ACCESS TO AND BENEFIT SHARING FROM *SWERTIA CHIRAYITA*: CASE FROM YAMPHUDIN, KANGCHENJUNGA CONSERVATION AREA, NEPAL

A Dissertation Submitted to Central Department of Environmental Science
Tribhuvan University, Kirtipur, Kathmandu, Nepal
In Partial Fulfillment of Requirements for the Degree of Masters of Science in Environmental Science

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LETTER OF RECOMMENDATION

This is to certify that Mr. **Ghanendra Uprety** has prepared this dissertation entitled **"Access and Benefit Sharing of *Swertia chirayita*: Case from Yamphudin, Kangchenjunga Conservation Area, Nepal"** as partial fulfillment of the requirements for the degree of masters of Sciences in Environmental Science **(Mountain Environment)** under my supervision and guidance.

This dissertation bears the candidate's own work has not been submitted for other purposes. I, therefore recommend this dissertation for approval and acceptance.

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DECLARATION

Me, **Ghanendra Uprety** hereby declare that the piece of work entitled **"Access to and Benefit Sharing from *Swertia chirayita*: Case from Yamphudin, Kangchenjunga Conservation Area, Nepal"** presented herein is genuine work, done under the financial support of Medicinal and Aromatic Plants Programme in Asia (MAPPA), International Center for Integrated Mountain Development (ICIMOD) for the requirements of a Master's degree program and has not been published or submitted elsewhere. Any literature data works done by others and cited within this dissertation has been given due acknowledgement and listed in the references.

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Ghanendra Uprety
15th July 2008.

II

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ABBREVIATIONS AND ACRONYMS

ABS	Access and Benefit Sharing
ANSAB	Asian Network for Small Scale Agriculture and Bio-resources
CAUC	Conservation Area User Committee
CBD	Convention on Biological Diversity
CBS	Central Bureau of Statistics
CFUGs	Community Forest User Groups
COP	Conference of the Parties
CSIR	Council of Scientific and Industrial Research
DDC	District Development Committee
DFO	District Forest Office
DNPWC	Department of National Parks and Wildlife Conservation
DPR	Department of Plant Resources
FWRD	Far-Western Development Region
ICIMOD	International Center for Integrated Mountain Development
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	The World Conservation Union
KCA-MC	Kangchenjunga Conservation Area Management Council
KCAP	Kangchenjunga Conservation Area Project
MAPPA	Medicinal and Aromatic Plants Programme in Asia
MAPs	Medicinal and Aromatic Plants
MFSC	Ministry of Forest and Soil Conservation
MG	Mothers' Group
MWDR	Mid-Western Development Region
NTFPs	Non-Timber Forest Products
PRA	Participatory Rural Appraisal
SHL	Sacred Himalayan Landscape
USD	United States Dollar
VDC	Village Development Committee
WWF-NP	World Wide Fund for Nature – Nepal Programme

GLOSSARY OF TECHNICAL TERMS

Acute:	leaf apex that is pointed in the form of acute angle ($<90^0$).
Alexiteric:	able to ward off communicable disease.
Anthelmintic:	capable of destroying or eliminating parasitic worms.
Anti-inflammatory:	reducing inflammation such as fever, swelling.
Anti-periodic:	efficacious against periodic diseases.
Anti-pyretic:	relieving the pain and stimulating the healing of burn.
Aphrodisiac:	drug promoting sexual desire.
Apiculate:	tipped with a short, abrupt point as of leaf.
Appetizer:	stimulating the desire to eat.
Astringent:	that which causes contraction and healing.
Bracts:	small modified leaves with underdeveloped blade.
Calculi:	stone.
Concoction:	in combination with.
Conjunctivitis:	inflammation of the delicate membrane lining the eyelids and covering the eyeball.
Decocted:	extract flavor or essence by boiling.
Decurrent:	extending down the stem below the place of insertion.
Decussate:	arranged along the stem in pairs, each pair at right angle to the pair next above or below.
Demulcent:	having a soothing effect on the skin and mucous membrane.
Diuretic:	increases the secretion and discharge of urine.
Ecoregion:	a relatively large area of land or water that contains a geographically distinct assemblage of natural communities.
Emetic:	that causes vomiting.
Febrifuge:	reducing fever.
Foliaceous:	leafy; leaf bearing.
Gastropathy:	disease of stomach.
Gestation:	act of carrying embryo.
Gonorrhoea:	infectious venereal disease.

Hemorrhage:	discharge of blood from blood vessel.
Hepatopathy:	disease of liver.
Infusions:	a liquid extract prepared by soaking in water.
Intangible:	that has no physical existence.
Lanceolate:	narrow or tapering at both ends.
Laxative:	relieving constipation.
Leucorrhoea:	a whitish, viscid discharge from vagina.
Maggot:	legless larva of certain dipterous insect (mosquito, housefly etc).
Nauseate:	to make feel uncomfortable.
Nepropathy:	disease of kidney.
Obtuse:	leaf apex that is blunt or round.
Ophthalmic:	related to eyes.
Ovate:	leaf having more or less egg shaped lamina, broader at base than at apex.
Panchang:	Root, stem, flower, leaf and fruit.
Pedicles:	thin stem (stalk) of single or individual flowers.
Pharmacopoeias:	books usually prepared under the jurisdiction of government containing information about drugs.
Pith:	soft spongy connective tissue found in many plant stem but not in woody plants.
Poultice:	herbal preparation usually applied hot to infected area to alleviate pain and reduce swelling.
Refrigerant:	reducing bodily heat or fever.
Rosette:	that grow in the shape of rose; patterns of leaves radiating from center.
Sclerosis:	hardening of the tissue.
Sessile:	attached directly without petiole.
Strangury:	slow and painful discharge of urine.
Sudorific:	causing sweat.
Tangible:	that can be perceived by touch.
Tinctures:	chemical drug.
Viability:	ability to germinate.

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ABSTRACT

Keywords: *ABS; bitterness; cultivation; Swertia chirayita; soil; trade*.

Access and Benefit Sharing (ABS) is provision under Convention on Biological Diversity (CBD) that governs access to genetic resources and how benefits arising from their use are shared. Draft ABS law has been prepared in Nepal which is still being debated and waiting for promulgation.

Chiraito *(Swertia chirayita)* is bitter plant possessing multipurpose medicinal uses categorized as vulnerable by Shrestha and Joshi (1996). Commercial cultivation of *S. chirayita* has been practiced in the study area between 1800 to 2800 masl. *S. chirayita* favors north facing slopes, sandy soil rich in organic matter with pH 4.5 to 5.5. *S. chirayita* was observed on slopes ranging from 5^0 to 70^0.

Questionnaire survey was conducted to generate primary data while literatures were reviewed to gather secondary information. Stratified sampling was used for the ecological study of *S. chirayita*. Soil parameters and bitter principle were analyzed in the laboratory.

Cultivated *S. chirayita* showed high density and accordingly high productivity. Bitter principle showed high value in *S. chirayita* collected from wild. However, student t-test showed no significant difference in bitter principle between wild and cultivated *S. chirayita*. Mostly positive correlation was observed between soil parameters and bitter principle.

About 30 percent of the household expense was found to be fulfilled from income generated from the trade of *S. chirayita*. Common household use of *S. chirayita* observed among different ethnic groups was to cure fever, cough, headache, cold, and throat problem. Market survey showed no adulteration on *S. chirayita* during trade. However, trader reported occurrence of such cases sometimes by mixing chiraito of inferior quality called as bhale chiraito.

Different royalty system exists in the study area for *S. chirayita* harvested from national forest/wild and that from private land. Harvesters have to obtain collection permit from KCA office to harvest *S. chirayita* from wild. Cultivation on private land showed higher income

than collecting from wild. Owing more land, rich people have more access to commercial cultivation of *S. chirayita*. Current status of local level value addition was confined to sun drying after harvest. Both legal and illegal trade network was noted form the area. Legally 3757 kg and illegally 1429 kg of *S. chirayita* have been estimated to be exported annually from the study area.

Nine NTFPs were found exported to Tibet from Taplejung. Due to lack of custom office at the border and relatively attractive price in Tibet market, trade of NTFPs towards Tibet has been reported to be increasing though in slow pace.

Harvesting of *S. chirayita* only after the seeds get mature and fall to the ground is recommended. Formation of market co-operatives and establishment of *Jadibuti mandi* should be initiated by KCAP. Appropriate and effective cultivation methods of high valued MAPs feasible to that agro-climatic zone should be initiated through establishing demonstration plot.

CHAPTER -1

Introduction

1.1 Access and Benefit Sharing in the Context of Convention on Biological Diversity (CBD)

In 1992, in Rio de Janeiro, the United Nations hosted an Earth Summit to consider the state of the world's environment. In addition to producing a number of nonbinding declarations of international environmental policy, the Earth Summit gave birth to the Convention on Biological Diversity (CBD 2000). The specific concern of the CBD is biological diversity, which the convention defines as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this include diversity within species, between species and of ecosystems." (CBD 1992).

As set forth in Article 1 of the Convention, the objective of the CBD is the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding. (CBD 1992).

Article 15(5) of the CBD gives teeth to the sovereignty principle by requiring collectors of genetic resources to obtain the permission of the nation where the resources are located before they may be removed and subject to Prior Informed Consent. The state's authority to regulate access is tempered by Article 15(2), which requires signatories to the CBD to "endeavor to create conditions to facilitate access to genetic resources," and forbids them to "impose restrictions which run counter to the objectives of this convention." The CBD's conception of sovereign rights does not grant states an "ownership" right over genetic resources. Article 16 of the CBD requires member countries "to provide and/or facilitate access for and transfer to other Contracting Parties of technologies that…make use of genetic resources. Article 19 of the CBD provides that developing countries should receive a share in the benefits from biotechnology. Parties to the Convention must "take all practicable measures to promote and advance priority access on a fair and equitable basis by Contracting

Parties, especially from developing countries, to the results and benefits arising from biotechnologies base upon genetic resources provided by those Contracting Parties, such access shall be on mutually agreed terms. (CBD 1992).

The CBD marked the end of the common heritage of mankind conception of genetic resources to common concern. Before that, there was no international legal regime to regulate access to genetic resources and to promote the sharing of benefits arising from the commercial and scientific uses in agricultural and industrial sector. The CBD does not refer to a "common heritage," and its preamble states only that conservation of biodiversity is a "common concern of humankind." Instead, the CBD reasserts the principle, earlier espoused in Resolution 3/91 of the FAO Commission on Plant Genetic Resources, that nations have sovereign rights over natural resources within their boundaries, and that "the authority to determine access to genetic resources rests with the national governments and is subject to national legislation." (ITPGRFA 2001).

Access and benefit sharing (ABS) from genetic resources is a major concern these days. The convention on Biological Diversity contains rules that clarify the rights and responsibilities of the parties accessing biological resources from member countries. One aspect of the convention addresses the system that governs access to genetic resources and how the benefits arising from their use are shared. This legislation is commonly called the Access and Benefit-Sharing program. Anyone pursuing collection activities, whether of tangible materials or intangible information, may be subject to these new regulations (Thornström and Björk 2007).

Conference of the Parties (COP) IV established an expert group on ABS in1998; COP-V established Open-ended Working Group on ABS in 2000, COP-VI developed Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of Benefits Arising out of their Utilization in 2002, COP-VII came up with negotiation of an international regime on ABS in 2004. Bonn Guidelines are voluntary guidelines to assist Governments and stakeholders to establish legislative, administrative or policy measures on access and benefit-sharing and to negotiate contractual arrangements for access and benefit-sharing (Scott 2008).

Access to genetic resources is not defined in the Bonn Guidelines and, therefore, definition varies according to national legislation and practice. Access may consist of various activities including entering a location where genetic resources are found, surveying activities, obtaining or acquiring genetic resources for scientific and or commercial purposes Oli et al. 2007). Benefit is the economic, academic and intellectual advantage arising from research on utilization of genetic resources (SAS 2006, cited in Oli et al. 2007). Benefit sharing according to World Conservation Union (IUCN) (2004b) is sharing of whatever accrues (whether monetary or non-monetary) from the utilization of biological resources, community knowledge, technologies, innovations or practice.

1.2 Adoption of Convention on Biological Diversity in Nepal

Nepal became party to the Convention on Biological Diversity in 12 June1992 when 154 countries signed the convention during the United Nations Conference on Environment and Development held in Rio de Janeiro. The fifth session of the Nepali parliament ratified the CBD on September 15, 1993. The convention entered into force globally on December 29 of the same year, while it has been implemented in Nepal since February 21, 1994. Acts and Rules formulated to suit to achieving the objectives of the CBD are: Environment Protection Act, 1996, and Regulations, 1997 (amended 1999)., Buffer Zone Management Guidelines, 1999., and Government Management on Conservation Area Rules, 2000 (Tamang 2006). Legal instrument to specifically address the issue of ABS has been initiated from 1998. This resulted in a draft ABS law which is still being debated and waiting for promulgation. In absence of specific law, earlier legal instrument are still operational for the regulations of Medicinal and Aromatic Plants (MAPs) in Nepal.

1.3 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. There is no consistency in the literature citing the growth of *S. chirayita*. Some authors have described chirata as an annual (Kirtikar and Basu 1984) and others as biennial (Bhattarai and Ghimire 2006).

Its medicinal usage is reported in Indian pharmaceutical codex, the British and the American pharmacopoeias and in different traditional systems of medicines such as the Ayurveda, Unani and Siddha (Joshi and Dhawan 2005). The whole plant i.e. root, stem, leaf, flower and fruit (Panchang) has been used as a refrigerant, anti-inflammatory, anti-pyretic, sudorific and anti-periodic in ayurvedic medicine (Chandola 2005).

Life cycle of *S. chirayita* involves two stages: rosette and reproductive; mature plant attains up to 1.5m high, densely leafy, branched, black or pinkish in colour after maturity, leaves sessile, numerous, approximate, decussate 2-3 by 1.3-2.5cm, broadly ovate, obtuse, sometimes shortly apiculate, 5-(less commonly 3) nerved. Flowers vary numerous in dense; pedicles 2.5-13mm long; bracts foliaceous, lanceolate, acute with a strong mid-nerve. Stem and leaves are smooth. Seeds are egg-shaped (Bhattarai and Acharya 1997).

The root is small, 5-10 cm long, light brown, somewhat twisted and gradually tapering, bearing a few rootlets or their remnants. It possesses the property of bitter tonic but, unlike most other bitters, it doesn't constipate the bowel. Instead, it tends to produce a regular action and cause a free discharge of bile. Like the other members of the family Gentianaceae, *S. chirayita* may also nauseate and oppress the stomach in over doses. It is particularly useful as a tonic or mild febrifuge. If taken with sandalwood paste, it is said to stop the internal hemorrhage of the stomach. It is also used in liquor industry as a bitter ingredient (CSIR 1976)

(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 km^2; small range (area of occupancy) <2000 km^2; small and declining in population (<10,000); very small population (<1000); very small range (<20 km^2 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). Since *S. chirayita* is one of the important medicinal plants and is reported to be supporting many of the mountain people's livelihood, this research has been

undertaken with a view to understand the following questions in a specified area of eastern Nepal.

