayito (*Swertia chirayita*) etc.

3.2 Research Design

Research design is one of the important aspects of research. A research design is a plan of the proposed research work. A research model or design represents a compromise dictated by practical considerations.

The research design has been proposed on the basis of the review and methodology developed on the basis of the objectives. The following research design has been proposed during the research.



3.3 Data Collection Methods

3.3.1 Primary Data Collection through Questionnaire Survey

Information on distribution, commercial cultivation, harvesting, trade, and income from *S.chirayita* at VDC level was collected through purposive selection of 50 informants (15% of the total households) from the VDC which included ward no. 3, 4, 5, 6 and 7 having 339 HHs (Source: Central Bureau of Statistics (CBS) 2001, Nepal). They were mainly cultivators/collectors. Structured and semi-structured questionnaires guided these dialogues (Appendix I). Households that were involved directly or indirectly in activities related to chirayito cultivation, collection and trade were selected as sample population for household survey. Local traders were interviewed mostly using open-end questionnaire. Information regarding annual volume they handle, trade, price and profit margin from chirayito was obtained from traders.

Adult persons and local NTFPs experts were selected as key informants to collect information about the history of commercial cultivation of chirayito, its habitat suitability, local uses, and annual production, impact after and before the commercial cultivation of chirayito and export from the study area. Dialogues with them were guided by structured, semi-structured questionnaire and often informal discussion was conducted. To study the distribution of chirayito, plots were laid down depending upon the information from the local people because it is very difficult to select the sites/plots in wild due to scanty distribution.

3.3.2 Secondary Data Collection

Literatures were reviewed from libraries, project offices and internet to gather information about distribution, importance of NTFPs in Nepal and in the study area, their economic value focusing particularly on *S. chirayita.*

3.3.3 Ecological Study of *S. chirayita*

Ecological study of *S. chirayita* was conducted following the methodology used by (Shrestha et al. 1998). Stratified sampling was adopted and accordingly quadrats were laid on 1800m, 2000m and 2200m along the contour line with the help of altimeter in both wild and cultivated sites. For this, 10m x 10m plot was laid. Six plots were laid at each elevation, three at wild and three at cultivated site. Each plots were further sub-divided into 25 sub-plots each of 2m x 2m, out of

which a minimum of 8 plots (>30%) was chosen randomly. In each sub-plot, the individual *S. chirayita* were counted and associated plants species were recorded. Similar method was adopted by Oli and Nepal (2003) for studying NTFPs in the KCA. Counting the observed plants number in sample plot formed the main basis of assessment of *S. chirayita* in both wild and cultivated sites. Some samples of chirayito from both wild and cultivated fields were uprooted for bitter principle analysis. The harvested samples were carefully shaked to remove the soil content and kept in clear polythene bags with proper labeling.

Density of *S. chirayita* at each elevation was calculated as:

$$\text{Density (D) no. /ha} = \frac{\text{total no. of individuals of S.chirayita at studied elevation}}{\text{total quadrats studied X area of quadrat}}$$

3.3.4 Soil Sampling and Soil Analysis

Method stated by Tolanur (2004) formed the basis of soil sampling. Litter on the soil surface was removed. "V" shaped furrow of 20 cm depth were made at the center of each plot. About 200 gm of soil sample was collected from each plot by cutting the slice of soil from top to bottom from the exposed soil surface. Collected soil samples were labeled properly. Samples from different sites of the same elevation were mixed later and one composite sample of ½ kg was made from respective elevations from both wild and cultivated. Altogether six samples of soil (three from wild and three from cultivated sites) were collected. Composite samples were placed on clean polythene bags with proper labeling and were made air tight. Soil samples were analyzed mostly using methods mentioned in Trivedi and Goel (1984) at the laboratory of Central Department of Environmental Science, Tribhuvan University, Kirtipur.

3.3.5 Determination of Soil Physical and Chemical Parameters

3.3.5.1 Determination of Soil Texture

Sand and silt were calculated using sieving method while clay was calculated using wet method (Thakur and Panthee 2004).

3.3.5.2 Sieving Method

- 500 g of air dried and grinded soil sample was kept on sets of sieve.

- Sieve was shaked in mechanical shaker for 10 minutes followed by weighing of soil that has fallen on respective sieves representing sand and silts.

3.3.5.3 Determination of Clay Particles

- 100 ml measuring cylinder was half filled with soil.
- The soil was wet to mud consistency and allowed to settle
- The level of soil on the jar was marked with marker.
- 2 gm of calgon was added.
- Water was added to the top of the cylinder and the mixture was stirred with the help of glass rod.
- Cylinder was kept on the table and the level of soil was observed and marked after 40 seconds which indicated the sand portion of the soil.
- Another marking at the soil level was made after 6 hours. The difference between the bottom mark (sand) and the second mark up was the silt portion of the soil.
- Depth of soil was measured and respective percentage of sand and silt was calculated.
- The percentage clay is the 100 minus the percentage of sand and silt.

3.3.5.4 Determination of Soil pH

Twenty gram of air dried soil sample was mixed with 100 ml distilled water in a 500 ml beaker. The mixture was stirred for half an hour at regular interval with the help of glass rod. pH of the sample was then determined using calibrated pH meter.

3.3.5.5 Determination of Soil Organic Matter *(Modified Walkley and Black method)*

- 0.25 g of oven dried soil sample was taken on 500 ml conical flask.
- 10 ml of 1N Potassium dichromate solution and 20 ml of concentrated Sulphuric acid was added and mixed by gentle swirling the flask.
- Conical flask was then kept to react the mixture for about 30 minutes.
- Content was then diluted adding 200 ml distilled water.
- 10 ml Phosphoric acid was added followed by 1 ml of diphenylamine indicator.
- Content was then diluted with 0.4N ferrous ammonium sulphate to obtain brilliant green color as the end point.
- Blank was run with same quantity of chemicals but without soil.

Calculation:

$$\% \text{ carbon} = \frac{3.951}{G}\left(1 - \frac{T}{S}\right)$$

A factor for average recovery of about 75 % organic matter by this method has been taken into consideration in the formula.

b. percentage organic matter = percentage carbon x 1.724

Where, g = weight of sample in gram, S = ml of ferrous solution with blank titration T = ml of ferrous solution with sample titration. The factor l.724 is based on the assumption that carbon is only 58 % of the organic matter.

3.3.5.6 Determination of Soil Nitrate

- 25 g of air dried soil sample was taken in a 500 ml conical flask.
- 125 ml of nitrate extract solution was added and was shaked for 10 minutes.
- 0.2 g calcium hydroxide was added and again shaked for 5 minutes.
- 0.5 g magnesium carbonate was added and the content was allowed to settle.
- The solution was filtered through dry filter paper, discarding first 20 ml of solution.
- 50 ml of filtrate was taken in a porcelain basin and evaporated to dryness.
- Basin was cooled and the residue was dissolved in 2 ml phenol disulphonic acid.
- The content was diluted to 50 ml in 50 ml volumetric flask followed by addition of 6ml liquid ammonia to develop a yellow color.
- Standard curve was prepared.
- Reading at 410 nm was taken with the help of spectrophotometer.
- Concentration of nitrate-nitrogen was calculated from the standard curve.

3.3.5.7 Determination of Soil Available Phosphorus

- 0.5 g of air dried soil was taken on 500 ml conical flask.
- 200 ml of 0.002 N sulphuric acid was added.
- The suspension was filtered to get a clear soil solution.
- 50 ml of filtered solution was taken on a conical flask.
- 2 ml of ammonium molybdate was added followed by 5 drops of stannous chloride solution to develop blue color.

- Reading was taken at 690 nm on a spectrophotometer using a distilled water blank with the same amount of chemicals.
- Reading was taken after 5 minutes but before 12 minutes of the addition of stannous chloride.

3.3.5.8 Determination of Soil Potassium

- 25g of soil sample was taken in conical flask followed by addition of 50 ml (40 % alcohol)
- Mixture was shaked well for 15 minutes and then filtered with frequent washing by 40 % alcohol.
- Sample was further washed with 50 % alcohol.
- Residue on filter paper was washed with 50 ml ammonium acetate and left whole night on conical flask.
- The residue was then filtered with frequent washing by ammonium acetate.
- 2g of qualigens (sodium hexametaphosphate powder) was mixed and observed in Potassium flame meter.

3.3.5.9 Determination of Bitter Principle

The bitter principle states that the taste of all things bitter will stimulate the production and release of bile from the liver, thus flushing toxins from the body. The bitter principles are the main constituents of *S. chirayita*. They are included in the Secoirodoid glucoside group. They are Amarogentin and Amaroswerin (Sharma 1983). According to Pharmacopoeia of India, the drug should contain not less than 1.3 % of the bitter principle. Bitter principle of *S. chirayita* of different elevation from wild and cultivated was determined using the method mentioned on Pharmacopoeia of India (1982). Similar method is being used by the Department of Plant Resources (DPR) located in Thapathali, Kathmandu.

- Two grams of dry powder *S. chirayita* plant was taken in conical flask
- 200ml ethanol and water (1:1) was added in plant material
- The mixture was shaked for 5-10 minutes and kept for overnight.
- The ethanol extract was filtered and concentrated on hot water bath till the syrup residue was obtained.