1.4 Research Questions

The present study has attempted to answer the following research questions:

1. Is resource base of *S. chirayita* degrading in wild as a result of over harvest?
2. Do wild and cultivated *S. chirayita* have the same amount of bitter principle?
3. Who gets access and who doesn't to commercial cultivation of *S. chirayita,* either rich or poor farmers?
4. Is current benefit sharing arrangement in area equitable among households?

1.5 Research Objectives

Trade of Non-Timber Forest Products (NTFPs) has played an important role in improving the livelihood of the people in the study area. With respect to the NTFPs, little is known about the benefits gain by the local communities of Yamphudin; though researches have been undertaken covering whole Kangchenjunga Conservation Area (Oli and Nepal 2003; Gurung 2006). Income generated from the trade of NTFPs may be unfair and benefit might be taken only by richer sector of the communities and the traders. Mountain peasants, the primary collectors may be getting just the crumbs that fall from a sumptuous table. In order to understand the current access and benefit sharing arrangements in one of NTFPs, *S. chirayita,* this study is proposed.

The key objectives include:

1. To study the density of *S. chirayita* according to altitude in wild and cultivated.
2. To study the relationship between soil characteristics and bitter principle of *S. chirayita* in wild and cultivated.
3. To study the trade route of *S. chirayita* from the study area and market value at different level.
4. To study the access and benefit sharing arrangements of *S. chirayita* in study area.

1.6 Justification of the Study

Due to rugged topography and fragile natural geology, development activities have been limited in the study area. Increased needs of people in remote areas caused to extract and use NTFPs in the mountain area such as the study area. Livelihood of the residents of Yamphudin is based on animal husbandry, agriculture, tourism, seasonal migration in search of work and collection of NTFPs. *S. chirayita* occupies the second major portion of trade after cardamom, all in raw form. Local level value addition of *S. chirayita* is not in practice, resulting in the inequitable sharing of benefits to the farmers/collectors as the collectors get nominal price.

Ongoing research has attempted to find out the relationship between distribution of *S. chirayita* and important soil characteristics according to altitude in wild and cultivated stages. Study also has aimed to find out the relationship between bitter principle of *S. chirayita* and soil parameters. Analyzing such parameters would provide information useful for all stakeholders who are concerned with improving livelihood of people through cultivation of *S. chirayita*. Further, study has aimed to understand the access of local people to commercial cultivation of S. *chirayita*, access to collection from wild and the amount involved in trade the benefit they get from trade through socio-economic interview. This would generate information that would be helpful to study the benefit sharing arrangements in the study area in future.

1.7 Description of the Study Area

1.7.1 Kangchenjunga Conservation Area (KCA)

The KCA, named after its highest peak, Kangchenjunga (8,586 meters), the third highest mountain in the world, is situated in the north-east corner of Nepal at $27^0$30'- $28^0$00' N and $87^0$45'- $88^0$15' E, sharing an international border with Sikkhim of India in the east and the Tibet Autonomous Region (TAR) of china in the north (Map 1.1) (Gurung 2006).

KCA lies in the eastern Himalaya and comprises some of the most stunning scenery in all of Nepal. KCA is a portion of Sacred Himalayan Landscape (SHL). The SHL is a vision for a Tran-boundary landscape that captures the alpine meadows and grasslands and the temperate

broadleaf and conifer forests of the eastern Himalayas. It includes two WWF Global ecoregions (Olsen and Dinerstein 2002; WWF-NP 2004) and lies within the Eastern Himalayan Hotspot (Sherpa et al. 2005), a testament to the global significance of its biodiversity. KCA has been declared as "A Gift to the Earth" in 1997 which is a public celebration by World Wide Fund for Nature (WWF) of a conservation action by the government, a company, an organization, or an individual which is both a demonstration of environmental leadership and a globally significant to the protection of the living world (Gurung 2006).

To manage the area, the MFSC/Department of National Parks and Wildlife Conservation (DNPWC) and WWF-NP jointly launched the Kangchenjunga Conservation Area Project (KCAP) on 22 March 1998 "… to safeguard biodiversity of the area and improve living conditions of the local residents by strengthening capacity of local institutions responsible for making decisions, which will effect long-term viability of genetic conservation and economic development of the area" (WWF-NP 1998). The KCAP model emphasizes the tri-partite partnership between the local community, the Government of Nepal and WWF-NP (WWF-NP 1998), and provides for the gradual handing over of management responsibilities to locally built organizations (KCA-MC 2005). The project is located in the northern part of Taplejung district, Nepal (Map 1.1). The project is largely financed by the WWF network (mainly WWF-US and WWF-UK), foundations (MacArther –US) and supported by a few private donors (Gurung 2006).

Over 1260 species of flowering plants have been recorded from the KCA, including 23 endemic species (Shrestha and Ghimire 1996). Vast reservoir of flowering plants is a result of varied topographic, altitudinal and geographic condition. Oli and Nepal (2003) reported 139 species of plant based NTFPs in KCA while it is a repository of about 200 species of plant based NTFPs according to (Ghimire and Nepal 2007). Ghimire and Nepal (2007) has identified 13 potentially important NTFPs in the KCA. Among them *S. chirayita* is one which is harvested in huge quantities for cross border trades.

KCA harbors some of the protected floral/ medicinal species like Jatamansi, Sugandhawal, Kutki, Panchaunle, Dhyangre Sallo. Larch, oak, juniper, fir, rhododendron are common

plants. There are numerous species important for income generation and household use: *S. chirayita*, kutki, panchaunle, maikopila, bikh, bikhma, sunpati, khokim, talispatra, malingo, okhar, lokta, argeli, majitho etc (Oli and Nepal 2003).

Due to its remote location, rugged terrain, and political isolation, the region has historically been affected very little by external influences, either domestic or foreign. The region is home to a diverse population of peoples of Sherpa, Gurung, Limbu, Rai, Lepcha, Chettri, Tamang, Tibetan, and Walangpa ethnicity. Within the 2035 square kilometer conservation area, people reside in numerous rural villages and engage in subsistence level agriculture, pastoralism, and trade (Gurung 2006). The limbu are the dominat ethnic groups in the lower region while Sherpas/Lamas dominate the settlement of higher altitude. The population is concentrated in the lower parts of the KCA (Gurung 2006).

The climate is subtropical to temperate and alpine with mixed vegetation in the lower middle hills to alpine grasslands in the high hills and mountain. The topography is characterized by narrow V-shaped valleys with steep side slopes. The area is drained by the Kabeli, Simbuwa, Gunsa and Yangma rivers which are tributaries of the Tamur river. These rivers cut deeply into the mountains, creating deep gorges (Pyakurel 2007).

1.7.2 Yamphudin

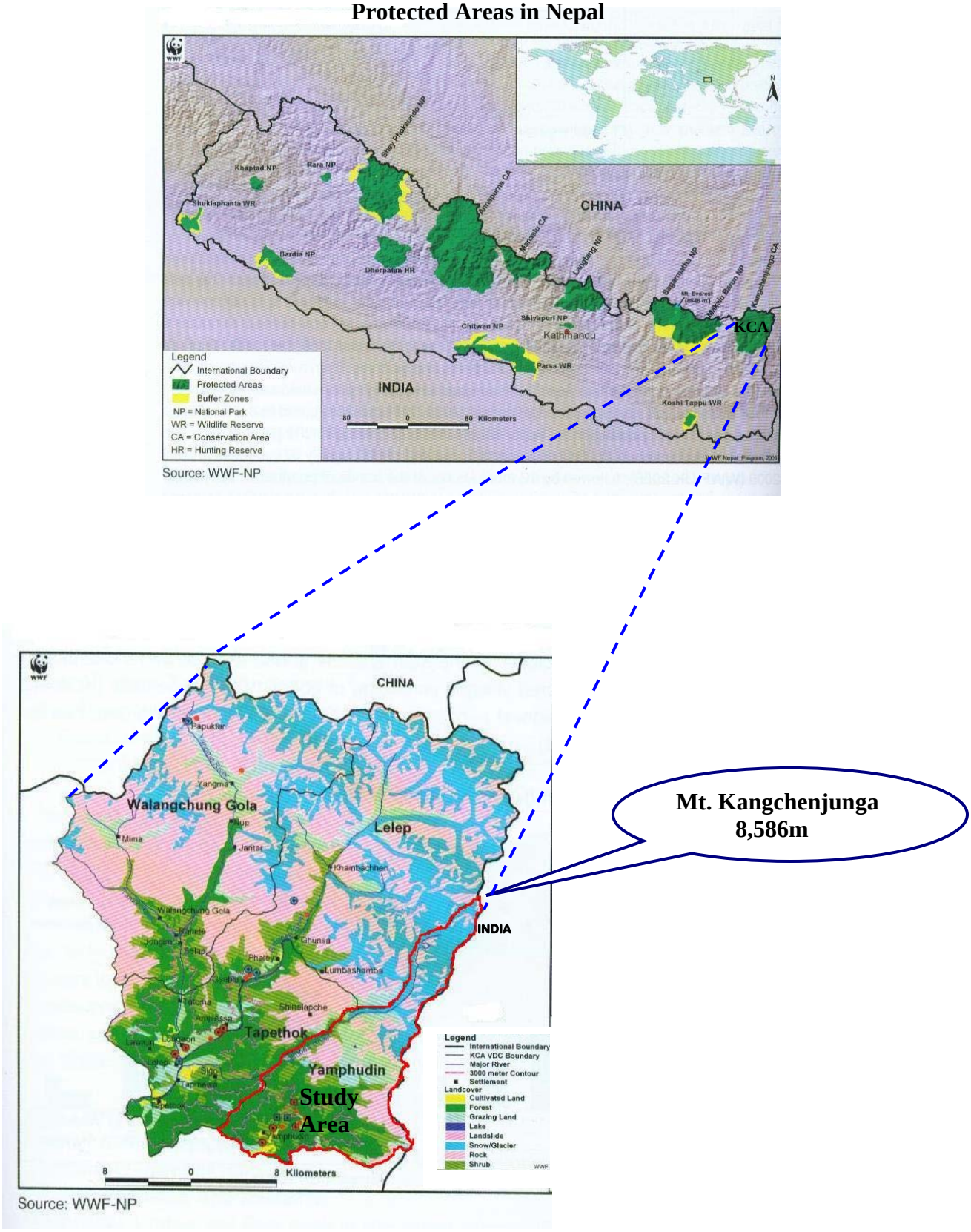
Due to the presence of extreme altitudinal gradients, virtually all types of climate ranging from subtropical monsoon to alpine to nival exist here. The monsoon arrives early and lasts for a long period of time. As a result, the area represents comparatively prolonged wet season. High rainfall and humidity generally characterize the climate (Shrestha and Ghimire 1996). Lower altitude area of Yamphudin experience a warm summer and mild winter; whereas the higher altitude areas (above 2500 m) go through mild summer and a cold winter with snow and frosts. According to Dhakal (1996), about 80% of the rainfall (2,625 mm annual average) in the area occurs during the monsoon (mainly June to September), while the rest is fairly and evenly spread throughout the year. There is no meteorological station in the study area, but the Taplejung district headquarter stations records an average of 2,013 mm of rain annually (KCA-MC 2005).

Signs of continental collision are visible from within the Conservation Area. After the northern margin of India slipped some 100 km under Tibet, a slice of India's shelf was skimmed off the top, forming the region of the north high Himalayas. The fault can be recognized by medium to high metamorphosed rocks such as schist and gneiss and minerals such as garnet. Layers of slippery surface rocks (mostly folded mica schist) that have slipped under one another to form a stack, in combination with the steep slopes of the Himalayas, creates a hazardous landscape with a tendency to slip and cause landslide (WWF NP 2000).

Yamphudin lies in Taplejung district of eastern Nepal. Yamphudin is one of the four Village Development Committee (VDC) of Taplejung district where Kangchenjunga Conservation Area Project (KCAP) has been implemented. The location map of the study area is shown in page 11 (Map 1.1). Yamphudin occupies 218.35 sq km (about 15.31 %) of the total area of KCA. It lies on lower temperate zone. Yamphudin is bordered by Timbung Pokhari and Deurali in the east and west, Mt. Kangchenjunga and Khebang in the North and South.

Majority of the population depends on agriculture and natural resource such as forest and medicinal plants for their livelihood. According to Central Bureau of Statistics (CBS) (2002), Yamphudin has a population of 804; 416 male and 388 female. Total households were 147. People in this VDC practice agriculture, pastoralism and trade for their subsistence. Sherpa, Bhotias, Limbu and Rai constitute the major bulk of population in the study area. People raise chickens, goats and pigs in lower area while transhumance system of animal rearing is practiced in high altitudes. Cultivation and trade of Alainchi is the main source of income of the people of lower belt of VDC followed by cultivation and trade of *S. chirayita*. Together these two commodities constitute 90 % of the economy of the local people (Oli and Nepal 2003).

Education facility up to secondary level is available on the study area. There is one police station, one health post and telecommunication facility in the area all concentrated on Thumgin (ward no 8) where sector office of KCAP also is located. There are two camping sites for tourists; one in Bhote gaun and another in Thumgin. Facility of homestay is available on same wards. One advanced Alainchi stack has been installed in Thumgin. Ectricity has been generated from peltric cell in Ward No 5.



Map 1.1. Map Showing Study Area

CHAPTER-2

Literature Review

2.1 Issues on Access and Benefit Sharing of Genetic Resources

The CBD has primarily dealt with access as an international issue, underwriting its prescription with the tenet that biological resources belong to the nation-state. This principle of national sovereignty was pushed through by biodiversity-rich countries of the south, who stressed that past relations of inequity which allowed Northern countries to freely access their biological resources and make enormous profits from them without appropriate returns were no longer tolerable. The CBD hence prescribe two critical prerequisites to international transfer of genetic resources prior informed consent of the country from which the resource is to be taken, and transfer on mutual agreement between the donor and the recipient country (CBD 1992).

Exploitation of the Himalayas' genetic resources has never involved benefit sharing with its indigenous peoples. The Red Jungle Fowl (*Gallus gallus*) of this region, for example, is the progenitor of the domesticated chicken- familiar the world over- yet none of the proceeds of the global poultry market are re-invested in the conservation of this wild fowl. Similarly, reserpine, isolated from Rauolfia serpentina, commands close to USD400 million in the American market alone; however, Nepal, India and other countries of the region- the home of not only this species but also the ethno-pharmacological knowledge that led to its discovery – remain empty handed (Tamang 2006).

Bhattarai et al. (2007) studied access to and use of biological resources by Dabur Nepal private limited. According to their study, the company fulfills its demand of biological resources mostly through plantation of species in nursery. However, the original access of species (*Kutaki, Loth salla*) planted in nursery was not disclosed by the company. This is against the spirit of third objective of CBD, fair and equitable sharing of benefits arising out of the utilization of biological and genetic resources.

Anuradha (1999) has reported the case of Kani tribes who were deprived of equitable benefit due absence of appropriate benefit sharing legislations. The Tropical Botanic Garden and

Research Institute, after developing a drug (Jeevani) based on knowledge of a plant (*Trichopus zeylanicus travancorius*) provided by the Kani tribals of Thiruvanathapurum district of Kerala, has agreed to share with them 50 percent of the licensed fee and the royalties obtained from the sale of drug. The Arya Vaidya Pharmacy (Coimbatore) Ltd. has been licensed to produce the drug. However, during 1997 and 1998 the agreement ran aground because the Forest Department, fearing overexploitation of the plant, did not allow its extraction from the forests in which it grows. There was no legal provision to provide the Kanis with tenurial rights to the plant and with necessary responsibility and powers to ensure its sustainable use and its protection from outside applications.

Kava (*Piper methysticum*) is preeminent mind-and mood-altering substance also is used for medicinal purpose. It is endemic to the South Pacific and farmers there have developed 118 cultivars by selecting desired traits over thousands of years. In the 1990s, promotion of kava on the international market led to an explosion in demand for kava products. The result is dramatic increases, and pressure on supply sources developed to serve regional markets and subsistence use. For example in the mass market, kava saw 473 per cent growth in the USA over the 52 weeks preceding July 1998, and was ranked the eighth top selling herb, with USD8 million in sales. The large profits made on kava product market, however, appear to be those of companies selling ground kava products without any form of standardization to American consumers. Concerns have been raised about the ways in which foreign buyers work with local growers. Although farmers appear to be benefitting from price increases, the types of commercial relationships they arrange with international buyers might not be to their long-term advantage as people are not educated to deal with multinational companies. Further steps are necessary in order to gains a greater share of commercial kava revenues and protects its claim as the true source of the crop (Kate and Laird 1998).

(Laird and Burningham, cite in Kate and Laird 1998) conducted case study on the development of benefit-sharing in ginsing (*Panax vietnamensis*), in Vietnam. The species, endemic to the region was being used traditionally as secret life-saving medicine, and where cultivation for local market was underway. Nature’s Way- a dietary supplement manufacturing company based in the USA began a multi-year process of correspondence, meetings, and negotiations with local communities, governments-owned pharmaceuticals

companies, researchers at universities, and the local and central governments, in order to design a sourcing and benefit-sharing package. After detail study on the species, Natures Way argued that regulation of species use and export would allow the local communities and the country to reap maximum benefit from a national treasure. Governments' officials were not aware of these issues, and in fact it is easier to get phytosanitary permits to export bulk raw materials from Vietnam than it is to get a permit to ship out herbarium specimen.

The issue of access and benefit-sharing with regard to biological resources has become one of the most hotly contested terrains in the international arena. As a specific subset of these resources, medicinal plants have attracted great attention, apart from crop genetic resources, because of their tremendous potential for human welfare, as also their enormous potential for economic profits. Access to and sharing of benefits from medicinal plants and their habitats can be extremely inequitable. Such inequalities are present within each community (more so in non-tribal societies), among communities and among countries. They can be economic, social, gender-based or political. Such issues are fundamentally political in nature, for who uses and conserves medicinal plants for what purpose and who benefits from this use and conservation is dependent on the relations of power among people and communities (Kothari 1998).

The potential of MAPs in Nepal is enormous and remains largely unexplored, while only insignificant benefits accrue to the government, primary harvesters, and in country dwelling traders. The export of plant material requires government permission yet there are no specific policies, laws, or processes in place to regulate access to genetic resources or to ensure that benefits flow to source countries. This dearth is the common cause of the widespread piracy of genetic resources by international biotech companies. Such foreign actors, either directly or through governmental and non-governmental sources, are seeking genetic materials from Nepal for bio-technological or other resource purposes. Failure to frame appropriate national legislation to protect and preserve the traditional practices and innovations of indigenous and local communities has left these groups vulnerable to biopiracy (Tamang 2006).

2.2 Access to and Benefit Sharing Legislation in Nepal

As a focal point for the Convention on Biological Diversity, Nepal's Ministry of Forest and Soil Conservation drafted a Bill on "Access to Genetic Resources and Benefit Sharing" as required by the Article 15(7) of the CBD. This Draft Bill aims to conserve and sustainable utilize biological and genetic resources, facilitate access to those resources, ensure equitable sharing of benefits and protect traditional knowledge associated with the resources and the knowledge holding communities' rights The bill proposes documentation and registration of biological resources and associated traditional knowledge as a *Sui generis* system for the protection of traditional knowledge and the relevant knowledge holders. (AGRBS 2002). But till date legislation regarding Access to and Benefit Sharing has not been promulgated.

2.3 Status and Importance of Non-Timber Forest Products (NTFPs) in Nepal

Forest products other than timber, fuel wood and fodder which are useful for trade, industry and human life are NTFPs (Chandrasekharan 1995; Hamro Ban 2004/2005). Among NTFPs, MAPs (Medicinal and Aromatic Plants); 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).

Tiwari and Shrestha (2000) published list of 1600 species having medicinal value. It is expected that the country is a home of more than 7000 higher plants, 10 % is said to be medicinal and aromatic (Joshi and Joshi 2001). Manandhar (2002) has reported ethno-botanical information of 1,500 plant species, majority of them have medicinal value. Similarlly, Baral and Kurmi (2006) has listed some 1700 plant species of medicinal uses comprising weeds, cultivated, exotic and naturalized and also indigenous and endemic texa.

Nepal Himalaya, the biologically diverse ecosystems produces a wide range of unique and valuable medicinal plants. High Mountain NTFPs are highly praised for high potency and organic nature (Bhattarai and Ghimire 2006). Herbal remedies are increasingly becoming mainstream consumer products manufactured by national and multinational companies. Food supplements, cosmetics, fragrances, aromatherapy, traditional cuisine, dying and coloring

agents are just a few of the applications where MAPs are finding increasing use day by day (Ghimire and Nepal 2007).

The trade of medicinal plant from Nepal to India dates back to century. Prithivi Narayan shah, the founder of modern Nepal, encouraged the export of medicinal herb and drug in the middle of the eighteen century (Regmi 1971). According to Olsen (2005a), it has been established that products from hundreds of species are being traded, that trade spans from remote forests and meadows to international markets and consumers, that almost all traded material is harvested in the wild, that markets are working even if they are not perfect and that harvest and sale provides an important source of income to a huge number of rural households.

Edward (1996a) estimated 10-15 thousand tones of MAPs composed of 100 species with a border value of USD8.6 million are exported from Nepal annually, while Subedi (1997) estimated the value of trade in medicinal plants at USD27 million: both studies indicate the importance of commercial medicinal plants as the source of income in rural areas (Olsen and Larsen 2003). Olsen (2005b) estimated annual export value of MAPs as USD7-30 million, with a value USD16 million in 1997-1998. Olsen (2005a) has estimated annul harvest of 7000 to 27 000 tons of medicinal plants from Nepal.

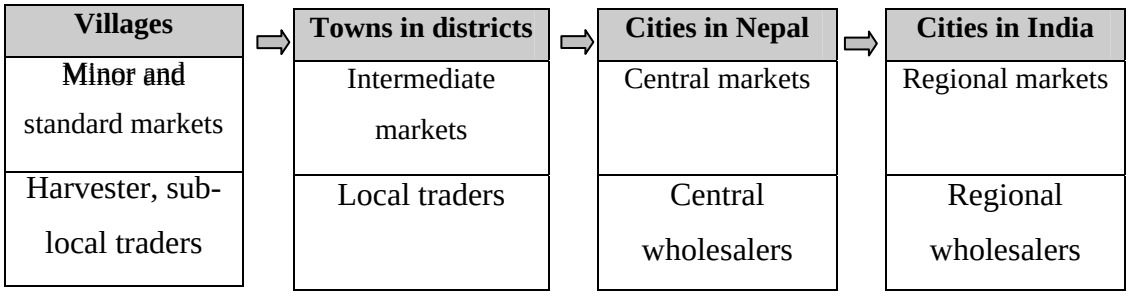
2.4 Markets and Marketing Channels of NTFPs from Nepal

According to Edward (1993), throughout the Himalayan region the trade in NTFPs comprises the flow of raw materials from northern high altitudes to the Indian plains in the south. After harvesting, NTFPs are pottered to collection points where they pass through a series of middlemen who handle progressively large volumes of trade. Important collection points are located at road heads-the northernmost point on the road network.

Nepal's largest NTFPs wholesalers reside in towns and manage their collection operations over large catchment areas that funnel northwards from road heads. The Terai-based wholesalers the smallest (in terms of number) are the most powerful group of middleman. Throughout Nepal, the access to knowledge of Indian markets is carefully controlled by these individuals (Paudel 2003). Olsen and Bhattarai (2005) has presented simple generalized flow

model of the flow of medicinal plants harvested in Nepal and exported to India: location, type of market and dominant economic agents (Figure 2.1).

Figure 2.1: Generalized flow model of medicinal plants harvested in Nepal



Harvesters are people who gather medicinal plants for the purpose of selling to traders. Sub-local traders are traders based in villages, usually beyond the road network, commonly known in literatures as village traders. Local traders, commonly known as road head traders or district traders in Nepal, are stationed at the interface between porterage and road transport. Wholesalers are agents who usually buy and sell wholesale. The central wholesalers are often called Terai traders in Nepal and are located in Terai or in Kathmandu. The regional wholesalers, positioned in the Indian cities on the Gangetic plain buy from central wholesalers and sell to intermediaries (Olsen and Bhattari 2005).

2.5 Status and Distribution of *Swertia chirayita* in Nepal

According to Hara et al. (1982) *S. chirayita* is found in the Himalaya from Kashmir to Bhutan and Assam. However, according to Shrestha and Joshi (1996), the species is found only in eastern and central Nepal. This is contradicted by Bhattarai and Acharya (1998) who found that Dadeldhura district in Far-Western Development Region (FWRD) and Baitadi district in Mid-Western Development Region (MWDR) were important source of *S. chirayita*. Barakoti et al. (2002) reported it to be found in 54 districts.

S. chirayita grows in open areas with little tree cover and recently slash-and-burnt forest. *S. chirayita* collection is labor intensive and doesn't involve a gender division of labor. Normally whole plant is harvested when seed matures (Daniggelis 1996). If cash is needed quickly for the farmers, *S. chirayita* is harvested before the seed matures. This prevents the

seed from falling, regeneration doesn't occur and people receive less money from the traders (Paudel 2003). Sustainable harvesting period of *S. chirayita* actually starts from mid-November when seed shed but local collects early. This is due to the limited cash for festival, school fees, festivals, salt buying trips, food shortage and competition among collectors (Raskoti 2004). Raskoti (2004) found luxuriant growth and higher population at an altitude of 1700m to 2500m m in shady habitats, covered with dense fog and accompanied by heavy rainfall while Barakoti (2007) found 1800m to 2800m suitable for this species.

Baral and Kurmi (2006) has listed thirteen species of Swertia that are found in the Nepalese Himalaya: *S. chirayita* (Roxb. ex Fleming) H. Karst; *Swertia angustifolia* Buch.-Ham ex D. Don; *Swertia bimaculata* (Sieb and Zucc.) C.B. Clarke; *Swertia racemosa* (Griseb.) C.B. Clarke; *Swertia ciliata* (D.Don ex G. Don); *Swertia cuneata* D. Don; *Swertia multicaulis* D.Don; *Swertia alata* (Royale ex D. Don) C.B. Clarke; *Swertia nervosa* (G.Don) C.B. Clarke; *Swertia paniculata* Wall; *Swertia pedicellata* Banerji; *Swertia speciosa* D.Don; and *Swertia kingii* Hook F.

2.6 Cultivation of *Swertia chirayita*

Barakoti (2002) developed a scheme for commercial cultivation of *S. chirayita*. The commercial cultivation of *S. chirayita* has been initiated on farmland in eastern and central Nepal. However, in western part, commercial production has not yet initiated. *S. chirayita* 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).

Only a few scattered reports in the literature suggest germination studies and nursery practices of *S. chirayita*. 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 and Pal 2002). *S. chirayita* is cultivated in KCA since early 1980s; however no comprehensive research has been carried out from the area, though it has been widely studied in other parts of eastern Nepal, especially in the Koshi hills (Paudel 2003).

According to Paudel (2003), cultivation method presently being practiced all over KCA includes:

1. Slash cutting is carried out up to Chaitra (mid March to mid April).
2. Burning is carried out in Chaitra to Baisakh (mid March to mid May).
3. Maize sowing is carried out in Chaitra to Baisakh. Maize is sown in very few cases, when the farmer's condition is not very good.
4. *S. chirayita* sowing is undertaken during Jestha to Ashad (mid May to mid July). The seed is mixed in moist sand in the ratio 1:40 (seed: sand).
5. In the cases where maize is sown, maize harvesting is carried out in Ashok 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). Rotation period of *S. chirayita* is about 30 months.
6. The harvested *S. chirayita* is dried in sun and tied in bundles for selling.

2.7 Agronomic Characteristics of *Swertia chirayita*

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). *S. chirayita* 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 marginalised lands slash and burn area and community forests of high hill (Barakoti 2007).

2.8 Use of *Swertia chirayita*

The whole plant is intensely bitter in taste and used in various treatments; blood purifier, skin disease, bittertonic for fever, indigestion, laxative, anthelmentic, antidiarrhoetic, antiperiodic, treatment for various liver problems and tonic for patients suffering from gout or bronchial asthma (Manandhar 1980b). Concoction of Chirata with cardamom, turmeric and kutki is given for gastrointestinal infections, and along with ginger it is considered good for fever (Kirtikar and Basu 1984). According to Ayurvedic pharmacology, Chirata is described as

bitter in taste (rasa). The thermal action (virya) of Chirata is defined as cooling (shita). Chirata is light (laghu), i.e. easily digestible, and ruksha (dry). These characteristics drain heat from the blood and liver (Joshi 2000). *S. chirayita* is used in British and American pharmacopoeias as tinctures and infusions (Joshi and Dhawan 2005). When given along with neem, manjishta and gotu kola, it serves as a cure for various skin problems. It is used in combination with other drugs in cases of scorpion bite (Joshi and Dhawan 2005).

The seeds are bitter, astringent, refrigerant, demulcent, emetic, diuretic, digestive, anthelminthic, aphrodisiac, ophthalmic, appetizer, alexiteric, tonic and water purifier. They are useful in various conditions of hepatopathy, nepropathy, gonorrhoea, leucorrhoea, gastropathy, bronchitis, chronic diarrhea and dysentery, strangury renal and vesicle calculi, diabetes, burning sensation, conjunctivitis, scleritis, ulcers and eye diseases. The leaves are used as a poultice for maggot infested ulcers. Powdered bark is useful in cholera. The roots are useful in leprosy (Prajapati et al. 2003).

2.9 Bitter Constituents of *Swertia chirayita* and their Uses

The bitter principles are the main constituents of *S. chirayita*. 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. They are included in the Secoirodoid glucoside group (Sharma 1983). *S. chirayita* is reported to contain a yellow bitter acid, ophleic acid ($C_{15}H_{20}O_{13}$), two bitter glucosides, chiratin ($C_{26}H_{48}O_{15}$) and amarogentin ($C_{32}H_{38}O_{16}$), two crystalline phenols, a neutral yellow crystalline compound and a new xanthone, swerchirin ($C_{25}H_{12}O_6$). Amarogentin is one of the most bitter substance known and can be detected by its taste even at a dilution of 1 in 14 million. 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 ingredient. (CSIR 1976).

The entire plant is used in traditional medicine; however, the root is mentioned to be the most powerful part (Kirtikar and Basu 1984). Herbal medicines such as Ayush-64, Diabecon, Mensturyl syrup and Melicon V ointment contain chirata extract in different amounts for its antipyretic, hypoglycemic, antifungal and antibacterial properties (Valecha et al. 2000).