- The syrupy residue was dissolved in small amount of hot alcohol and washed with 50ml of hot water and then transferred into the separating funnel for successive extraction with 25ml, 20ml, 15ml and 10ml of ethyl acetate (till the yellowish colour develops).
- The total ethyl acetate extract was transferred in the beaker and solvent was evaporated to dryness until the constant weight was obtained.

$$\text{Bitter principle} = \frac{\text{weight of sample taken}}{\text{weight of residue left}} \times 100$$

3.3.6 Statistical Tests

Certain statistical tests were applied following books "A Practical Manual for Ecology" (Zobel et. al. 1987), "A First Course in Statistics with Applications" (Swain 2003) and "Statistical Methods" (2005). Correlation between bitter principle/Nitrate; bitter principle/ Phosphorus; bitter principle/ Potassium; bitter principle/ organic matter and bitter principle/ soil pH (in both wild and cultivated) was calculated using Karl Pearson correlation coefficient (r) as follows:

$$(r) = \frac{n\sum XY - \sum X \sum Y}{\sqrt{n\sum X^2 - (\sum X)^2}\ \sqrt{n\sum Y^2 - (\sum Y)^2}}$$

Where, X = one variable of a pair of observation

Y = second variable of same pair of observation

n = number of observations

Student's t-test was applied to determine if there was any significant difference in bitter principle in two different sites of same elevation in wild (site 1) and in cultivated (site 2).

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{S^2\ (\frac{1}{n_1} + \frac{1}{n_2})}}$$

Where,

$\overline{x_2}$ = mean of observed parameter of site2

$\overline{x_1}$ = mean of observed parameter of site1

S^2 = combined variance of calculated parameter of both sites which is calculated as:

$$S^2 = \frac{\sum (x_1-\overline{x_1})^2 + \sum(x_2-\overline{x_2})^2}{n_1 + n_2 - 2}$$

n_1 = no of samples taken from site 1

n_2 = no of samples taken from site 2

Observed values were compared with tabulated value at 5% significance level and $n_1 + n_2 - 2$ degree of freedom.

3.3 Methods of data analysis

The datas obtained from field and lab works were analyzed through various software programs of computer like Microsoft excels, Statistical Package for Social Science (SPSS) software. During the analysis, it has focused for high reliability and accuracy with low error.

CHAPTER-4

RESULTS

4.1 Ecological study of *Swertia chirayita*

The ecological study in the study area showed relatively high density and production of *Swertia chirayita* in cultivated fields than in wild at all altitudes. Relatively at 1800m altitude, the density was quite low because there are more trees and they do not provide sufficient space to grow chirayito. According to the altitude, the density as well as the production of *S.chirayita* has increased. In cultivated land, farmers/harvesters did much more care and harvest as much as they can in unsustainable manner. But the bitter principle of *S.chirayita* was found quite high in wild than those in private land as in figure 4.1. As per pharmacopeia of India, the plant should contain not less than 1.3% of bitter principle. Thus the bitter principle of *S.chirayita* in both wild and cultivated sites was found in the range of 2.048 - 2.83% which was in the range done by Joshi (2003) in the same area. Joshi (2003) found the higher % of bitter principle in the inflorescence part than root and stem and recommended to collect the plant in the flowering season.

Table 4.1: Densities, Productivities and Bitter Principle of *S. chirayita* at different altitudes

Altitude	Density of *Swertia chirayita*(plants/ha)		Production of *Swertia chirayita*/ha(kg)		Bitter principle of *Swertia chirayita* (in %)	
	wild	cultivated	wild	cultivated	Wild	cultivated
1800m	1026	16892	13.68	225.22	2.83	2.055
2000m	1882	17936	25.09	239.14	2.76	2.048
2200m	1944	18523	25.92	246.97	2.80	2.050

Average = 21.56 237.11 *Averaging 75 dried plants= 1kg

4.2 Comparison of soil parameters along with bitter principle in wild and cultivated land according to altitude

Different physical and chemical parameters of soil from both wild and cultivated land at different altitudes were analyzed (Appendix II (A)). Along with this, the soil texture and textural classification have also been done (Appendix II (B)). Comparisons of some important parameters in both sites at different altitudes are shown in figure below:

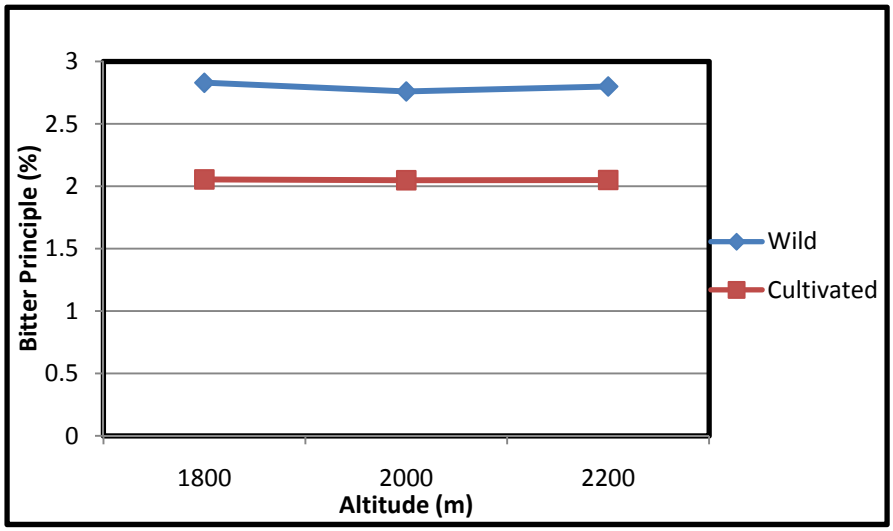


Figure 4.1: Bitter principle in wild and cultivated *S.chirayita*

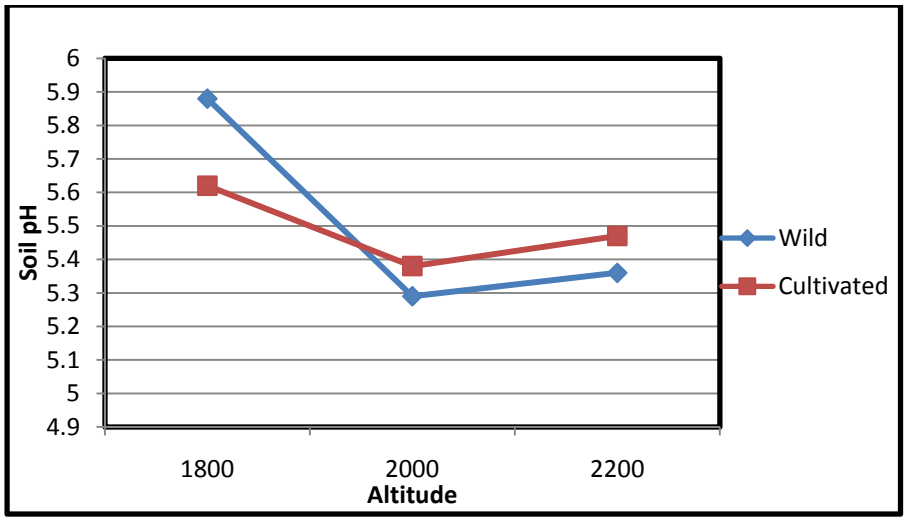


Figure 4.2: Soil pH in wild and cultivated sites

On all sites soil pH was found high in cultivated sites than wild. The pH range was 5.29-5.88 in wild and 5.38-5.62 in cultivated sites. The soil must be acidic for the suitable growth of *S.*

chirayita as suggested by Barakoti (2002). The degree of soil acidity or alkalinity, expressed as soil pH, is a master variable that affects a wide range of soil properties. This chemical variable greatly influences the availability for root uptake of many elements including roots and toxins.

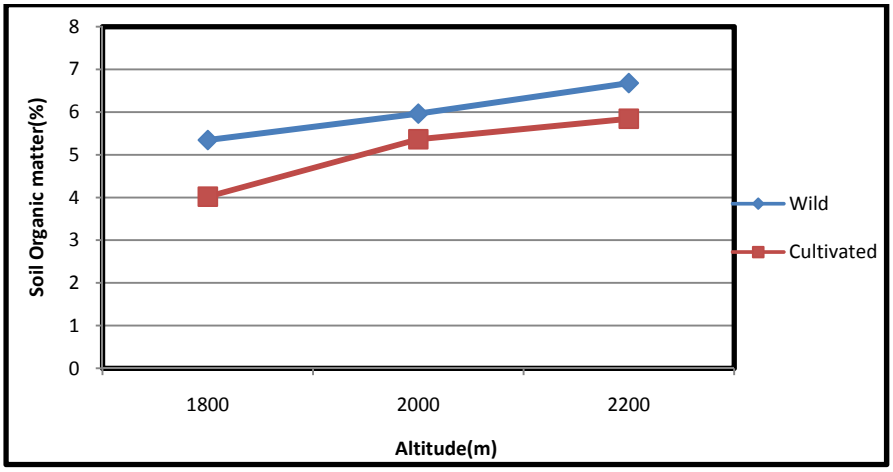


Figure 4.3: Percentage organic matter in soil of wild and cultivated sites

The percentage organic matter on soil showed higher value on most of the altitudes on wild than cultivated. This may be due the dispersal of livestock excreta during rearing period at the forest and litter/biomass content which was decomposed in soil. Generally organic matter improves the conditions of all mineral soils, helps sandy soil by increasing their water and nutrient holding capacity, nutrient and water storage, nutrient availability, soil aggregation, preventing erosion and maintaining soil matters (Edward 1997).

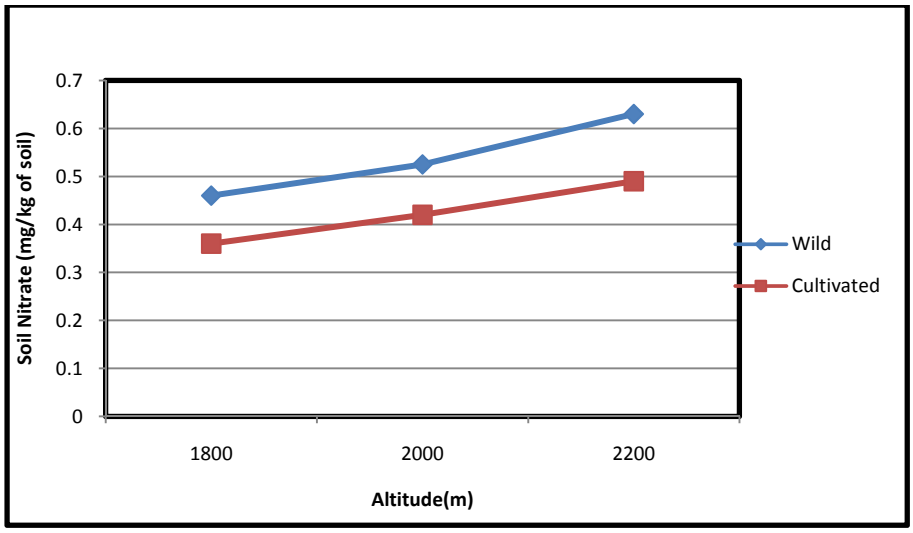


Figure 4.4: Soil nitrate in wild and cultivated soil

Soil nitrate was found quite high in wild at all altitudes as compared to cultivated sites. Atmospheric conversion of nitrogen gas into nitrate through nitrification process is the main source of nitrate on soil. No any direct addition of fertilizers supplying nitrate was observed.

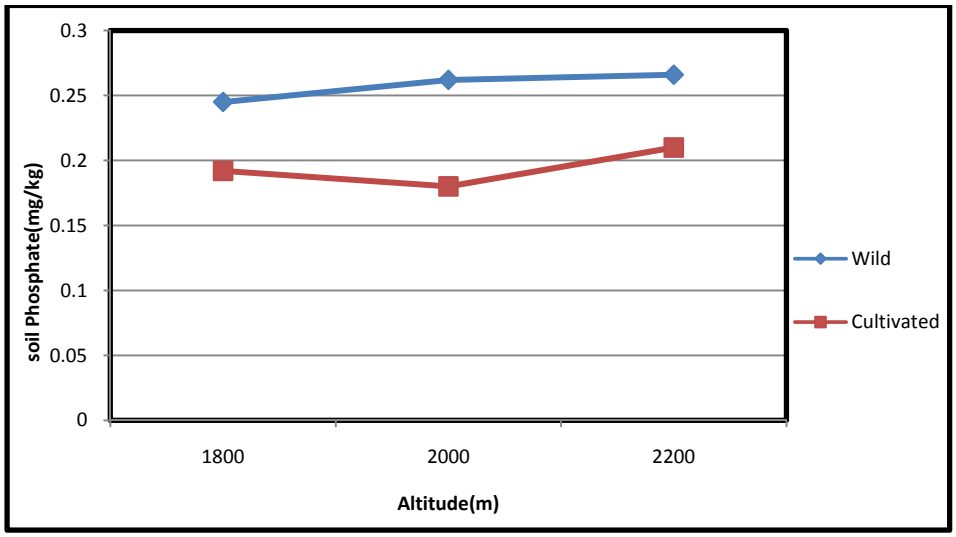


Figure 4.5: Soil phosphate in wild and cultivated soil

High value of soil phosphate was found in forest soil than in cultivated fields. Phosphorous is a part of genetic material (chromosome and genes) and so is involved in plant reproduction and cell division. But shortage of phosphate can cause stunting (Plaster 1997).

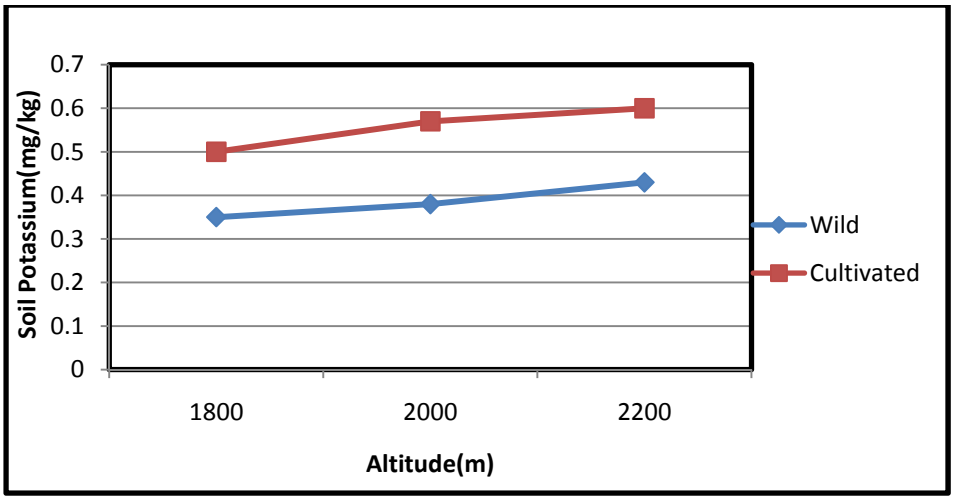


Figure 4.6: Soil potassium in wild and cultivated soil

Potassium value was found relatively higher in cultivated soils in all altitudes whereas it was lower in forest soil. This may be due to the incorporation of potassium into the soil from ash generated from slash and burn practice. Potassium is necessary for the development of thick cell wall and strong, rigid plant stems. It involves in the gas exchange needed for photosynthesis and in transpiration. Plants well stocked with potassium have strong stems that are less prone to lodging. Potassium makes plants more winter-hardy and less likely to be injured by spring or fall frosts. Deficiency of potassium in soil causes tips and edges of oldest leaves yellow (chlorosis) and then dies (necrosis) (Plaster 1997).

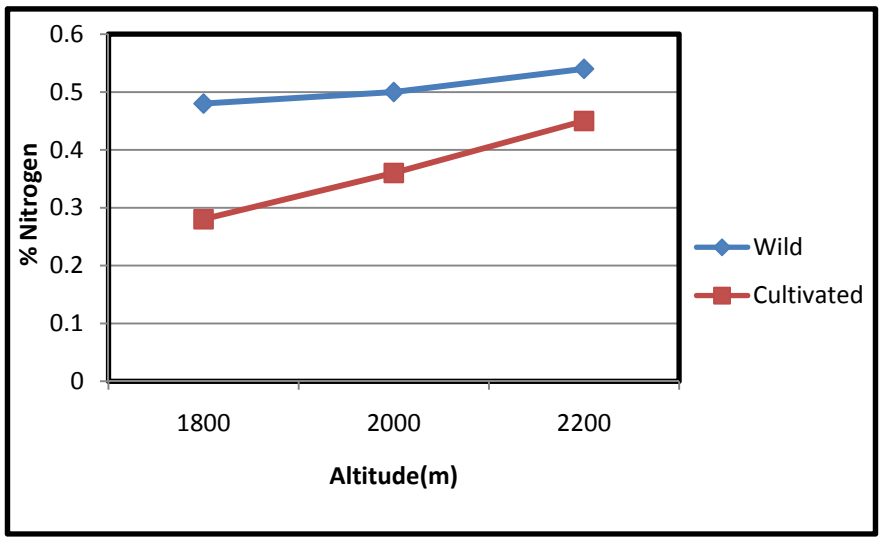


Figure 4.7: Percentage nitrogen in wild and cultivated soil

Generally nitrogen speeds the growth, make larger amounts of chlorophyll in plants. Plants use water best when they have ample nitrogen. But too much nitrogen makes the stem weaker and lodging, soft growth is more prone to diseases and insects while excess nitrogen impairs flavors. In general, nitrogen promotes vegetative growth- the growth of stems and leaves while nitrogen deficiency lead to chlorosis (yellowing of leaves) and firing (drying up of leaves) (Plaster 1997).

4.3 Statistical Analysis

4.3.1 Correlation

Correlation implies mutual relationship or association between two or more variables. For the degree of relationship, we have to compute the correlation coefficient. Correlation coefficient is a single figure which expresses the degree of relationship between two variables. Its value ranges from -1 to +1. If its value is nearer to -1, it shows negative correlation. If its value is nearer to +1, it shows positive correlation and if its value is nearer to 0, it shows no correlation (Swain 2003).