2.10 Trade of *Swertia chirayita* from Nepal

S. chirayita enjoys a good domestic and international market. *S. chirayita* comprises around 75 % of the total cash value and 60 % of the total volume of trade from the Koshi Hill (Edward 1993). Edward (1996b) estimated 60,000-100,000 kg. of *S. chirayita* per year is exported to India and India exports it to Italy, Singapore and Afghanistan and Europe. Bhattarai and Acharya (1998) found two traded *S. chirayita* products: (i) pothi chiraito (*S. chirayita*) consisting of more than 95 % chiraito bulk and (ii) bhale chiraito consisting of a mix of eight other spp. They recorded prices paid to collectors for pothi *S. chirayita* as four to five times higher than bhale *S. chirayita* and found that pothi *S. chirayita* made up approximately 80 % of the traded *S. chirayita* volume. The true chirata (Pothi *S. chirayita*) can be distinguished from other substitutes and adulterants by its intense bitterness, brownish-purple stem (dark colour), continuous yellowish pith and petals with double nectarines (Joshi and Dhawan 2005).

Nepal is the main global supplier of *S. chirayita* (74 ± 13%) as stated by (Olsen and Larsen 2003). Olsen and Treue (2005) estimated annual supply of air-dried unprocessed whole plants of *S. chirayita* from Nepal, almost all harvested in the wild to be 300-1500 tonnes with an export value of USD0.7-3.5 million; trade in the case year 1997/98 was estimated to be 849 tonnes worth of USD 2.0 million. About 45% of chirayita in the Himalayan region is collected from Nepal (Joshi and Dhawan 2005).

2.11 Over Harvesting of *Swertia chirayita*

Wild populations of *S. chirayita* are highly threatened due to over and premature harvesting for trade, reduction of forest cover, and overall habitat destruction. Although, cultivation practice in private land has been started, the wild collection is still going on from government as well as from community forests. People pay great attention while collecting *S. chirayita* from their own land but similar attention is lacking from community or government forests (Oli and Nepal 2003; Ghimire and Nepal 2007; Barakoti 2007).

2.12 Adulteration on *Swertia chirayita*

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., are adulterants found along with true *S. chirayita* as listed by Joshi and Dhawan (2005).

2.13 Existing Policies on NTFPs Conservation, Marketing and Trade

The policy and regulatory environment plays a very significant role in all the aspects of trade of NTFPs. Some polices may be supportive while some may be hindering. The Forest Act (1993) 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. The Forest Rules (1995) further describes the regulations some of which are: Certification of Income Tax Registration; Collection Permit; Checking and Weighing; Royalty Payment; Release order or Transit Permit; Local Taxes; Checking and Endorsement; Export Recommendation letter for processed NTFPs to India; Product Certification and Export Permission for some NTFPs; Certification of Origin; Certification of General system of Preference; Phyto Sanitary Certificate of the Product; Export Permission and Duty; Product Certification from Indian Quarantine Check post; Import Permission and Duty.

These procedures seem to contain a set of complex and restrictive provisions to obtain permits and to extract and utilize forest products; the trade has been criticized as being ineffective because the objectives of conservation and sustainable management are not being achieved (Subedi 2000). However, the 10^{th} plan (2002-2007) has explicitly recognized the importance of the management and trade of NTFPs in poverty reduction, biodiversity conservation and ecotourism development. After the finalization of the 10^{th} plan, the Herbs and NTFPs Coordination Committee chaired by Minister of Forests and Soil Conservation has been formed working on NTFP policy improvement to achieve the poverty reduction goal (ANSAB 2003).

CHAPTER - 3

Research Methodology

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 30 informants (20 % of the total households) from the whole VDC. Structured and semi-structured questionnaires guided these dialogues (Appendix I). Group discussion with members of mother group and Community Forest User Groups (CFUGs) was conducted to clarify the objectives of ongoing research and to generate information regarding the abundance, annual harvest and income, and trade route of *S. chirayita* in the study area from wild and cultivated. Households that were involved directly or indirectly in activities related to *S. chirayita* cultivation, collection and trade were selected as sample population for household survey. Information for this was obtained from members of mother groups, members of CFUGs of the wards and also from staffs at Yamphudin sector office. Ten traders of different categories (sub-local trader to central wholesalers) were interviewed mostly using open-end questionnaire. Information regarding annual volume they handle, trade, price and profit margin from *S. chirayita* 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 *S. chirayita*, its habitat suitability, local uses, and annual production and export from the study area. Dialogues with them were guided by structured, semi-structured questionnaire and often informal discussion was conducted. Rough map of the distribution of *S. chirayita* in VDC was prepared using Participatory Rural Appraisal (PRA) technique and plots were laid according to their information about the distribution of *S. chirayita*. The risk of being selective and/or gathering biased information was avoided by including people from all sectors.

3.2 Secondary Data Collection

Literatures dating from 1971 to 2008 were reviewed from libraries, project offices and internet to gather information about access and benefit sharing among genetic resources in global and Nepalese context; status, distribution, importance of NTFPs in Nepal and in the study area, their economic value focusing particularly on *S. chirayita.*

3.3 Ecological Study of *Swertia chirayita*

In all ecological work there is certain error involved in any field observations or experimental results. This is partly due to inadequacies of the equipments and, more important, to an unknown amount of variations always found in biological materials (Karshew et al. 1985). Stratified sampling was adopted and accordingly quadrats were laid on 1800m, 2000m, 2500m and 2800m along the contour line with the help of altimeter in both wild and cultivated. Ecological study of *S. chirayita* was conducted following the methodology used by (Shrestha et al. 1998). 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. All *S. chirayita* individuals inside each qaudrat were counted and recorded. Counting the observed plants number in sample plot formed the main basis of resource assessment of *S. chirayita*. Some samples of *S. chirayita* from both wild and cultivated 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:

$$\text{Density (D)} = \frac{\text{total no of individual of S. chirayita at studied elevation}}{\text{total quadrates studied} \times \text{area of quadrat}}$$

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. 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) on laboratory of Central Department of Environmental Science.

3.4.1 Determination of Soil Physical Parameters

3.4.1.1 Determination of Soil Texture

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

3.4.1.2 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.

3.4.1.3. 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.

3.4.2 Determination of Soil Chemical Parameters

3.4.2.1 Determination of Soil pH

- 20 g 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.

3.4.2.2 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:

a. $\%\ \text{carbon} = \frac{3.951}{g}(1 - \frac{T}{S})$

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.

3.4.2.3 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 disulfonic acid.
- The content was diluted to 50 ml in 50 ml volumetric flask followed by addition of 6 ml 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.

3.4.2.4 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.

3.4.2.5 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 ammonim actetate.
- 2g of qualigens (sodium hexametaphosphate powder) was mixed and observed in potassium flamemeter.

3.5 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 Department of Plant Resources (DPR) located in Thapathali, Kathmandu.

- 2g of powdered sample was taken on a conical flask.
- The sample was mixed with 50 % ethyl alcohol and shaked.
- The mixture was left whole night and filtered using whatmann filter paper.
- Filtrate was evaporated in hot water bath.
- Residue obtained was dissolved in hot alcohol and filtered when hot.
- Filtration was continued first by washing with hot alcohol and later by frequent washing with hot water.
- Filtrate thus obtained was mixed with ethyl acetate and shaked to prepare extract.
- Mixture was then evaporated in hot water bath.
- Residue obtained was dried and weighed using electric balance.
- Bitter principle was then calculated.

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

3.6 Statistical Tests

Certain statistical tests were applied following books "A Practical Manual for Ecology" (Zobel et al. 1987) and "A First Course in Statistics with Applications" (Swain 2003). Correlation between density/elevation; 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:

$$(r) = \frac{\sum (xy - n\bar{x}\bar{y})}{\sqrt{\sum x^2 - n(\bar{x})^2}\ \sqrt{\sum y^2 - n(\bar{y})^2}}$$

Where, x = one variable of a pair of observation

y = second variable of same pair of observation

n = number of observations

$\bar{x}$ = mean of first variable

$\bar{y}$ = mean of second variable

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). Null hypothesis (H_0) was set in this way:

H_0: there is no significant difference in bitter principle between wild and cultivate *S. chirayita* and alternate hypothesis (H_1) as:

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

The following formula was applied:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Where,

$\bar{x}_2$ = mean of observed parameter of site 2

$\bar{x}_1$ = mean of observed parameter of site 1

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

$$s^2 = \frac{\sum (x_1 - \bar{x}_1)^2 + \sum (x_2 - \bar{x}_2)^2}{n_1 + n_2 - 2}$$

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.

CHAPTER-4

Results

4.1 Ecological Study of *Swertia chirayita*

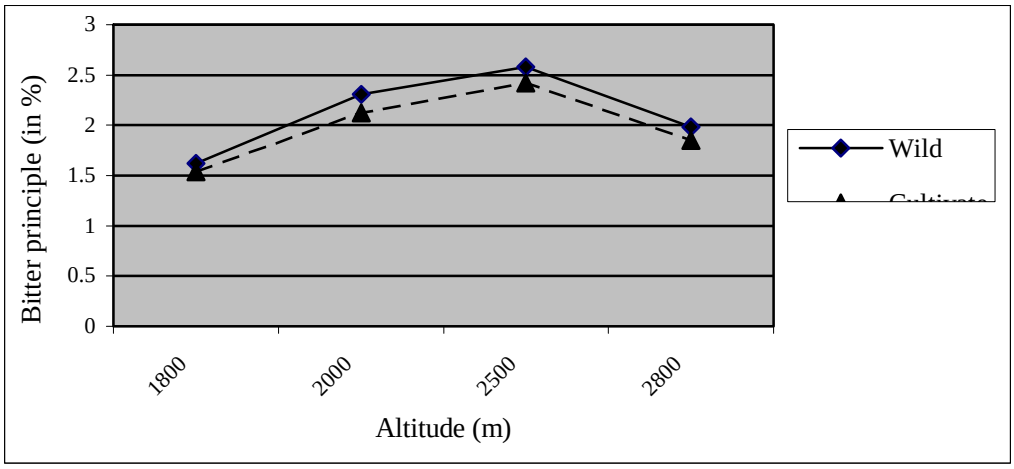
Table 4.1: Densities, productivities and bitter principle of *S. chirayita*

Altitude (m)	Aspect (^{0})	Slope(^{0})	Density of *S. chirayita*(plants/ha)		Production/yield of *S. chirayita*/ha (kg)*		Bitter principle of *S. chirayita* (in %)	
			wild	Cultivated	Wild	Cultivated	Wild	Cultivated
1800	34-274	5-55	2941	16,295	39.21	217.26	1.62	1.54
2000	8-327	6-50	3382	19,132	45.09	250.09	2.31	2.12
2500	12-353	15-65	3534	20,635	47.12	275.13	2.58	2.42
2800	5-341	10-70	3438	18,933	45.84	252.44	1.98	1.85
				Average	44.29	248.73		

*Averaging 75 dried plants = 1 kg of *S. chirayita*

The above table 4.1 shows high density and accordingly high production of *S. chirayita* in cultivated on all altitudes. This is because farmer care much for *S. chirayita* cultivated on private land and try to harvest as much from wild without due consideration of its sustainability. But the bitter principle has been found higher on wild *S. chirayita* on all altitudes (Figure 4.1). Aspects facing NE and NW having slope angle in the range of 5 to 70^0 were observed for *S. chirayita* distribution. North facing slopes are better for *S. chirayita* growth (Barakoti 2007).

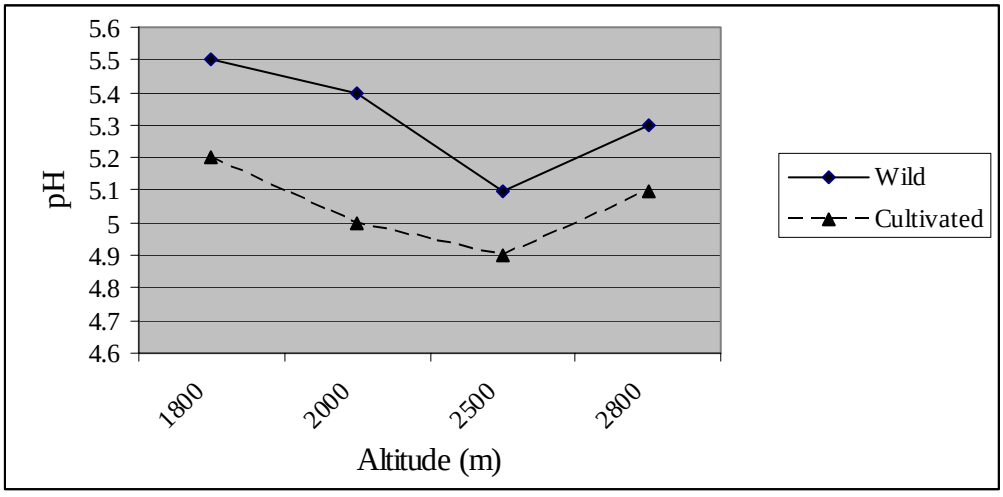
Figure 4.1: Bitter principle in wild and cultivated S. *chirayita*



4.2 Comparison of Soil Parameters According to Altitude

Several physical and chemical parameters of soils from both wild and cultivated sites have been analyzed (Appendix II A). Similarly, soil texture and textural class have also been determined (Appendix II B). Comparison of some important parameters in both sites according to altitudes is shown in Figures below.

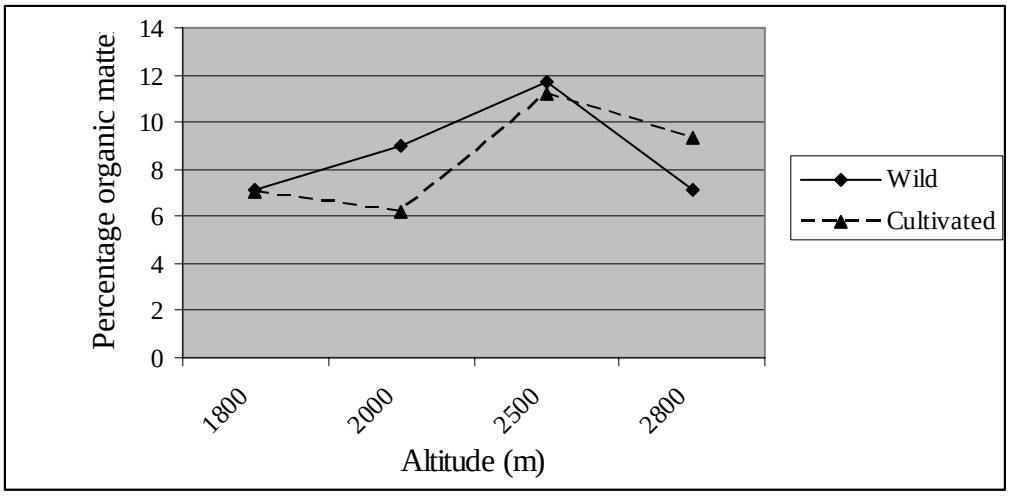
Figure 4.2: pH of soil in wild and cultivated



On all sites, pH showed higher value on wild. The range of pH was 5.1 to 5.5 in wild while it was 4.9 to 5.2 in cultivated. This is suitable range for the growth and distribution 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

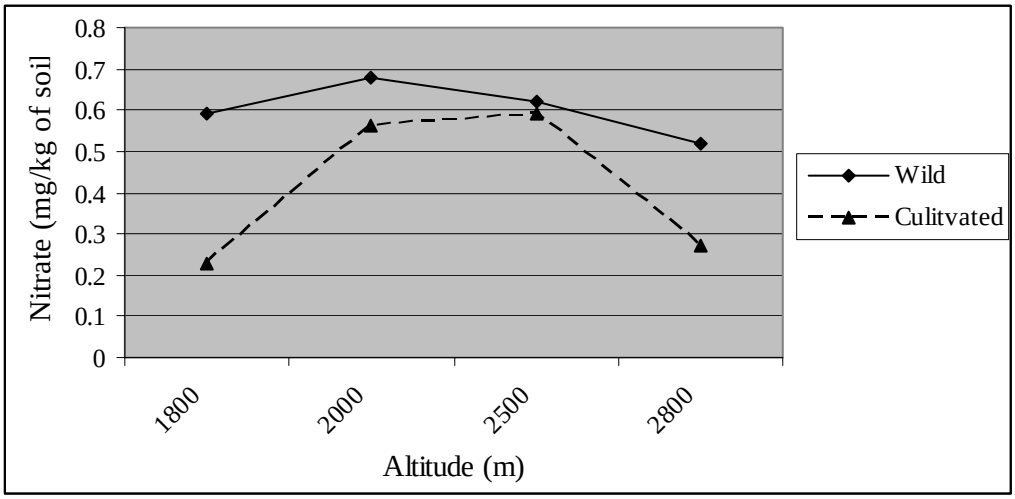
variable greatly influences the availability for root uptake of many elements including roots and toxins.