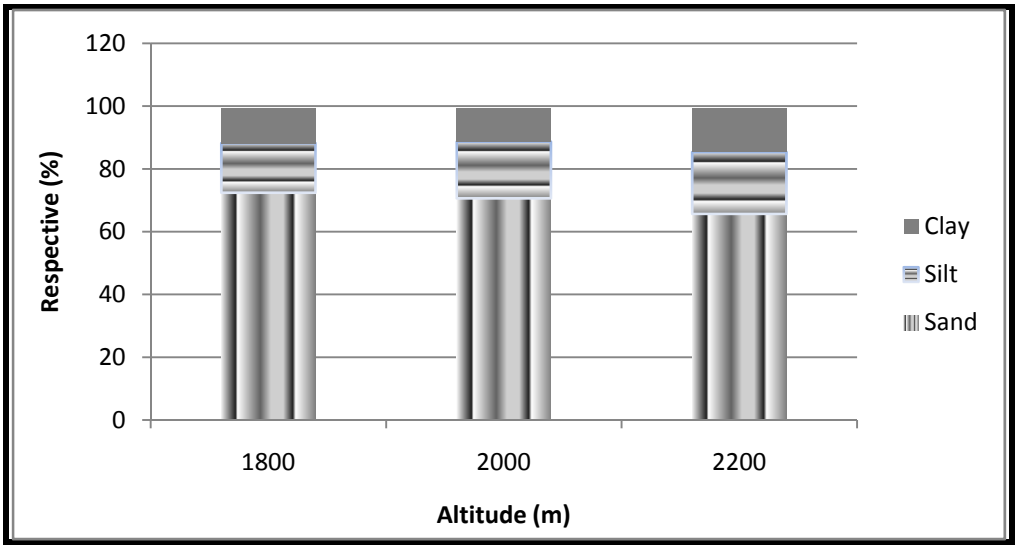
Table 4.2: Correlation between bitter principle and soil parameters

S.N	Variables	Bitter Principle	
		Wild	cultivated
1.	Bitter principle/pH	0.785	0.6075
2.	Bitter principle/nitrate	0.167	0.98
3.	Bitter principle/phosphate	-0.54	-0.29
4.	Bitter principle/potassium	0.423	0.193
5.	Bitter principle/percentage organic matter	0.26	0.4
6.	Bitter principle/percentage nitrogen	0.16	0.033

Correlation between different soil parameters and bitter principle was determined. Bitter principle/pH, Bitter principle/nitrate, Bitter principle/Percentage organic matter, Bitter principle/Percentage nitrogen and Bitter principle/potassium gave positive correlation in both wild and cultivated soils. Statistically, this means that with the increase in one parameter (bitter

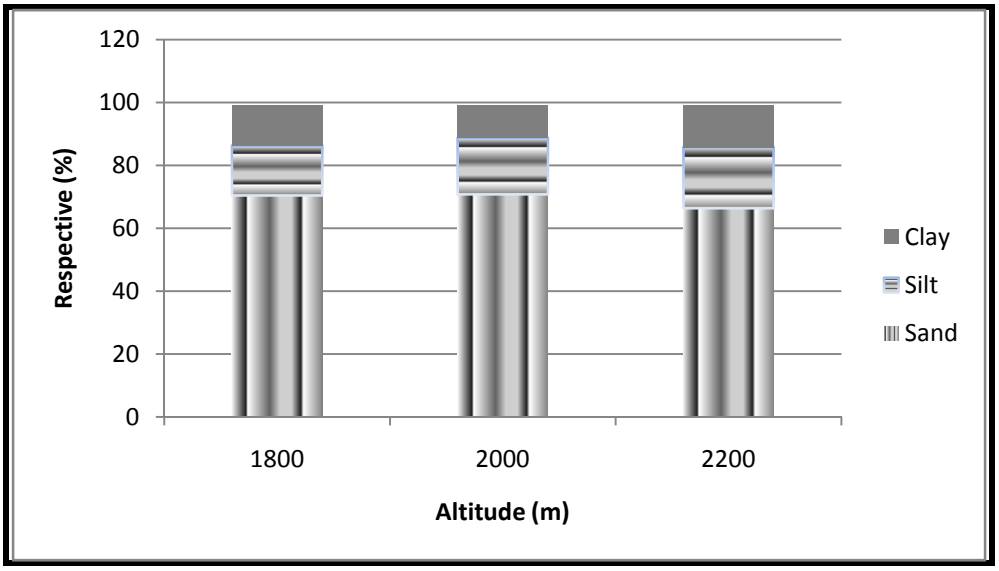
principle) of a pair (Say Bitter principle/pH) other parameter (pH) also increases and vice-versa. While Bitter principle/phosphate showed negative correlation in both wild and cultivated soils. Statistically, this means that with the increase in one parameter (bitter principle) of a pair (Say Bitter principle/phosphate) other parameter (phosphate) decreases and vice-versa.

Figure 4.8: Soil separates in wild state



Analysis of soil samples in wild showed dominancy of sandy soil on all altitudes which is most suitable for the growth of *S. chirayita* as suggested by Barakoti (2002).

Figure 4.9: Soil separates in cultivated state



Similarly, analysis of soil samples from cultivated state also showed the dominancy of sandy soil on all altitudes.

4.4 Socioeconomic Aspects

Purposive selection of 50 households was made in 5 wards and accordingly 50 respondents (at least 15 from each ward) were interviewed which includes chirayito cultivators, community forest user groups and local traders. Among them, 39 were male and 11 were female. All 50 respondents were permanent residents of that area. On the literacy basis, 39 were literate and 11 were illiterate. According to religion, 16 were Buddhist, 26 were Kirats, 2 were Hindus and 6 were others. Based on their ethnicity, 27 were Rai, 13 were Gurung, 2 were Brahmins/Chhetri, and 8 were others.

Mostly all the respondents have cultivated chirayito in their private land. It takes minimum 2 minute to maximum 20 minute to reach to the cultivated and collection site because most respondents have cultivated chirayito in their private land and private forest which are easily accessible. Paying on daily basis for harvesting and collecting of *S. chirayita* was negligible due labor shortage. Mostly male and female members of the family harvested and collected chirayito. In total, 56% of the respondents have obtained training for chirayito cultivation whereas 38% have learnt from others. 84% of the respondents have done chirayito cultivation for commercial purpose and remaining 16% for both medicine and commercial purpose. 62% respondents have done chirayito cultivation by both uniformly throwing seeds on land and by Slash and burn method whereas 38% cultivated chirayito by uniformly throwing seeds on land. 88% produce seeds of chirayito by themselves and remaining bought from others.

Almost 98% have selected chirayito for cultivation than other food crops for better income and less labor cost. Out of 100%, subsidy such as training for chirayito cultivation was given to 56% of the respondents and remaining others. All 100% respondents have found the chirayito as beneficial crop than other food crops. Almost all the respondents do not use any kind of chemical or organic fertilizers. During Chirayito cultivation, approximately 94% have found disease as the main problem. Almost 100% have knowledge about the harvesting technique and they do not have to pay royalty/tax for the sale of Chirayito. 100% respondents have knowledge of chirayito harvesting and post harvesting. Chirayito was kept for drying on sun. Chirayito is ready for sale after 15-30 days depending upon the sunny days.

Eighty six percent of the respondents sold chirayito to the buyers who came to house and 10% respondents took it to another place for sale. The market price of chirayito was found to be around Rs 8000-15000/Mann (1mann=40kg). But the fluctuation in price has been seen in the previous year according to cultivators/collectors. The cultivators sold chirayito in the range of 3-200kg (0.03-0.2ton) depending upon the amount that can be harvested yearly. Those who have large ropanies of land in which chirayito was cultivated, harvest chirayito in large amount.

The annual income of the households was in between Rs 500-50000 and above. Almost 94% respondents invest money for household expenses (such as buy foods, medical expenses etc), 4% for kids education and remaining other than that. Approximately ninety percent (90%) of respondents have agreed that the income from sale of chirayito has improved their livelihood where as 10% are not satisfied from its market value. Almost all the respondents told that income from other food crops is very difficult to sustain the family but chirayito cultivation has improved their livelihood. So, most of local people are attracted for chirayito cultivation and are planning to enhance their land for it. Thus chirayito cultivation has become an easy way to improve livelihood and better income source than other crops.

4.5 Status of *S. chirayita* in Vedichowk community forest

Chirayito was generally found in the natural state in the community forest. It was found above 1200m in barren land where there were no trees. It occupies the major position than other NTFPs in the community forest. People used to collect chirayito haphazardly from the nearby forest especially for their household uses and for sale in small amount. Based on the resource current distribution, the density of chirayita was found low as compared to those cultivated in private land. The different associated trees such as Katus (*Alnus nepalensis*), Salla(*Pinus roxburghii*), Kharane (*Sympcoces theifolia*), Khanakpa, Siltimur, Malato, kholme (*Sympcoces pyrifolia*), Jhigane, Dudhilo (*Ficus neriifolia*), Gurans (*Rhododendron sps*), Keshari (Bixa orellana), Paiyu(*Prunus cerasoides)*), Chutro (berberis aristata), Ashare were found which donot provide the sufficient space to grow chirayito. In addition, theft, no proper conservation practices, are also the reasons for chirayito to decline.