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



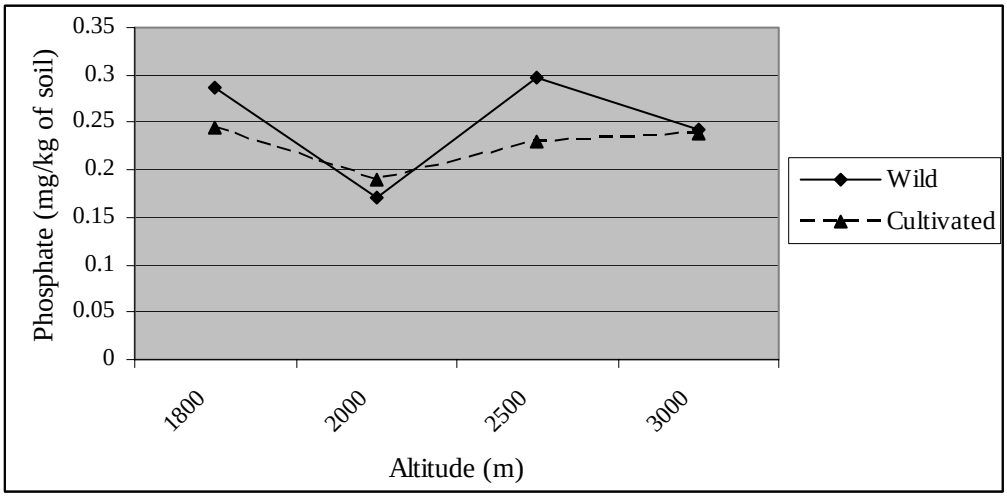
Percentage organic matter on soil showed higher value on most of the altitudes on wild soil except at 2800 masl. This may be due incorporation of livestock excreta from transhumance system of animal rearing in preceding years in sites from where soil sample was collected. Organic matter encourages granulation, reduces plasticity and cohesion and increases water holding capacity of the soil. Further, organic matter has easily replaceable cations, nitrogen, sulphur, phosphorus and, moreover, the acid humus extracts nutrients for minerals (Brady and Weil 1999).

Figure 4.4: Soil nitrate in wild and cultivated soil



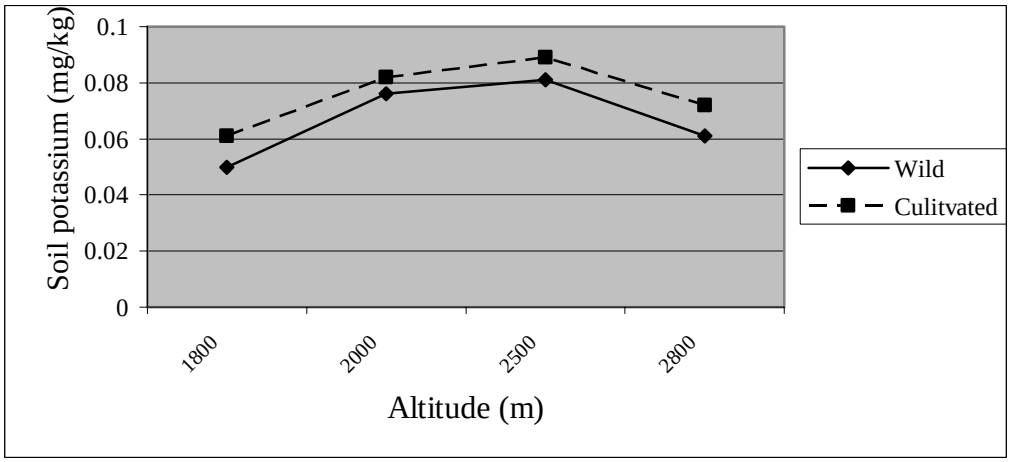
Soil nitrate showed high value on all altitudes on wild soils. Atmospheric conversion of nitrogen gas into nitrate through nitrification process is the main source of nitrate on soil. No any addition direct addition of fertilizer supplying nitrate was observed.

Figure 4.5: Soil Phosphate in wild and cultivated state



High value of soil phosphate was found on wild soil on all altitudes except at 2000masl where cultivated soils have high phosphate value. Phosphorus is essential component of the organic compound often called energy currency of the living cell. Phosphorus deficient in soil cause stunted growth of plants (Brady and Weil 1999).

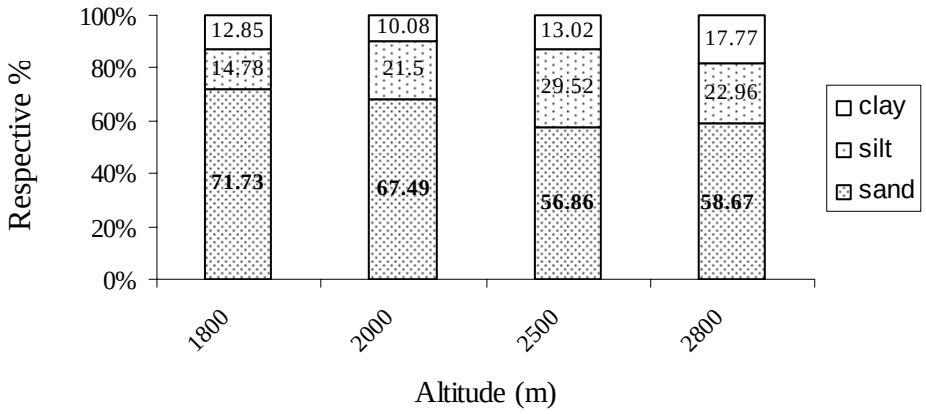
Figure 4.6: Soil Potassium in wild and cultivated state



But, in the case of soil potassium, higher value for it was found on all sites on cultivated soils. This may be due incorporation of potassium into the soil from ash generated from

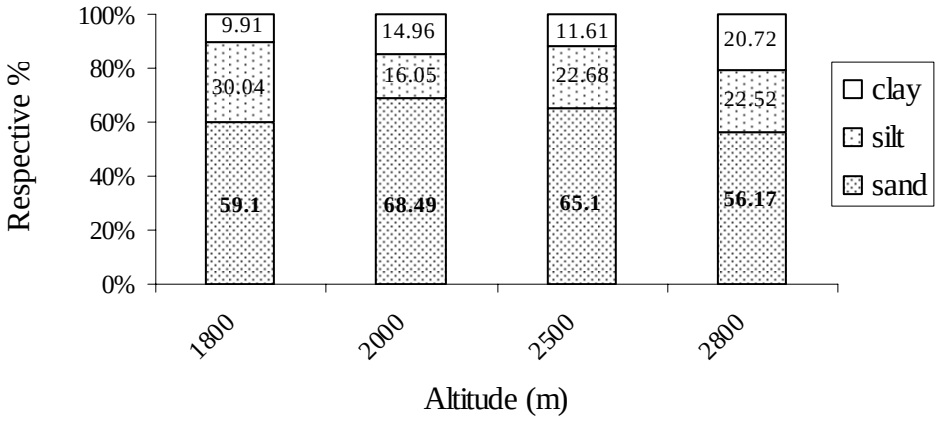
slash-and-burn practice. Deficiency of potassium in soil causes tips and edges of oldest leaves yellow (chlorosis) and then dies (necrosis).

Figure 4.7: Soil separates in wild state



Analysis of soil samples in wild showed, dominancy of sandy soil on all altitudes. This is in accordance with Barakoti (2002) who has suggested sandy soil rich in organic matter is suitable for growth of *S. chirayita*.

Figure 4.8: Soil separates in cultivated form



Similarly, analysis of soil samples from cultivation also showed dominance of sandy soil on all altitudes.

4.3 Statistical Analysis

4.3.1 Correlation

Correlation implies mutual relationship or association between two or more variables. Thus, correlation is not concerned with variation in one series but with the comparison of variation in two or more series. The linear relationship between two series is measured by calculating a coefficient, which is called the coefficient of correlation, usually denoted by symbol *r*. This coefficient is a pure number and is free from the unit of measurement of unit of both the variables. The value of *r* ranges from -1 to +1. If the value of one variable increases with the increase in the value of another variable and vice-versa, the correlation is said to be positive. But if the value of one variable increases with the decrease in the value of another variable and vice-versa, the correlation is said to be negative (Swain 2003). The correlation between various parameters is shown (Table: 4.2)

Table 4.2: Correlation between bitter principle and soil parameters

S.N.	Variables	Correlation coefficient	
		Wild	**Cultivated**
1	Elevation/density	0.757	0.357
2	Bitter principle/pH	0.712	0.630
3	Bitter principle/nitrate	0.490	0.914
4	Bitter principle/phosphate	-0.153	-0.488
5	Bitter principle/potassium	0. 57	0.493
6	Bitter principle/percentage organic matter	0.905	0.548

Elevation/density, Bitter principle/nitrate, Bitter principle/potassium and Bitter principle/percentage organic matter gave positive correlation on both wild and cultivated soils. Statistically, this means that with the increase in one parameter (Elevation) of a pair (say elevation/density) other parameter (density) also increases and vice-versa. However, negative correlation on both wild and cultivated *S. chirayita* was observed among Bitter principle/phosphate suggesting decrease in bitter principle with the increase in phosphate and vice-versa.

4.4 Socio-economic Aspects

Purposive selection of 30 households was made and accordingly 30 respondents (at least 3 from each ward) were interviewed. Among them, 17 were males and 13 were females. Trade of *S. chirayita* has become an important source of income of 70 percent of the household, among which 63 percent households were adopting commercial cultivation of *S. chirayita*. Minimum of ½ hour to maximum of 1 day walk was required to reach to *S. chirayita* collection site. Provision of paying on daily basis for cultivation and harvesting of *S. chirayita* was negligible due shortage of labor, however, 20 percent of household cultivating *S. chirayita* stated the provision of hiring collectors (Thekka).

Among 63 percent, 17 percent households were practicising *S. chirayita* cultivation since last year. Majority (37 percent) of the households were cultivating *S. chirayita* since last 2-5 years. About 10 percent were cultivating *S. chirayita* before 5 years. Slash-and-burn method was the major method adopted by most of the farmers. Regarding the question asked for selecting *S. chirayita* cultivation, 40 percent of the respondents reported cultivating *S. chirayita* for better income while 23 percent responded being encouraged after receiving technical and commercial cultivation training from KCA. Selection of individuals for such trainings was determined by the mother group of the concerned ward.

Significant (93 percent) respondents, almost equal proportion of male and female respondents cultivating *S. chirayita* reported better income from it than from other food crops but it requires patience. Among households cultivating *S. chirayita*, 70 percent were cultivating on land lower than 10 ropani/household and 30 percent were cultivating on land greater than 10 ropanis. About 30 percent of household expenses are fulfilled by income earned from *S. chirayita.*

None of the households reported cultivating on the whole land. According to some, lack of time and labor shortage was the main problem while for other separation of land to grow food crop other than *S. chirayita* prevent using whole land. Not a single respondent reported of using any kind of chemical fertilizers and pesticides. In most of the sampled household, it was found that all members of the family were engaged for commercial cultivation, mostly parents. About 90 percent of the household reported on average of 1 month/year being spent

on *S. chirayita* related activities such as harvesting/collecting, drying, storing, and selling. Males were found involved mainly during seed sowing, frequent monitoring of the field, harvesting and trade while women were involved in drying and storage of the harvested product. In the past farmer used to buy the seeds of *S. chirayita* outside of the VDC or collect from nearby forest. But now they collect seeds from their own private land.

KCA has the provision of paying royalty for collection of *S. chirayita* regardless of origin. Royalty rate is NRs.2.50/kg for *S. chirayita* collected from private land and NRs.15 for *S. chirayita* collected from national forest. None of the respondents stated illegal collection of *S. chirayita*. Anyone from or outside the VDC can collect *S. chirayita* after receiving permission from KCA/User group. All of the respondents claimed having knowledge about harvesting of *S. chirayita* which according to them is when *S. chirayita* matures; however, 56 percent of the 70 percent household engaged on *S. chirayita* cultivation, collection and trade castigated neighbor for immature harvesting *S. chirayita*.

All respondents stated drying of *S. chirayita* on sun after harvesting. Lack of appropriate place was major problem being encountered during storage; common problem of 84 percent of households regardless of the origin of *S. chirayita*. Improperly sun dried and accidental mixing of water on dry *S. chirayita* on storage was the major problem according to 97 percent of the respondents. About 10-15 days sun drying of *S. chirayita* is sufficient for sale. Almost 90 percent of respondents reported *S. chirayita* occupying second position in terms of trade, Alainchi occupying the first position. Almost 86 percent of the respondents stated fixed buyer of *S. chirayita* coming to their house and taking away the *S. chirayita* as per the price he propose.

When asked about the current price of *S. chirayita*, many respondents stated NRs 200-250/kg which was double than the last year. More than 96 percent of the respondents reported fluctuating *S. chirayita* price compared to previous years. Lack of market and low price paid by buyers were the common problem of all respondents. Selling of *S. chirayita* from sampled household varied from less than 10kg to 500kg in one season, major bulk was from private land. Buying price of *S. chirayita* was same; be it from wild or cultivated. Mature, Properly

dried and unbroken plants fetched higher price. Income generated from selling *S. chirayita* was used mostly for buying foods in most of the household.