4.6 Trade Differences

As regard to the trade of chirayito from Maipokhari VDC to Birtamod, which is the central market area, there has been seen the differences in the prices as:

From Maipokhari to Birtamod,

In 2009(NRs. /Mann (40 kg)):

Harvesters NRs10, 000-12,000 ⟶ Local traders NRs. 12,000-13,500 ⟶ Central Wholesalers NRs. 13,000-15,000 ⟶ Regional Wholesalers (not found)

Accordingly in 2009, per kg price of *S. chirayita* (on average) is:

Harvesters NRs. 250 ⟶ Local Traders NRs. 300 ⟶ Central Wholesalers NRs. 350 ⟶ Regional Wholesalers (not found)

(Source: SHAHGPI, 2009-2010)

But there has been seen the fluctuation in the market price of chirayito from the previous years depending upon the demand. Sometimes it was decreasing and sometimes it was increasing.

4.7 Royalty/Tax system in the Study area

Regarding to the trade of chirayito from Maipokhari VDC, before 2003, chirayito was sold individually to the local traders in Deurali bazar. Before 2008, the farmers/collectors have to pay Rs.2-3/kg as royalty/tax directly to the local traders. But after that, Shree High Altitude Herbal Growers and Preservation Institute (SHAHGPI), Maipokhari in collaboration with District Plant Resources department, Illam had made the provision/rule of not paying royalty/tax to government/forest office for the collection of chirayito from the private land. They store the chirayito from each household and sold them. Chirayito is collected from farmers by setting up depots. As chirayito fulfilling certain criteria are only collected in the depots, quality of chirayito has also increased. They have to pay Rs.1/kg as district export tax to District Development Office and District Forest Office took Rs 15/kg/yr indirectly in the form of royalty. But there has been seen the different royalty/tax system directly or indirectly up to the destination center. Cultivators/Collectors on average got Rs 13500/ Mann (1mann=40kg) but in India, the price would be Rs. 25,000/Mann. So there has been the evidence of vast difference in the price.

4.8 History of *Swertia chirayita* cultivation in Maipokhari VDC

In Maipokhari VDC, chirayito cultivation was reported to start since 1985 A.D. In 2001 A.D, chirayito has gained the good commercial value. Due to lesser availability of seeds, seeds were brought from Taplejung and Panchthar district. Two types of cultivation practices were done.

First was throwing of seeds on the ploughed land directly. Secondly, nursery was established by spreading the seeds on the prepared land which needed organic manure of the previous year. Seedlings were planted on the ploughed land. Sand and clay mixed soil with lesser water is necessary for the efficient growth of chirayito. If more water exists, the whole plant will turn black and affected by diseases. It doesn't need any type of manure. Chirayito was planted mainly in land facing North East and North West slope. After the seeds get matured, the whole plant is collected and left to dry for 10-15days.Then it is ready to sell.

Chirayito cultivation was started in 32 VDC in Illam district including Maipokhari VDC. Generally two types of chirayito was found which includes Bhale chirayito and Pothi chirayito in which Bhale chirayito has high economic value as compared to Pothi chirayito. Pothi chirayito are Seto malinge (white stem) and Rato malinge (red stem) types. Red stem has weight and more economic value than white stem which is termed as *Swertia chirayita.*

Once the seeds were spread on the land, it was left till the plant gets matured. Chirayito was collected during November-December. Collection starts after 2 years of spreading when the plant gets fully matured and income gain started after that. Therefore, chirayito cultivation was taken as good income source than other cash crops in Maipokhari VDC.

Especially chirayito was used for curing fever, decrease diabetes and sugar. The amount of chiretten (Tito) was generally found in equal amount in stem, root and leaves. If the amount of chiretten was found lesser in plant, the medicine companies pay fewer amounts for it. Yearly, 4-5 Mann (1mann=40kg) was collected in average from each household. About 2200 farmers have started chirayito cultivation and up to 20-24 Mann (0.8-0.96ton) chirayito have been collected yearly.

4.9 Existing method of *Swertia chirayita* Cultivation in Maipokhari VDC

Cultivation method presently being practiced in the study area includes:

- Slash cutting is carried out in Chaitra-Baisakh (mid March to mid April).
- After rain at Baisakh, cleaning of land took place, and then 100gm seeds of Chirayito are mixed in 1 tin (4 pathi) sand and left spread on1 ropani land for 1 year.
- After 1 year, *S. chirayita* seedling *is* sown during Jestha to Ashad (mid May to mid July) by removing weeds. The seed is mixed in moist sand in the ratio 1:40 (seed: sand).

- In the cases where maize is sown, maize harvesting is carried out in Ashwin to Kartik (mid September to mid November) of the first year. In the second year maize is not sown. Weeding is carried out in the second year. *S. chirayita* is harvested in the third Year's Kartik to Mangshir (mid October to mid December).
- In 1 ropani land, around 150kg Chirayito can be produced from which 5 kg seeds can be obtained.
- Once the seeds are spread, the production period is up to 5 year from the same land. Again same process will be repeated.
- The harvested chirayito is dried in sun normally for 15 days and tied in bundles for selling.

However, slash and burn method also exists mainly in the private forest since it is easy method and does not need labor cost.

SHAHGPI has been providing technical support in herbs farming. The organization informed that there was a ten percent increase in production of chirayito this year. Moreover, due to the five per cent increase in selling price of the product farmers have become even more attracted towards commercial chirayito farming.

4.10 Flow Chart of Existing Market Channel of *S.chirayita* in the study area

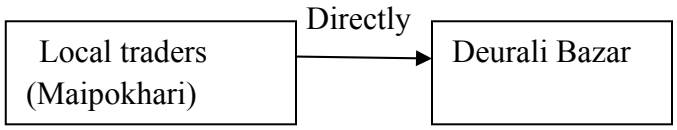


Fig: Trade route before 2003 A.D

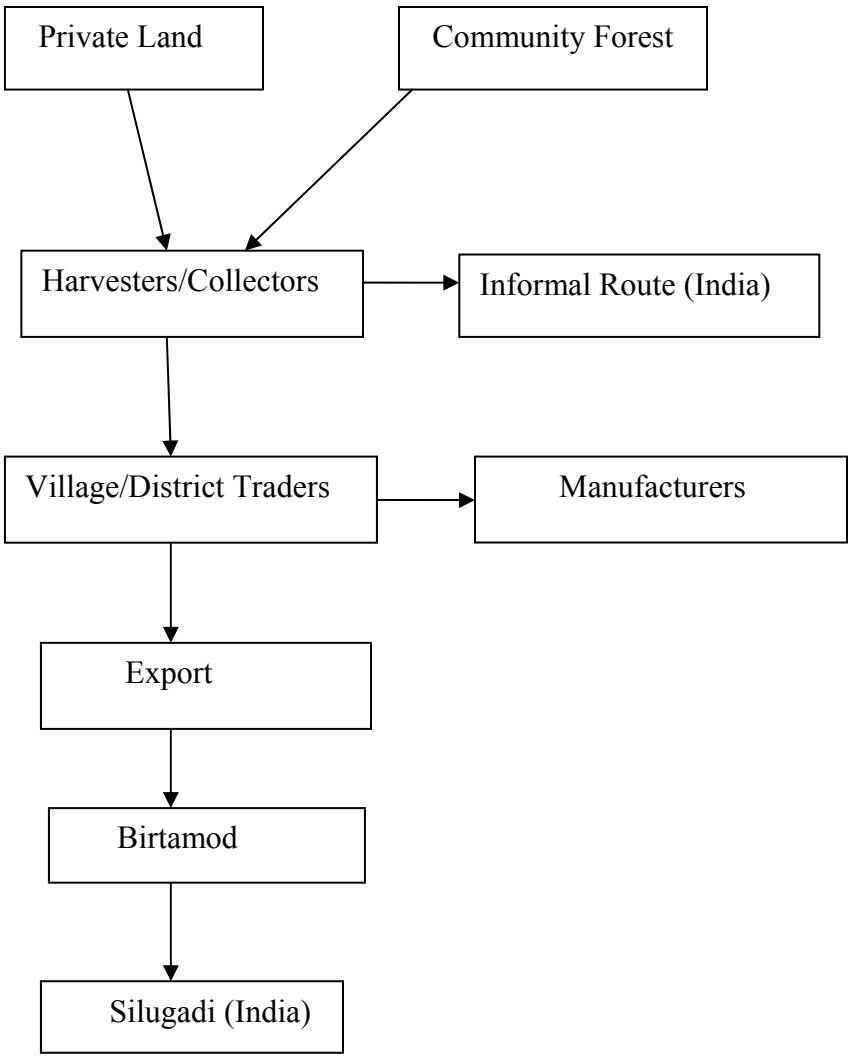


Fig: Trade Route after 2003 **Source:** SHAHGPI, 2009-2010

CHAPTER-5

DISCUSSION

5.1 Status of *Swertia chirayita* in Maipokhari VDC

With the increasing needs of growing population, together with poverty, the people of Maipokhari VDC are highly dependent on the natural resources for their subsistence livelihoods. The main occupation of almost all the people of this VDC is agriculture which is insufficient to ruin their family. From the earlier times, there has been seen the exploitation of the natural resources mostly NTFPs/medicinal plants especially *Swertia chirayita*. Since chirayito has been found as the most potential medicinal plant for valuable income source, research questions regarding the study of chirayito has been analyzed.

Since the study regarding the current status of chirayito in both community forest and private land has not been done yet, thus the present study analyzes the current situation of chirayito and its possible impacts on livelihood. Making Maipokhari Lake as base of survey of mapping was taken and from there, samples of different altitude were taken. Though the resource base of chirayito in wild has been in degrading, due to various reasons primarily because it is under public land. The present study has shown the significant number of plants per ha on wild at different altitude as 1026 plants per ha in 1800m, 1882 plants per ha in 2000m and 1944 plants per ha in 2200m relatively showing higher number in high altitude where as in cultivated sites as 16892 plants per ha in 1800m, 17936 plants per ha in 2100m and 18523 plants per ha in 2200m. Since the collection of chirayito was common among CFUGs, the resource base has been in the declining stage in the forest. This may be that in wild, collection of chirayita has been taken place very haphazardly without due consideration of its conservation and harvesting occurred before the harvesting period. The effort from the Vedichowk Community Forest Office had made the provision of paying charge if he/she collects chirayito from the forest without permission. Additionally, chirayito cultivation practices have been done in the barren land inside the forest. Thus chirayito has been conserved up to certain limit in wild. Further motivation of District Plant Resources Department, Illam in Collaboration with SHAHGPI to local people towards commercial cultivation of chirayito by providing trainings from experts since many years also has contributed to such results.

With respect to the quality of *S.chirayita* in wild and cultivated site, results were compared to examine the significant differences. Student's t-test was used to determine any significant difference between the bitter principle of chirayito among wild and cultivated sites at different altitudes. From the comparison, it was found that the calculated value of t at 5% and 1% level of significance (95% and 99% confidence level) and 4 degree of freedom (0.52) was less than that of tabulated value at 5% and 1% level of significance and 4 degree of freedom (2.132 and 3.747). Thus tabulated t-value is greater than (>) calculated t-value, hence Null hypothesis (No) is accepted. This implies that there is no significant difference in bitter principle of S.chirayita in both community forest and cultivated fields.

Thirdly, potentiality of commercial chirayito cultivation among the different groups (rich and poor) as livelihood option was examined. Almost all the wards of Maipokhari VDC were motivated to chirayito cultivation in which the present study was done in ward no. 3,4,5,6 and 7 in which most of the respondents were mainly the cultivators/collectors and traders. It was found that the capacity enhancement by DOP and SHAHGPI, Illam has significant impact on getting benefit among the poor family as well. Though the commercial chirayito cultivation has been started since 2001 A.D. due to the unavailability of seeds and lack of proper training from the experts has not been flourished. Due to the higher market value of chirayito in the study area, SHAHGPI has provided training on chirayito cultivation regarding the sustainable cultivation and uses of NTFPs. The participants who attended the training were mostly from the poor family. Nursery Preparation has also been established in the study area. Also The Mountain Institute (TMI) timely has been providing training, financial support to buy seeds in the area. Purposive selection of 50 respondents was determined which implies 15% of the total population which were mostly the collectors/cultivators. Initially, the respondents who have attended training stated the lack of financial resource to buy seed, lack of land to cultivate chirayito and lengthy harvesting time (about 2-3 years). Once land was set for cultivation, there will have proper production.

Further, the slopy land facing northeast and northwest are suitable for chirayito cultivation. People who have enough land especially rich people use larger portion of appropriate land for commercial cultivation by keeping aside the land for growing food crops. Due to the declining stage of resource base of chirayito in community forest, whether rich or poor people don't have

access for collection of chirayito in the forest now. Thus farmers/collectors were found more concentrated on commercial cultivation.

5.2 Distribution Pattern of *Swertia chirayita*, Cultivation and Soil Parameters

According to literature, *S. chirayita* is found to be at altitudes between 1200m to 3000masl (Edward 1996a, Manandhar 1980a) and in the present area also, it was reported above 1800m. Generally, occurrence of chirayito was frequent in the open land inside community forest where there were few trees. Such condition provides necessary space for chirayito to grow. Almost all the cultivated site showed the high distribution of chirayito because farmers care more in their private land. 2000-2200m altitude sites was found to be favorable where scattered chirayito saplings were observed on terraces risers near houses for household uses but not for commercial purpose.

In wild stage, two types of Swertia were found to be occurred namely Pothi chirayito (*S. chirayita*) and Bhale chirayito (*S. angustifolia*). *S. chirayita* (local name: Rato malinge having red stem) is highly bitter in taste than *S. angustifolia* (local name: Seto malinge having white stem). Average density of *S. chirayita* in study area was found to be 17784plants/ha which is comparatively higher than in wild sites. This is due to the motivation of the local people towards commercial cultivation in the study area.

On all sites, soil pH was found in the range 5.29-5.88 i.e. acidic which according to Barakoti (2000) is suitable for chirayito growth and cultivation. Slopy land with medium sunlight, dominancy of sandy soil with organic matter, north east and northwest facing slope, further aids Maipokhari VDC as potential area for commercial cultivation of chirayito.

5.3 Household Uses of *S. chirayita* among Ethnic Groups

S. chirayita has been used basically for the medicinal purpose from the ancient times in the study area. It has been seen that the traditional use of chirayito as means of treatment of fever, cough, cold and curing wounds is still dominant among the different ethnic groups mainly Rai, Limbu, Gurung and Sherpa.

An ethno-botanical use of chirayito among different ethnic groups is summarized below:

It is used to treat different diseases as:

a. Fever: Chirayito is boiled with hot water and the water is drunk to cure fever.

b. Cold, cough and Throat problem: Normally, the fresh roots are chewed but mostly, chirayito is boiled in water and then the water is drunk
c. Headache: Chirayito soaked with hot water is used to cure headache.
d. Inflammation: Body pains, wounds are also cured by chirayito.

Along with these, chirayito can also be used to control high blood pressure and to decrease the sugar/diabetes level. Since it has high medicinal value, the demand of chirayito is high in the market.

5.4 Adulteration during Trade

Generally the quality of any commodity is affected by adulteration as it reduces their cost. The trade of *S. chirayita* is also affected by the adulterants of the herb. Initially, in the past, there has been seen the high degree of adulteration by mixing bhale chirayito (*S. angustifolia*) in the bundle of pothi chirayito (*S. chirayita*). Since people realized that the bhale chirayito has less value in market than pothi chirayito, hence people are more conscious about the quality of chirayito. Hence nowadays no adulteration was observed in the samples that were ready for sale.

5.5 Marketing Routes of *Swertia chirayita* and Price Differences

Before 2003 A.D., chirayito was sold by local traders directly to Deurali bazar which was the local destination point. But nowadays with the advancement of chirayito cultivation in Maipokhari VDC, firstly chirayito was collected from each household and store in depots by SHAHGPI. They have to pay Rs 1/kg as District export tax to District Development Office (DDO), Illam and Rs 15/kg/year royalty indirectly to District Forest Office. Then the bundles were loaded in truck which contains around 50mann/truck which is headed towards Barbate VDC. In that place, Rs 500-700 tax have to be paid directly and Rs 5000 royalty at Chure Ghati Dhat, DFO. Then it was headed to Illam Bazar, Police Check Post (Ziro), Maikhola. Chirayito loaded here is finally transported by local traders to central wholesalers of Terai, mainly of Birtamod and is directly taken to Silugadi (India) by them.

At the local level, chirayito was stored in depots by SHAHGPI which collects chirayito from the harvesters/collectors as per their demand. They deduct the transportation cost and keep some profit margin and pay the remaining amount to the farmers. The farmers do not have to pay any tax/royalty directly but the amount is given to them by deducting all the expenses like local tax,

transportation cost including profit margin. Then local traders export chirayito to central wholesalers (mainly Birtamod) and then directly to India. When the price increases, then it is deliver it to regional wholesalers. Later chirayito was exported to different Indian Ayurvedic and Pharmaceutical companies.

The traders in Maipokhari VDC make good money from the sale of chirayito than cultivators/farmers. The farmers are always unaware about the fluctuating price rate outside the district and they are satisfied on amount they get. And they have no other choice except to sell their products to sub-local traders. According to relevant source, a vast price difference between cultivators and regional wholesalers has been seen as the amount is almost double the amount that the farmers get. Thus marketing co-operatives and proper market management system should be formed at VDC level to maximize benefit to the harvesters as they can directly sale their product to the ultimate market.