4.5 Price Differences

As regards the trade of *S. chirayita* from its origin to Birtamod, which is considered as destination by the traders of the study area, there are significant price differences as follows:

From Yamphudin to Birtamod

In 2008 (NRs. /40 kg):

Harvesters ⟶ NRs. 8,000-8,500 ⟶ Sub-local traders ⟶ NRs. 9,000-10,000 ⟶ Local Traders ⟶ NRs. 10,000-11,000 ⟶ Central Wholesalers ⟶ NRs. 12,000-14,000 ⟶ Regional Wholesalers

and accordingly in 2008, per kg price of *S. chirayita* (on average) is:

Harvesters ⟶ NRs. 206 ⟶ Sub-local Traders ⟶ NRs. 244 ⟶ Local Traders ⟶ NRs. 263 ⟶ Central Wholesalers ⟶ NRs. 325 ⟶ Regional Wholesalers

Similarly, percentage higher price received by traders at different level compared to price received by harvester is:

Harvesters ⟶ NRs. 206 ⟶ Sub-local Traders ⟶ NRs. 244 (18 %) ⟶ Local Traders ⟶ NRs. 263 (28 %) ⟶ Central Wholesalers NRs. 325 (57 %) ⟶ Regional Wholesalers

4.6 Benefit Sharing Arrangements in the Study Area

The transfer of KCA management responsibilities from Government to the KCA-MC began in 2005 with the preparation of the KCA Management Plan and the KCA Rules. This is the first time that a community-based organization has been entrusted with the responsibility of managing a project area (KCAP) of this scale and importance (Gurung 2006). Community-Based KCA institutions are shown (Appendix IV).

Yamphudin is one of four VDCs where Kangchenjunga Conservation Area Project (KCAP) has been implemented and accordingly is managed by community based organizations. The 10 Community Forest User Groups (CFUGs) and 7 Mothers' Groups (MGs) are the foundation of the local organizations. The MGs and CFUGs are formed in each settlement for practical reasons and each household is represented by at least one member in each group.

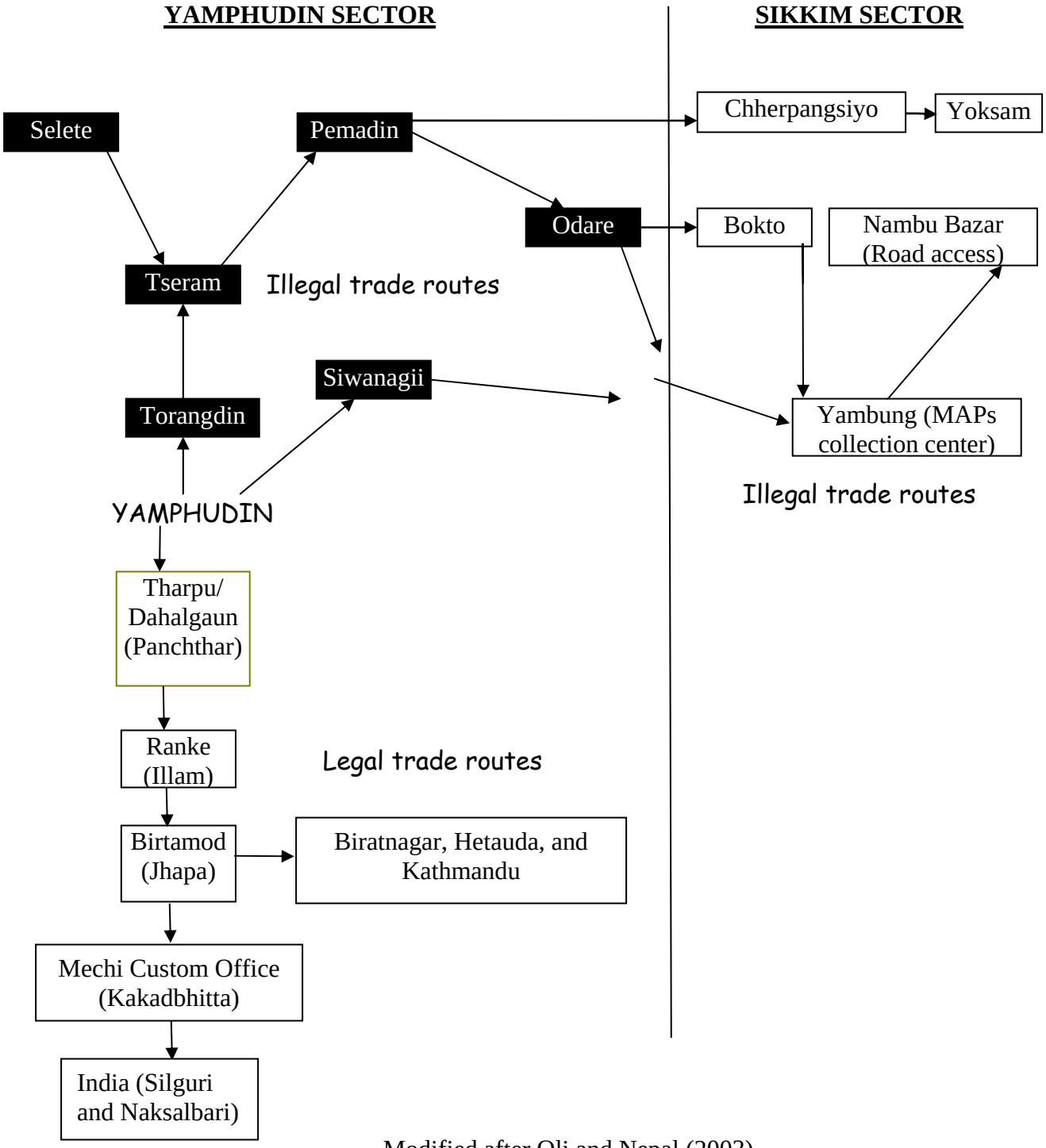
For CFUG, at least 1 member; and for MG, 1 female from each household should be a member. Their representatives form the Conservation Area User Committees (CAUCs) and finally the Kangchenjunga Conservation Area Management Council (KCA-MC) which includes representatives from all four VDCs of KCAP.

The CAUCs are responsible for the implementation of conservation and development initiatives through CFUGs and MGs. The KCA-MC is primarily responsible and accountable for resource distribution, monitoring and the overall management of the area. The VDC chairperson in the CAUCs and the District Development Committee (DDC) representative in the KCA-MC are mandatory members to ensure and effective partnership with local government to improve coordination and to avoid duplication of conservation and development initiatives in the area.

Anyone whishing to collect *S. chirayita* from community forests should have to obtain collection permit. For this individual collector gives application to the concerned user group for collection of *S. chirayita*. User group takes necessary royalty and forwards the application to KCA for approval (Field verification by KCA if necessary). KCA then gives collection permit to the collectors with a copy sent to District Forest Office (DFO) and concerned User Groups. There is a rule made by KCAP to prevent unsustainable harvesting of *S. chirayita*. Farmers actually cultivating the *S. chirayita* have to ask a KCA official to monitor their field and certify that the *S. chirayita* is cultivated rather than collected from the wild. Royalty rate is NRs. 2.50 per kg for *S. chirayita* cultivated on private which later on is deposited on their committee fund. Similarly, it is NRs. 15 per kg for *S. chirayita* collected from national forest which is deposited on national tax revenue office and half of the price collected comes back to community fund.

4.7 Local Level Value Addition on *Swertia chirayita* and Marketing Linkages

Figure 4.9: Legal and illegal trade routes of *S. chirayita* from Yamphudin



Modified after Oli and Nepal (2003)

Both legal and illegal trade routes were observed from the study area (Figure 4.8). The trade network and route is the legal network where the provisions and procedures of NTFPs trade as mentioned by the Nepal Government are employed, despite some irregularities and gaps. Similarly, trade network and route is the illegal network where the provisions and procedures of NTFPs trade are not in accordance with the Nepal Government.

Survey of the area showed local level value addition was confined to drying in the sun for one to two weeks or in light smoke after harvesting. The whole plant except the root is harvested. Drying is followed by storing in cool dark place and protecting from water and fire. Sub-local trader takes away the product which is then entered into NTFPs marketing channel. Surveying markets at different place (Tharpu, Phungling, Birtamod, Dharan) showed no further value addition on *S. chirayita*. All *S. chirayita* is exported in crude form to India.

4.8 Annual Export of *Swertia chirayita* from Study Area and Taplejung

Every year significant amount of *S. chirayita* is collected from the study area and is exported legally and illegally (Figure 4.8). To find both legal and illegal export annually from the study area, informal individual dialogues were conducted with members of CAUCs, sub-local traders, staff of KCA, and local NTFPs experts. Based on that, annually about 3757 kg of *S. chirayita* is exported legally from the study area through legal routes. Similarly, about 1429 kg is estimated to be exported annually through illegal routes.

Table 4.3: *Swertia chirayita* export from Taplejung

Fiscal Year	*S. chirayita* export (kg)	Total export from EDR* (kg)
2054/55	55,115	-
2055/56	38,209	-
2056/57	14,500	-
2057/58	16,995	
2058/59	34,339	1,00,410
2059/60	41,068	66,824
2060/61	33,789	1,05,568
2061/62	17,219	82,191
2062/63	10,460	33,760
2063/64	13,700 (until Falgun 12, 2064)	-

Source: DFO Official Records * EDR = Eastern Development Region

4.9 NTFPs Exported from Taplejung District

According to DFO Taplejung (2006), 58 NTFPs are important for sustainable economic source (Appendix III A). Among them 16 species namely *S. chirayita* (*Swertia chirayita*), Kutki (*Neopicrorhiza scrophulariifloraI*), Argeli (*Edgeworthia gardneri*), Lokta (*Daphne spp.*), Bikh (*Aconitum spp.*), Bikhma (*Aconitum bisma*), Majito (*Rubia manjith*), Vhir mauri ko maha (Honey), Sunpati (*Rhododendron anthopogon*), Nagbeli (*Lycopodium clavatum*), Bhojo (*Acorus calamus*), Jatamansi (*Nardostachys grandiflora*), Bhutkehs (*Selinum tenufolium*), Dhupi (*Juniperus spp.*), Rhitta (*Sapindus mukorossi*) and Ban lasun (*Allium wallichii*) are exported from the district and have official records.

Only two species of NTFPs viz. Kutki and *S. chirayita* were traded from Taplejung district before 1995. Since then many other species have been added in the list. The number of species traded and exported (officially) reached up to 8 species in the year between 1996/97 to 1998/99. Species added in the trade list were Ban lasun, Bikh, Chiratio, Jatamansi, Kutki, Lokta, Majhito, Nagbeli, Bhojo and Argeli. However, in 2002/2003, only 3 species were exported from Taplejung (Oli and Nepal 2003). The number of exported NTFPs grew to 8 in year 2007/2008. Species included in the trade list were; *S. chirayita*, Majhito, Jatamansi, Ban lasun, Lokta, Dhupi ko paat, and Jhau.

4.10 NTFPs Exported to Tibet from Taplejung

Significant volume of NTFPs is exported from Taplejung to Tibet. According to DFO officials such trade is mostly illegal and due to lack of custom office at the border of Tibet, government is not able to control such illegal trade. Further, due low taxes and royalties; lesser to pay all the royalties (both to CAUCs and DFO), taxes, transportation cost and custom revenue when the NFFPs including *S. chirayita* was traded towards Tharpu/Dahalgaun, and also attractive market price in Tibet, traders prefer to sell product to Tibet. NTFPs that are exported to Tibet are listed (Appendix III B). Among 9 NTFPs listed, 3 species namely: *S. chirayita* (*Swertia chirayita*), Kutki (*Neopicrorhiza scrophulariiflora*) and Maikopila (*Saussurea tridactyla*) were found exported in significant amount to Tibet from the project district. The demand of Kutki and *S. chirayita* was from pharmaceuticals companies while the demand of Bikh was high from agro-pestiscides producing companies.

CHAPTER -5

Discussion

5.1 Issues on Access and Benefit Sharing

The issue of access and benefit-sharing with regard to biological resources has become one of the most hotly contested terrains in the international arena. As a specific subset of these resources, medicinal plants have attracted great attention, apart from crop genetic resources, because of their tremendous potential for human welfare, as also their enormous potential for economic profits. Access to and sharing of benefits from medicinal plants and their habitats can be extremely inequitable. Such inequalities are present within each community (more so in non-tribal societies), among communities and among countries. They can be economic, social, gender-based or political.

5.2 Status of *Swertia chirayita*

The situation of Yamphudin is that people are highly dependent upon natural resources for their subsistence livelihoods and basic community infrastructure and social services remain poor in the area. Increasing needs of the growing population, together with poverty are likely to threaten the co-existence between nature and humans, as the exploitation of natural resources mostly NTFPs such as *S. chirayita* in every possible way is a compulsion for survival for the overwhelming majority of the Yamphudin inhabitants. Majority of people earn less than USD 200 per year (Barakoti 2007). NTFPs provide valuable income, and are an important source of food, medicine, fodder, building materials and fuel (Barakoti In this regard, research questions regarding study of *S. chirayita* have been analyzed.

During his study of survey of mapping of *S. chirayita* in the KCA, Paudel (2003) found scanty distribution of *S. chirayita* plants per ha in Yamphudin. But the present study has shown significant number of plants per ha on wild; 2941 plants per ha at 1800m, 3382 plants per ha at 2000m, 3534 plants per ha at 2500m, and 3438 plants per ha at 2800m. This shows that resource base of S. *chirayita* is not degrading as a result of collection as compared to a study by Paudel (2003). Instead, plant number has increased. Such increment is due to increased awareness among local people who are aware about the sustainable harvesting of *S.*

chirayita due effort of KCAP. Further, motivation of KCAP to local people towards commercial cultivation by providing trainings from experts timely also has contributed to such results.

When considering the quality of *S. chirayita* in wild and cultivated, results were compared to examine the significant differences. Student t-test was used to determine any significant difference in bitter principle among wild and cultivate *S. chirayita*. From the comparison, it was found that calculated value of t at 5% significance level and 6 degree of freedom (0.51) was less that of tabulated value at 5% significance level and 6 degree of freedom (2.45). Since, tabulated value is greater than (>) calculated value, Null hypothesis is accepted. This implies that there is no significant difference in bitter principle in wild and cultivated *S. chirayita*.

Thirdly, access to commercialized cultivation among different groups (rich and poor) of people was examined. It was found the capacity enhancement by KCAP has significant impact on facilitating access among the poor family as well. KCAP timely organizes trainings regarding the sustainable cultivation and uses of NTFPs. Training on commercial cultivation of *S. chirayita* through nursery preparation had been organized lastly on July 2007 (Barakoti 2007). Coincidently, participants from Yamphudin who attended the training were from poor community. Selection of participants from each ward is determined by the Mothers' Group of the concerned ward. During interview, participants of that training stated lack of financial resource to buy seed, lack of enough land to cultivate *S. chirayita*, lack of labor, and lengthy harvesting time (about 30 months) has retarded the pace of poor people towards the commercial cultivation of *S. chirayita*.

Further not all land is not suitable for *S. chirayita* cultivation. Sloppy land facing Northeast and Northwest are preferable. People who have enough land (rich people) use significant portion of appropriate land for commercial cultivation by keeping aside land for growing food crops. This shows both rich and poor people have equal access to commercial cultivation but because of larger landholding of rich people, they have more access to commercial cultivation compared to poor farmer having small farm size. Regarding the access to the harvest of *S. chirayita* from the wild, equal access to both rich and poor farmer

was observed after paying royalty. But due to scanty number of *S. chirayita* in wild, rich farmers were found more concentrated on commercial cultivation than collection from wild.