5.6 Socio-economic impact analysis from *Swertia chirayita*

In the study area, almost all the local people are dependent on agriculture to sustain their livelihood. Income from the sale of food crops is sufficient only for 4-6 months. From the earlier times, the traditional uses mainly household uses and sale of *S. chirayita* from wild has been seen which was found economically important medicinal herb in the study area. Due to the habitat suitability, almost all land has been cultivated by chirayito. Since the trade of chirayito plays a vital role to improve livelihood which is meant to be the good income source, thus almost all the local people have cultivated chirayito in their cultivated fields and private forest as a good cash crop in small and large scale. Those land which used to be cultivated by main food crops as maize, potato, vegetables etc has been shifted to chirayito cultivation in the study area. More than half of the respondents have obtained training for chirayito cultivation and others learnt from them. Thus chirayito cultivation was done mainly for commercial purpose as good income source. Within 3 years of cultivation, the people are getting benefit from the sale of chirayito. Since chirayito has high market value, mostly all the people have selected chirayito for cultivation than other food crops for better income and less labor cost.

The market price of chirayito was found to be around Rs 8,000- 15,000/Mann (1mann=40kg) but there has been seen the fluctuating price according to cultivators. Most of the people were satisfied with this price though they are not getting the actual price of the market. Trade of

chirayito as mean of income source has more or less improved the local people livelihood. So most of the people are attracted for enhancing their land for chirayito cultivation.

5.7 Cost/Benefit Analysis in Cultivation and Wild Harvesting of *Swertia chirayita* in Maipokhari VDC

Average production of chirayito on kg/ha from cultivated land has been found to be 237.11kg/ha (Table 5.1).Thus considering the current village level price NRs. 250, total income per ha comes to be about NRs. 68,277. Subtracting on average 20 percent of such income (NRs. 13655); investment required during land preparation, seed sowing, harvesting, drying, storage and finally sell to the traders, the net profit per ha on cultivated land is NRs.54622. Thus the present study showed that the farmers/cultivators are getting benefit from the commercial cultivation of chirayito than other food crops.

Average production of chirayito on kg/ha basis in wild i.e. community forest has been found to be 21.56kg/ha. Thus total income per ha comes to be about NRs. 5390. Subtracting on average 10% of this income (NRs. 539); investment required during harvesting, drying, royalty, storage and finally to sell traders, net profit from wild harvest is NRs. 4851. Thus the profit from cultivated field is around 12 times higher than that from wild harvesting. From the cost/benefit analysis, chirayito harvesting from cultivated field has the high potentiality to uplift the local people's livelihood.

5.8 Problems and Issues Related to *Swertia chirayita* in wild and cultivated sites

5.8.1 Premature harvesting

The whole plant is collected from wild before the appropriate harvesting time. It leads to no regeneration for the next year which has reduced the plant population in community forest yearly. Thus the resource base of chirayito is in declining trend.

5.8.2 Theft

Theft is one of the main problems on chirayito from both wild and especially from cultivated land. The farmers have said that due to high market price of chirayito, even the local people steal chirayito from their cultivated land and sell them to traders.

5.8.3 Diseases

Farmers have the problem of having the diseases in chirayito turning the whole plant black in color due to which it has no value in the market. The disease has not been identified yet and its treatment too. This may lead to problem in future.

5.8.4 Price Difference

Farmers are not getting the actual price from the sale of chirayito. They are always unaware about the price existing in the market. Thus farmers have to pay tax/royalty indirectly to the local traders. Whether farmers produce/collect more chirayito in large quantities but they are getting half of the market price.

5.9 Possible Steps to maximize benefit from *Swertia chirayita* Cultivation

5.9.1 Establishing NTFPs/MAPs based Enterprises and Herbal Processing Unit

Since chirayito has been found as the potential NTFPs (MAPs) in Maipokhari VDC, it is necessary that the products should gain its value locally. This could be maximized by establishing local enterprises and local processing units in the area so that the local farmers would get fair and actual price. Thus this will encourage farmers for chirayito cultivation in larger scale and sale of their products will provide them reasonable price which could be the good livelihood option. TMI is planning to establish herbal processing unit in the study area.

5.9.2 Formation of Marketing Co-Operatives

Market cooperatives, with a greater power to bargain and by-pass the Terai level traders need to be formed.

CHAPTER-6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Due to suitable environmental condition, *S. chirayita* is commonly found in Central and Eastern Nepal than Western region. Since chirayito is found in Maipokhari VDC, Illam, thus the present study was carried out to study its current status along with its soil parameter analysis, market potentiality and its impact on livelihood in the study area.

In the study area, chirayito was mostly confined in between the altitude of 1800masl-2220masl in both wild and cultivated sites though it can be observed between 1500-3000masl. For commercial cultivation of chirayito, above 1200masl where there are no trees is suitable for its growth in that area. Slopy northwest and northeast facing slopes are favorable for chirayito cultivation.

Density of chirayito was found high in cultivated sites, i.e.17783 plants/ha than in wild, i.e. 1617 plants/ha on average. Production of chirayito per ha on average was 237.11 kg from cultivated field and 21.56 kg from community forest. Bitter principle analysis showed high value on all altitudes in wild i.e. 2.79% on average (>1.3%) which is according to Pharmacopoeia of India. Soil parameters analysis showed high value in soil collected from wild except soil potassium which is high in cultivated sites. Dominancy of sandy soil is found in both wild and cultivated chirayito.

Statistical analysis showed both positive and negative correlation among bitter principle of chirayito and soil parameters in both wild and cultivated sites. T-test showed no significant difference in bitter principle between chirayito collected from both community forest and cultivated fields.

Most of the respondents have done chirayito cultivation in their private land in the study area. Over ninety percent of the local people are satisfied from the income generated through the trade of chirayito which they used for household expenditures (such as buy foods, medical expenses etc). Thus shifting of people towards commercial chirayito cultivation in larger amount is increasing than other food crops. DOP, Illam in collaboration with TMI and SHAHGPI timely provide trainings for cultivation of chirayito. But people still use slash and burn method

especially in their private forest since it is very easy method. No any use of chemical fertilizers and pesticides was seen but in some cases the organic fertilizers has been used.

Traditionally people use chirayito to cure cold, cough, headache, fever and throat problem. However chirayito cultivation was done for commercial purpose as income source. Cultivators/collectors have to pay royalty/tax directly/indirectly for the sale of chirayito harvested from private land earlier but TMI had made provision of not paying royalty from the cultivators. So no royalty system exists for chirayito harvested from cultivated fields. Mainly legal trade network exists in the study area in which destination point is Silugadi (India).

There is a high price and profit difference in between producers and central wholesalers. No adulteration in chirayito was observed in the study area. Cost/Benefit analysis showed profit about 12 times higher in chirayito harvested from cultivated fields than harvested from wild (community forest) based on its current production.

Before cultivation, chirayito has low market value but after cultivation, its market value has increased. Hence people are planning to expand to cultivate it even in their agricultural land also. Income from other food crops is very difficult to run the family but chirayito cultivation and its sale have improved livelihood and if farmers are given its actual price, then it will definitely uplift their livelihood.

Due to the suitable environmental condition, adequate northeast and northwest facing slopes, altitudes, the study area is suitable for commercial cultivation of chirayito. Thus analysis of its distribution, bitter principle, soil parameters and its impact on local people's livelihood would provide suggestive informations for the further livelihood enhancement works in the study area. Benefit and livelihood of the cultivators/collectors of the study area can be improved by increasing their access to techniques of cultivation with proper market management system. Additionally, commercial chirayito cultivation will not only be livelihood option but also help for the conservation of this species in their natural state.

6.2 Recommendations

Based on the findings of the present study, the following recommendations have been made with regard of the production, management and trade of MAPs emphasizing *S.chirayita*.

- Since chirayito cultivation is easy way to improve livelihood, it should be prioritized as main cash crops.
- Information about the markets and price rate should be provided to the cultivators.
- Sufficient technical knowledge and trainings for the cultivation of chirayito should be given to the local people along with the treatment of the diseases.
- Rules and regulations related to the market management should be made and communicated to the cultivators/farmers.
- MAPs based enterprises, herbal processing units and market cooperatives should be established at local level involving all the sectors of the community.
- Provision of good quality seeds of chirayito having high weight should be made by establishing demonstration plots in the study area.
- Provision of forming groups for seed distribution and diseases control should be made.
- MAP-based industries should be established which not only expand jobs, but enhance traditional uses through value added processing and increase cash earnings to the local people.
- MAPs section under District Forest office with special responsibility for promotion and marketing of Jadibuties should separately be set up so that MAPs section may work efficiently for inspiration, production, value addition, processing, marketing and demand-supply situation of the concerned district.

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APPENDIXES

APPENDIX I: Guiding Questions for Interviews

Name of the interviewer: …… Date: …….. Place: …… Time: ……

Introduction of respondent:

Name: ……

Age: …….. Gender: ……. Literacy: …….

Residence period: ……..

Household characteristics:

1. Name of the household head: ……

2. Religion: …….

3. Ethnicity: ……

4. Family structure:

S.N	Name	Age	Gender	Relation to head	Marital status	Education	Occupation

5. Type of house:

a) pucca b) Semi pucca c) Kutchha

6. Do you own any agricultural land?

If "yes", how much and what type? .....

If "no" what will you do? .....

7. What type of crop do you grow?

S.N	Crop type	Area	Production	Consumption	Surplus/deficit	Deficit period (months)

7. Does agricultural production sustain your family for a whole year? Yes/No

If "No" for how many months? .....

8. How will you manage for the deficit months?

Buy/Burrow/Barter/Wage labor/ others. (…….)