5.3 Altitudinal Range of *Swertia chirayita* Distribution, Cultivation, Key Associated Species and Soil Parameters

Though literature suggests *S. chirayita* to be found at altitudes 1200 to 3000masl (Edward 1996a; Manandhar 1980a), but in the study area, it was not reported below 1500m. Occurrence of *S. chirayita* was frequent from 1700masl to 2800masl and the growth condition was good in this range. Ward no 2,3,4,5, and 9 showed high distribution of *S. chirayita*. No *S. chirayita* cultivation was done below 1700masl and above 2800masl. However, there were scattered *S. chirayita* saplings on terrace risers near houses below 1800m not for commercial purpose but for household medicinal use.

Bhale *S. chirayita* (*Swertia angustifolia)* was observed throughout with pothi *S. chirayita (S. chirayita)* upto 2500masl which differ from pothi *S. chirayita* by having smaller leaves, large flowers and low bitter in taste. Uttis *(Alnus nepalensis)*, Argeli *(Edgeworthia gardeneri)*, Lokta (Daphne *spp.)*, Titepati *(Artemessia indica)*, and Jamanemandro *(Mahonia nepaulensis)* were found dominant associated species with *S. chirayita*. Average density of *S. chirayita* on VDC was found to be 18748.75 plants per ha which is higher compared to Paudel (2003) who found 17169 plants per ha. According to staff of Yamphudin Sector Office, this is due to increase of awareness among local people and motivation of people towards commercial cultivation.

On all sites, soil pH was found in the range 4.5 to 5.5 which according to Barakoti (2002) is suitable for *S. chirayita* growth and cultivation. Further dominancy of sandy soil along with organic matter, moderate slopes not directly exposed to sunlight i.e. facing northeast and northwest further aids VDC as the potential area for commercial cultivation of *S. chirayita*. Similar, findings had been reported by Aryal and Kerkhoff (2008) during their study "shifting cultivation in the KCA"

High pH on wild soil is due to the slow mixing of carbon-dioxide from soil which is released due to microbial respiration and converted to carbonic acid (Brady and Weil 1999). But, in case of cultivated soil, frequent activities of human help churn the soil which release carbon-

dioxide in the atmosphere resulting in lowering of pH. High value of soil potassium on cultivated soil on all sites is may be due to addition of ass, source of potassium through slash-and-burn practices. Similarly, high value of soil nitrate in wild soil may be due to high nitrification and low value in cultivated soil due to denitrification process through exposed soil after human intervene.

5.4 Household Uses of *Swertia chirayita* Among Ethnic Groups and Adulteration during Trade

The use of *S. chirayita* was basically medicinal purpose in the past. People used to take it as a means of treatment of fever, cough, cold, and inflammation. With the establishment of health post in the study are, shifting of people towards modern medicine is increasing because of effectiveness and immediate relief. However, the summary of ethno botanical uses of *S. chirayita* observed among different ethnic groups (Rai, Limbu, Gurung, Bhote, and Sherpa) is shown below.

It is used to treat different aliments.

a. Fever: *S. chirayita* is soaked in cold water or boiled with hot water. Then the water is drunk to cure fever.
b. Cough: *S. chirayita* is boiled in water and the water is drunk. In some cases, the fresh roots are chewed.
c. Headache: *S. chirayita* soaked hot water is used to cure headache.
d. Cold: Common cold is also treated by *S. chirayita.*
e. Throat problem: Throat problems are also cured by *S. chirayita*. The water boiled with *S. chirayita* is inhaled to cure throat problems. Some people also said that it can be chewed directly to cure throat disorders.

Among the available species *S. chirayita* is the most commonly found and traded species among *S. bimaculata, S. dilatata, S. hookeri, S. multicaulis, S. nervosa* and *S. petiolata* in the study area (Ghimire and Nepal, 2007). People are very careful in the quality of their commodity as any adulteration may reduce the cost of their products. The trade and economics of *S. chirayita* is affected by adulterants of the herb. No adulteration was observed in samples that were ready for export. According to petty traders, in the past there was high degree of adulteration on commodity by mixing bhale chiraito in the bundle of pothi chiraito

(*Swertia. chirayita*). Such mixing constituted 5-15 percent of total volume of pothi chiarito. Later traders knew that and started checking products before taking away. If any adulteration found, refused to buy such adulterated product. But now such case is rare. This sort of mix up with other similar plants is done basically to increase the volume of the products (Oli and Nepal 2003).

5.5 Marketing Channel of *Swertia chirayita* and Price Differences

Marketing channel of *S. chirayita* from Yamphudin includes both legal and illegal channels. Legal channel comprises one road head marketing center, Tharpu/Dahal Gaun (Which lies in Mehadibung VDC of Panchthar district). *S. chirayita* collected here is finally transported by local traders to central wholesalers of Terai or is directly taken to India by them.

On the other hand, illegal trade network comprises mainly two cross border markets: Tibet and Sikkhim. Due to relatively attractive price of *S. chirayita* in cross boarder markets and low burden of tax payment, farmers of lower belt of the KCA including Yamphudin are encouraged to sell their *S. chirayita* in Tibet and Sikkhim.

Petty trader is the first actor of trade network who buys *S. chirayita* from harvesters at local level, as per the demand of the local trader. Such trader deducts the transportation (porter) cost and keeps some margin of profit and only pays the remaining amount to the farmers. Local trader buys *S. chirayita* from village trader only after deducting all the costs like royalties, local taxes, transportation cost, extra expenses (unofficial cost paid for easy transport) in check post/beats enroute including the profit margin. So, it seems that all the costs are deducted from farmer gate price. Local trader then exports *S. chirayita* to central wholesaler (Birtamod, Dharan and Biratnagar) or directly to India. The wholesaler in the Terai store *S. chirayita* and deliver it to regional wholesalers through Mechi and Jogbani Custom Office when the price increases. The Indian wholesalers later exports *S. chirayita* to Delhi, Calcutta, and Bombay which as reported is consumed by the Ayurvedic and drugs factories, brewing industries and pharmaceutical companies.

Traders in the Yamphudin make good money from the sale of *S. chirayita* produced and collected from the farmers. The fluctuating rates outside the district do not have much impact

on the buying rates of the traders because local people are not aware of the rates outside the district and within the VDC, there is not much competition among the traders. Thus, local people usually have no choice except to sell their products to sub-local traders. Significant price difference (about NRs. 56) between harvester and traders was observed. Formation of marketing co-operatives at VDC level is one way to maximize benefit to the harvesters as these can direct sale the product to the ultimate market.

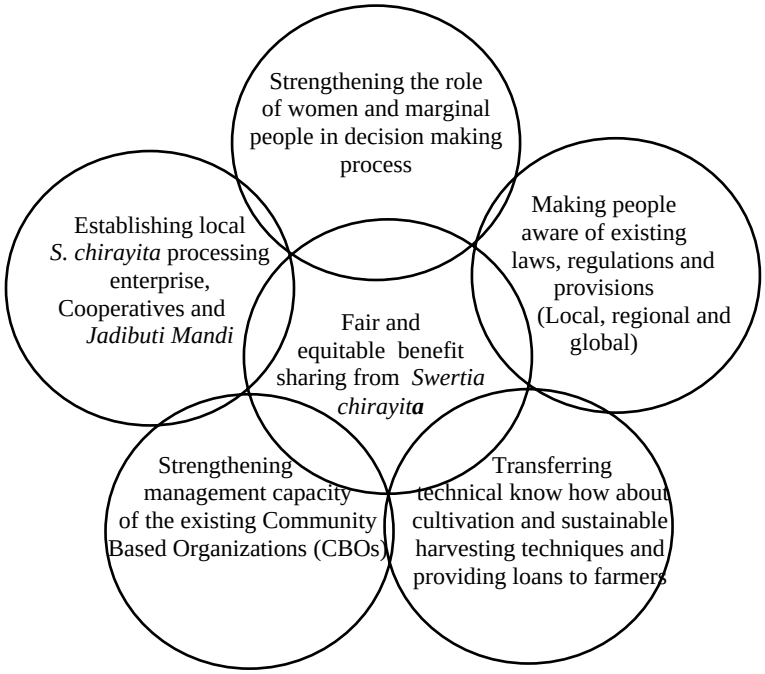
5.6 Benefit Sharing Arrangement

There is a rule made by KCAP to prevent the wild harvesting of *S. chirayita* and harmful harvesting practices through certification process and different royalty system for *S. chirayita* collected from private land and national forest. But one representatives of CFUG member and staff of Sector Office Yamphudin stated that farmers seldom inform KCA office for monitoring before the harvest. Further, both the practice of collecting revenue is not practical in the case of Yamphudin. It was reported that some of the collectors bring collection permit directly from DFO Taplejung and collect *S. chirayita* from national forest without informing KCA.

No royalty is charged for *S. chirayita* that comes from KCA. But, Paudel (2003) has stated that people have to pay up to NRs. 13/kg on the way to Birtamod as unofficial expenditure which is paid to government staff (police and forest) for easy delivery of *S. chirayita*. The price thus paid is that deduced from the farmer's actual receivable amount. Farmers need to pay royalty even though the *S. chirayita* is cultivated on private land, which doesn't apply for other agricultural crops grown from farmer's land. This has been the matter of discussion among traders and local staffs of KCAP.

Fair and equitable benefit sharing from *S. chirayita* may possibly be achieved when several interconnected aspects are taken into consideration as shown (Figure: 5.1).

Figure 5.1: Aspects needed to take into consideration for equitable benefit sharing from *Swertia chirayita*



Adoption of MAPs by farmers and CFUGs doesn't only depend upon the availability of domestication technologies, but equally on the chain of other activities involving sustainable harvesting, grading, storage, co-operatives arrangements for bargaining for better prices in the market, strengthening the capacity and role of local organizations, and maximizing the role of women and marginalized people in decision making process.

5.7 Cost/Benefit Analysis in Culitvation and Wild Collection

Average production of *S. chirayita* on kg/ha basis in cultivated land has been found to be 249 kg (Table 4.1). Considering the current village level price NRs. 206/kg, total income per ha comes to be about NRs. 51,300. Subtracting on average 20 percent of such income (NRs. 10,260); investment required during land preparation, seed sowing, monitoring site, harvesting, royalty, drying, storage and finally to sell to traders, the net profit per ha on cultivated land is NRs. 41,040.

Similarly, average production of *S. chirayita* on kg/ha basis on wild has been found to be 44 kg/ha. Total income per ha comes to be about NRs. 9,134. Subtracting on average 12 percent of this income (NRs. 1,096); investment required during harvesting, royalty, drying, storage and finally to sell trader, net profit per ha on wild is NRs. 8,038. Thus, the present study showed benefit from commercial cultivation of *S. chirayita* per ha is about 5 times higher than that from wild collection at current level of production. But, this is not always true. With the increase of density of *S. chirayita* in wild, the profit gap would be reduced.

5.8 Threats and Issues Related to *Swertia chirayita*

5.8.1 Livestock grazing

Stray livestock (cattle, goats, sheep and buffaloes) especially from migratory livestock and pressure in forest is a major problem *S. chirayita* was not observed in areas where livestock graze freely provided that same altitude where livestock were absent where distribution of *S. chirayita* was abundant.

5.8.2 Uprooting and Premature Harvesting

Uprooting the whole plant before the seed is shed leaves no to regenerate *S. chirayita* for next year. Similarly, premature harvesting of stock in off season is still practiced which has reduced the plant population greatly. Due to this, resource base of *S. chirayita* is declining. Similar result has been reported by (Paudel 2003).

5.8.3 Land Tenure Issues

Clear boundaries of private and government land have not been delineated in many upland areas where *S. chirayita* is being cultivated. The people put large areas on fire each year for *S. chirayita* cultivation. Wherever the farmers carry out slash-and-burn practice, they claim that the piece of land belong to them. KCAP is against of it but remains quite since they do not have evidence whether the burnt piece of land is private or government land.

5.8.4 Theft

Theft is one of the main problems on *S. chirayita* from cultivated land though the degree varies. One of the farmers whom we had met in the field informed that people steal *S. chirayita* by placing it inside the bundle of grass so that no one would suspect.

5.8.5 Slash-and-Burn practice

Since slash and burn is operated before rainy season, rain washes out large amount of top fertile soil. In KCA, commercial *S. chirayita* cultivation is synonymous to slash-and-burn *S. chirayita* cultivation except on terrace risers and home garden's *S. chirayita* cultivation. According to Shrestha (1989), this practice is most detrimental to forest ecology and contributes to the total extinction of a large number of biological species. Thus slash-and-burn practice doesn't seem to be a viable tool for longer period. Khoriya farming of maize and *S. chirayita* through slash-and-burn method as shifting cultivation has been practiced by the farmers in Yamphudin VDC. It has been one of the burning issues challenging biodiversity conservation in KCA.

Despite this slash-and-burn cultivation has some positive aspects. Farmers believe that *S. chirayita* favors land subjected to slash and burn. This may be because ash resulting from fire add nutrient to the nutrient poor soil of forest. The heat and ash may also hasten the cycling of plant nutrients. Further, heat also affects the breakdown and release of organic matter locked in freshly incorporated organic compounds (leaves, twigs, animal dung, and urine) humus and peat (Brady and Weil 1999).

5.8.6 Royalty

People have to pay royalty even though the *S. chirayita* is collected from private land. People, trader and NGO personnel say it is not fair and doesn't apply to other agricultural crops.

5.9 Possible Steps to Maximize Benefit from *Swertia chirayita* Cultivation

5.9.1 Establishing Herbal Processing Units and Herbal Farm

Inequitable share of benefits and unfair price of the products could be minimized by establishing local processing units in the area. This will encourage the farmers towards cultivation, conservation, sustainable harvesting, drying, cleaning and finally selling of medicinal herbs and their derivatives which will provide reasonable price to the primary collectors for their product.

5.9.2 Demonstration Plots of *S. chirayita*

Establishment of *S. chirayita* demonstration plot and displaying of innovative practices will encourage the local community to apply and follow in their own private land. This may also shift the belief of local people towards commercial cultivation through nursery preparation which is more environment friend technique than slash-and-burn. Slash-and-burn technique accelerates the rate of soil erosion on sloppy land.

5.9.3 Formation of Marketing Co-operatives and Establishing *Jadibuti Mandi*

Market co-operatives, with a greater power to bargain and by-pass the Terai level traders need to be formed. Similarly *Jadibuti Mandi* could help people sell their products easily and get fair price regardless of the quantity.

CHAPTER-6

Conclusions and Recommendations

6.1 Conclusions

In the study area, *S. chirayita* was confined in cultivated in between the altitude of 1700 to 2800 masl though it can be observed from 1500 to 3000 masl. Growth is stunted to provide good commercial benefits to people between 1500 to1700 masl and above 2800 to 3000 masl. Northwest and Northeast facing slopes are favorable for *S. chirayita* distribution.

Production of *S. chirayita* per ha on average was 248.73 kg on cultivated and 44.29 kg on wild. Bitter principle showed high value on all altitudes in wild (>1.3 %); which is in conformity of pharmacopoeia of India. At all the altitudes, soil parameters shows high value in soil collected from wild except soil potassium which is high on cultivated soil. This may be due to mixing of ash on slash-and-burn. Dominance of sandy soil is prevalent on both wild and cultivated .*S. chirayita*.

Statistical analysis shows positive correlation among bitter principle and soil parameters in most of the sites. However, bitter principle/phosphate shows negative correlation on both wild and cultivated *S. chirayita*. T-test showed no significant difference in bitter principle between *S. chirayita* collected from wild and from private land.