9. If surplus what do you do with surplus crop?

Store/Sale/Barter/Other (……)

NTFPs collection:

1. Name the NTFPs found in your CF. What are their traditional uses and which part is used for which purpose?

S.N	NTFPs	Parts used	Uses

2. Did you go to collect NTFPs from your CF?

3. How many family members are involved in NTFPs collection?.....

4. Purpose:

a) Subsistence b) Commercial

5. If you sold then how much did you sell, at what rate and where?

S.N	NTFPs	Sold quantity(in kg)	Rate	Place	Year

B. Semi-structured Questions for Farmers/Collectors regarding chirayito

1. Do you have any knowledge about medicinal plant, “chirayito” found in your CF?

a. Yes b. No

2. How much it takes you to reach to collection site?

3. What is the current situation of chirayito in your CF? If not good then why?

4. Since how many years you have been collecting chirayito from your CF?

a. 1 year b. 2 year c. 3 year d. 4 year e. 5 year f. > 5 year

5. What is the purpose of collecting chirayito in CF?

a. Medicine b. commercial

6. Do you have any knowledge about the collection of chirayito?

a. Yes b. No

7. If yes then what is the appropriate time?

a. At early stage b. when flower bloom c. After seed matures

8. Do you collect chirayito before appropriate time even if you know?

a. Yes b. No

9. If yes ten from where?

a. Wild b. Cultivated

10. Why do you do so?

a. Due to lack of money b. Others do so c. For medicine d. Others

11. Have you cultivate chirayito in your own land?

a. Yes b. No

12. How did you know about chirayito cultivation?

13. What is the purpose of cultivating chirayito?

a. Medicine b. Commercial c. Others

14. Since when are you being cultivating *S. chirayita* commercially?

a. 1 year b. 2 year c. 3 year d. > 3 year

15. How have you cultivated chirayito?

a. Slash and burn b. Uniformly throwing seed on land c. Ploughing land d. Others

16. On how much ropanies/areas have you cultivated through slash and burn

17. Why do you prefer for slash and burn?

a. It is faster and reliable b. Gives more production c. others

18. How do you obtain seed of chirayito?

a. Produce myself b. buy from neighbours c. organization provide d. others

19. Why do you select chirayito?

a. For better income b. Others

20. Do you get any kind of subsidy for cultivating chirayito?

a. Yes b. No

21. What type of subsidy if any?

a. Technical b. Financial c.Training for commercial cultivation d. Others

22. Which cultivation is beneficial, chirayito or other food crops?

23. What is the main problem on commercial cultivation of chirayito?

a. Lack of technical knowledge b. Unavailability of seed/ fertilizer on time

c. Labor shortage d. Disease e. Others

24. How much you have use fertilizer and which type?

a. organic b. chemical

25. If chemical fertilizer has been used then how much you spend on it and from where do you bring?

a. local market b. District headquarter c. Others

26. Which member of your family is more involved in collection and cultivation of chirayito?

a. Male b. Female c. Both

27. Did you have to pay any tax for collection of chirayito in wild or cultivated?

a. Yes b. No

28. If you have to pay tax then how much is the tax/kg?

29. Do you have the provision to pay royalty for selling chirayito, if then by how much/kg?

30. Do you have knowledge about the collection of chirayito either in wild or cultivated?

a. At early stage b. After seed matures c. Flowering stage

31. How do you do harvesting of chirayito in wild or cultivated?

32. After collection, how do you store chirayito?

a. By drying on sun b. Drying on shed c. drying on wood-fired oven

d. Others

33. In how many days does chirayito become ready for sale after subjected to drying?

34. What is the position of chirayito regarding other than NTFPs and why?

35. How do you sell chirayito?

a. Buyers come to house b. have to take somewhere else

36. To whom do you sell chirayito?

a. Buyers whom you know b. Buyers who pay high c. Others

37. Do you know about its market price? if yes then how much?

38. Are you satisfied with its price?

a. Yes b. No

39. What problem do you face while selling chirayito?

a. Lack of market b. Lower price than expected c. Others

40. Yearly how much you sell and gain while selling chirayito from cultivated land?

41. Quantitatively how much amount you have expected to obtain yearly?

42. Where do you spend the money that gained from selling chirayito?

43. Do you think chirayito cultivation will improve your livelihood?

APPENDIX II (A): **Physical and Chemical Parameters of Soil**

	Wild *S.chirayita*			**Cultivated *S.chirayita***		
Parameters	Site1	Site2	Site3	Site4	Site5	Site6
Altitude	1800m	2000m	2200m	1800m	2000m	2200m
pH	5.29	5.88	5.36	5.62	5.38	5.47
% organic matter	5.34	5.96	6.68	4.01	5.36	5.84
Nitrate (mg/kg)	0.46	0.52	0.63	0.36	0.42	0.49
%Nitrogen	0.48	0.5	0.54	0.28	0.36	0.4
Phosphate(mg/kg)	0.24	0.26	0.26	0.19	0.18	0.21
Potassium(mg/kg)	0.5	0.57	0.6	0.35	0.38	0.43

APPENDIX II (B): Texture and Textural Classification of Soil

	Wild *S.chirayita*			**Cultivated *S.chirayita***		
Soil separates (%)	**Site1**	**Site2**	**Site3**	**Site1**	**Site2**	**Site3**
Altitude(m)	1800m	2000m	2200m	1800m	2000m	2200m
Coarse sand	38.52	38.03	40.47	37.85	38.28	41.39
Fine sand	33.95	32.63	25.24	32.62	32.55	25.03
Silt	15.76	18.05	19.72	15.89	17.95	19.42
Clay	11.18	10.59	13.84	12.96	10.47	13.36
Sieve loss (%)	0.59	0.70	0.73	0.68	0.75	0.80
Soil textural classes	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Soil type	Poorly graded uniform soil	Poorly graded uniform soil	Poorly graded uniform soil	Well - graded sand	Well - graded sand	Well - graded sand

APPENDIX III (A): Prioritized and Economically important MAPs Cultivation data in Illam District

S.N	MAPs Species	Total Production in kg/bulbs/plants
1.	Chirayito *(Swertia chirayita)*	32659
2.	Lokta *(Daphne bholua)*	19235
3.	Ok Aalu *(Lilium nepalenises)*	97300
4.	Sugandhawal*(Valeriana jatamansi)*	2040 (Plant)
5.	Chameli*(Jasminum arborescence*)	10220 (bulb)
6.	Bikhuma	215
7.	Bhalu Toho	4600
9.	Budo Okhati	40
9.	Timur (*Zanthophylum alatum*)	10 kg
10.	Chimfing	5 kg

APPENDIX III (B): MAPs Cultivation Data in Maipokhari VDC

S.N.	MAPs Species	Production in KG/bulb/Plant	Total Income NRs	Cultivation areas in ropani	Benefitted Households
1.	Chiraito (*Swertia chirayita*)	5587	1512580	1381	217
2.	Lokta (*Daphne bholua*)	3280	123200	138	36
3.	Ok Aalu*(Lilium nepalenises)*	900 bulbs	3600	4	2
	Total		**1639380**	**1523**	**255**

(Source: SHAHGPC, 2009-2010)

APPENDIX III (C) : Major NTFPs found in community forest and its uses

S.N	NTFPs	Parts used	Uses
1.	Chirayito	Root, stem, leaves	Fever, cold, cough, body pain
2.	Harchur	Leaves, stem	Body wounds, body pain
3.	Pakhanbeth	Root	Body pain, women's pregnancy period
4.	Budho okhati	Root	Body pain
5.	Dudhe lahara	Stem	Leg and hand fracture part
6.	Thulo okhati	Stem	Chest pain, body pain

(Source: Samudayik Banko Karyayojana, Vedichowk Community Forest, 2065)

APPENDIX IV: GLOSSARY OF TECHNICAL TERMS

Rosette: that grow in the shape of rose; patterns of leaves radiating from center

Viability: ability to germinate.

Decurrent: extending down the stem below the place of insertion.

Stout: strong and thick

Axillary: placed or growing in the axis of a branch of leaf

Bivalent: a pair of homologous, synapsed chromosomes associated together during meiosis

Gestation: act of carrying embryo.

Melancholia: A mental disorder characterized by severe depression, guilt, hopelessness and withdrawl

Anthelmintic: capable of destroying or eliminating parasitic worms.

Anti-inflammatory: reducing inflammation such as fever, swelling.

Tinctures: chemical drug.

Infusions: a liquid extract prepared by soaking in water.

Anti-pyretic: relieving the pain and stimulating the healing of burn.

Hepatoprotective: pertaining to medicines that protect the liver

Hypoglycemic: an agent that lowers blood glucose or levels

Anti-diabetic: pertaining to an agent that prevents or relieves symptoms of diabetes

Anti-hepatotoxic: the medicine that acts against hepatotoxicity i.e. the quality or condition of being toxic or destructive to the liver

PHOTOGRAPHS

Interviewing with local farmers

DOP, sector office at Maipokhari and SHAHGAPI, Illam


Collecting soil sample and sample of *S. chirayita*


Chirayito siblings and its plantation on terraces


Vedichowk community forest


***Swertia chirayita* (Pothi chirayito)**

Bhale chirayito