About 30 percent expenses of the sampled household in the study area is fulfilled from the income generated from trade of *S. chirayita*. Shifting of people towards commercial cultivation is increasing. KCA timely provides trainings about cultivation of *S. chirayita* emphasizing cultivation through nursery preparation; however, slash-and-burn is still the dominant method of cultivation on private land. Use of chemical fertilizer and pesticide was nill in the study area.

People were found using *S. chirayita* to cure health disorders like cough, cold, fever, headache, and throat problem. Different royalty system exists for *S. chirayita* harvested from national forest and that from private land. Unlike other crops produced from private land,

farmers have to pay royalty for *S. chirayita*. Both legal and illegal trade network exists in the study area.

Significant price and thus profit differences were observed in between harvesters to central wholesalers. No adulteration was observed while observing sample in the VDC ready for export. Cost/Benefit analysis shows profit 5 times higher from *S. chirayita* cultivated in private land than harvested from wild at current level of production.

Provided the temperate climate, dominancy of sandy soil, sufficient north facing slopes and altitudes, the study area is suitable for commercial cultivation of *S. chirayita*. Benefit of the farmers of the study area can be improved by increasing their access to commercial cultivation techniques along with providing market guarantee.

6.2 Recommendations

Based on findings of the present study, the following recommendations have been made in respect of production, management, and marketing of medicinal herbs in general and *S. chirayita* in particular.

- Harvesting of *S. chirayita* should be done only after seed get matured leaving 10-15 percent mother plants for regeneration to next crop.
- Stall feeding of animals should be encouraged in the villages and *S. chirayita* cultivated areas.
- MAPs based income generating opportunities such as local level value addition on *S. chirayita* and other species need to be introduced.
- Appropriate and effective cultivation methods of high valued MAPs such as *S. chirayita* feasible to that particular agro-climatic zone should be initiated through establishing demonstration plots.
- Detailed nutrient study of soil at different altitudes should be carried out for suitability of commercial cultivation of NTFPs.
- Formation of market co-operatives and establishment of *Jadibuti Mandi* should be promoted involving all sectors of the community. As the market guarantees, communities will be motivated towards commercial cultivation of MAPs including *S. chirayita*.
- External investments and involvement of established entrepreneurs are essential to run the enterprise in the long run. Thus, extensive program have to be initiated to attract the external investments in Yamphudin.
- Access to poor people in government land should be allowed so that they have fair chance of livelihoods.
- Access to Bioprospecting of other genetic resources should be regulated with Prior Informed Consent from the local communities.

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APPENDIX I: Guiding Questions for Interviews

A. Questions for Farmers/Collectors

District…… VDC…… Ward No. …….. Altitude.....

1. What is your purpose of cultivating *S. chirayita*?

a. Medicine b. Commercial c. Livestock feeding d. Other

2. On average how much it takes you to reach to *S. chirayita* collection site in wild and cultivated?

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

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

4. How have you cultivated *S. chirayita*?

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

5. On how much ropanis have you cultivated through slash and burn?

6. Why do you prefer for slash and burn?

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

7. How do you shed seed?

a. Mixing on sand b. Soaking on water c. Mixing on cow/buffaloes dry dung d. Mixing on ash d. Others

8. What type of land is appropriate for cultivation of *S. chirayita*?

a. Edge b. Slopy land c. Plain land d. Others

9. How do you obtain seed of *S. chirayita*?

a. Produce myself b. Buy from neighbour c. Organizations provide d. Others

10. Why do you select *S. chirayita*?

a. For better income b. Subsidized by KCAP c. Others

11. What type of subsidy have you got if any?

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

12. What is the criteria for receiving such subsidy?

a. Having more land b. Have to pay initially c. Others

13. Whose cultivation is beneficial, *S. chirayita* or other food crops?

a. *S. chirayita* ☐ b. Other food crops ☐

14. Approximately how much is the benefit per ropanis?

15. On how much ropanis have you cultivated *S. chirayita*?

16. If not on whole land, why?

a. Lobor shortage b. Financial constraint c. Need to grow food crops d. Others

17. What is the main problem on commercial cultivation of *S. chirayita*?

a. Lack of technical knowledge b. Unavailablity of seed/fertizer on time c. Labor shortage d. Disease e. Others

18. Yearly how much organic fertilizer you use per ropanis?

19. Yearly how much chemical fertilizer you use per ropanis?

20. Name five chemical fertilizers you use if any?

a…… b……. c……. d…….. e……..

21. From where do you bring chemical fertilizer if you use?

a. local market b. district headquarter c. Others

22. Yearly how much you spend on chemical chemical fertilizer?

23. How many members of your family are involved on cultivation and collection of *S. chirayita*?

24.Yearly how many month your family spend on cultivation and collection of *S. chirayita*?

25. How much you pay for labor on daily basis for collection and cultivation of *S. chirayita*?

26. What are the main diseases of *S. chirayita*?

a…….. b …… c…… d……. e……

27. What are the chemical pesticides you use for commercial cultivation if any?

a…… b…… c……. d…….. e…….

28. Yearly how much you spend on buying pesticides?

28. From where do you buy chemical pesticides?

a. local market b. district headquarter c. Others

29. Do you have to pay tax for collection of *S. chirayita*?

a. Yes ☐ b. No ☐

30. If yes, then for what type?

a. *S. chirayita* collected from wild b. *S. chirayita* cultivated commercially

31. How much is the royalty/tax per kg?

32. Do you collect *S. chirayita* without paying royalty/tax?

a. Yes ☐ b. No ☐

33. If yes, than for what purpose?

a. Household medicinal use b. Trade c. Other

34. Do you have to pay royalty/tax for selling of *S. chirayita*?

a. Yes ☐ b. No ☐

35. If yes, then for what type?

a. *S. chirayita* collected from wild b. *S. chirayita* cultivated commercially

36. How much is the selling tax per kg if any?

37. Can people outside of your VDC are allowed to collect *S. chirayita* on your VDC?

a. Yes ☐ b. No ☐

38. If yes, than how much is the royalty/tax?

a. < local b. equal c. > local

39. Who will get priority for *S. chirayita* collection from wild, if more than one applies for it?

a. Local residents/communities b. Residents/ communities outside VDC

40. Do you have knowledge about collection of *S. chirayita*?

a. Yes ☐ b. No ☐

41. If yes, than what is the appropriate time?

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

42. Do you collect *S. chirayita* before appropriate time even if you know?

a. Yes ☐ b. No ☐

43. If yes, than from where?

a. Wild b. Cultivated

44. Why do you do so?

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

45. How do you store *S. chirayita* after you bring it to your house?

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

46. What are the problems during storage of *S. chirayita*?

a. Rottening b. Disease/pest problem c. Lack of appropriate place d. Others

47. Under what conditions, *S. chirayita* damages quickly?

a. If collected early b. If not properly dried c. If become wet on storage d. Others

48. In how many days does *S. chirayita* become ready for sale after subjected to drying?

49. Which type of *S. chirayita* damages quickly on storage?

a. *S. chirayita* collected from wild b. *S. chirayita* cultivated commercially

50. What is the position of *S. chirayita* regarding the export of NTFPs?

51. How do you sell your *S. chirayita*?

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

52. To whom do you sell *S. chirayita*?

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

53. How do you understand market price?

a. Depend on buyers b. From KCAP c. From radio d. Others

54. What is the current per kg price of *S. chirayita*?

a. Wild…… b. commercially cultivated……

55. How is the price trend of *S. chirayita* in the last 4/5 years?

a. Increasing b. Fluctuating c. Decreasing

56. What is the main problem you encounter during selling of *S. chirayita*?

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

57. Yearly how much dry wild *S. chirayita* do you sell?

58. Year how much Cultivated *S. chirayita* do you sell?

59. Is there any selling price difference between *S. chirayita* collected from wild and cultivated commercially?

a. Yes ☐ b. No ☐

60. If yes, than whose price is higher?

a. *S. chirayita* collected from wild b. *S. chirayita* cultivated commercially

61. Where do you spend the income generated from selling of *S. chirayita*?

a. Fooding b. Clothing c. Children education d. Others

B. Questions for Traders

1. Since when are you being involved on the trade of *S. chirayita*?

2. Annually how much *S. chirayita* volume you handle per year?

3. What is the position of *S. chirayita* regarding export quantity?

4. What is the net profit per mon (40 kg)?

5. What is the price trend of *S. chirayita* in last 4/5 years?

a. Increasing b. Fluctuating c. Decreasing

C. Questions for Staffs of DFO/KCAP

1. What are five commercially important NTFPs of the area?

a…… b…… c…… d…… e……..

2. How is the export trend of *S. chirayita* in last 4/5 years?

a. Increasing b. Fluctuating c. Decreasing

3. What is the royalty per kg of *S. chirayita*?

4. What are the NTFPs being exported to Tibet?

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

Parameters	Wild *S. chirayita*				Cultivated *S. chirayita*			
	Site 1	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**
Altitude	1800 m	2000 m	2500 m	2800 m	1800 m	2000 m	2500 m	2800 m
pH	5.5	5.4	5.1	5.3	5.2	5.0	4.9	5.1
% carbon	4.13	5.23	4.12	6.81	4.07	3.59	5.41	6.44
% Organic matter	7.13	9.01	11.74	7.1	7.02	6.18	11.18	9.32
Nitrate (mg/kg)	0.590	0.680	0.619	0.523	0.236	0.56	0.599	0.274
Phosphate (mg/kg)	0.287	0.171	0.297	0.243	0.245	0.189	0.229	0.238
Potassium (mg/kg)	0.05	0.076	0.081	0.061	0.061	0.082	0.089	0.072

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

Soil separates (%)	Wild *S. chirayita*				Cultivated *S. chirayita*			
	Site 1	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**
Altitude (m)	1800	2000	2500	2800	1800	2000	2500	2800
Coarse sand	39.02	38.51	40.28	39.41	43.41	38.43	35.93	37.93
Fine sand	32.71	28.98	16.58	19.26	15.69	30.06	29.17	18.24
Silt	14.78	21.50	29.52	22.96	30.04	16.05	22.68	22.52
Clay	12.85	10.08	13.02	17.77	9.91	14.96	11.61	20.72
Sieve loss (%)	0.64	0.93	0.60	0.60	0.95	0.50	0.61	0.59
Soil textural classes	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy clay loam

APPENDIX III (A): Major Economically Important NTFPs of Taplejung District

S.N.	Local Name	Scientific Name
1	*S. chirayita*	*Swertia chirayita*
2	Panchaule	*Dactylorhiza hatagirea*
3	Kutki	*Neopicrorhiza scrophulariiflora*
4	Jatamansi	*Nardostachys grandiflora*
5	Jhaau	*Parmelia spp.*
6	Argeli	*Edgeworthia gardneri*
7	Lokta	*Daphne spp.*
8	Allo	*Girardinia diversifolia*
9	Nagbeli	*Lycopodium clavatum*
10	Bikh	*Aconitum spp.*
11	Bikhma	*Aconitum bisma*
12	Maikopila	*Saussurea spp.*
13	Sunpati	*Rhododendron anthopogon*
14	Khokim	*Rheum australe*
15	Malingo	*Arundinaria maling*
16	Harro	*Terminalia chebula*
17	Timmur	*Zanthoxylum armatum*
18	Kurilo	*Asparagus racemosus*
19	Barro	*Terminalia chebula*
20	Amala	*Embliaca offcinalis*
21	Majito	*Rubia manjith*
22	Pani amala	*Nephrolepis cordifolia*
23	Lauth salla	*Taxus wallichiana*
24	Rudraxcha	*Elaeocarpus sphaericus*
25	Rajbrikcha	*Cassia fistula*
26	Tatelo	*Oroxylum indicum*
27	Pangra	*Entada phaseoloides*
28	Khoto	
29	Rittha	*Sapindus mukorossi*
30	Jazurgan	
31	Vhir mauri ko maha	
32	Ban lasun	*Allium wallichii*
33	Dhokra phul	*Datura suaveolens*
34	Titepati	*Artemessia indica*
35	Mirage chau	
36	Bhojo	*Acorus calamus*
37	Hadchur	*Vicsum album*
38	Pakhenved	*Bergenia ciliate*
39	Budi okhati	*Astilbe rivularis*
40	Gurjo	*Tinospora cordifolia*

41	Akash beli	*Cuscuta reflexa*
42	Neem	*Azadirachta indica*
43	Tejpat	*Cinamomum tamala*
44	Kaulo	*Persea odoratissima*
45	Dhasingarae	*Gaultheria fragrantissima*
46	Dhaturo	*Datura stramonium*
47	Nirmasi	*Delphinium denudatum*
48	Shilajit	
49	Lazzawati zhar	*Mimosa pudica*
50	Bhujetro	*Butea minor*
51	Seto guzarganu	
52	Bel	*Aegle marmelos*
53	Okhar	*Juglans regia*
54	Chutro	*Mahonia napaulensis*
55	Thotne	*Aconogonum molle*
56	Sisno	*Urtica dioica*
57	Bhutkesh	*Selinum tenufolium*
58	Dhupi	*Juniperus spp.*

Source: DFO Taplejung (2006)

APPENDIX III (B): NTFPs Export to Tibet from Taplejung District

S.N.	Local name	Scientific Name	Distribution (m)
1	Maikopila	*Saussurea tridactyla*	4500-5800
2	Kutki	*Neopicrorhiza scrophulariiflora*	4000-4800
3	*S. chirayita*	*Swertia chirayita*	1500-2800
4	Panchaunle	*Dactylorhiza hatagirea*	3500-4200
5	Bikhma	*Aconitum bisma*	3500-4800
6	Jatamansi	*Nardostachys grandiflora*	3200-5000
7	Dhupi	*Juniperus spp.*	3500-4500
8	Khhokim	*Rheum australe*	3200-4200
9	Sunpati	*Rhododendron anthopogon*	3400-4900

This information is based on interview with staffs of District Forest Office (DFO), Staffs of DDC and Project Manager of KCAP.

APPENDIX IV: Community-Based KCA Institutions and Location

	Ward	CAUCs	User Groups-44	Mothers' Groups-32
Lelep	1	Laligurans	Batase, Nagotha, Nimawang, Phukwan Philang	Sarmalla, Kopiyak
	2		Dandatol, Madhibung	Madibung, Lepchung
	3		Lelep, Ashi-Gaun	Lelep, Devi- Sthan
	4		Lawajin Kang Devi	Kang Devi
	5		Kumbakarna, Pathibhara	Lungthung
	6		Shrijana, Buddha-Tharpaling	Tharpaling
	7	Sekathum-Ghunsa	Shekhathum Saino	Shringkhala
	8		Gimigilla, Nagphokhari	Amjilessa, Gyabla
	9		Kumbhakarna, Phalay	Ghunsa, Sambeling
Tapethok	1	Bihani	Pawaden	Tapethok
	2		Sangbo	Pathibhara
	3		Namphowa	Khamthak
	4		Seti-Devi	Sisawa
	5		Angwa Karva-Devi	
	6		Lukumba	Pathibhara
	7	Simbuwa-Khola	Deurali Kumbhakarna	Kumbhakarna
	8		Parewa-Khim, Hangpangyok	Styalung
	9		Laligurans, Phaktanglung	Sewalung
Walanchung-Gola	1	Ghanglung	Rikhate	Himali
	2			
	3			
	4		Dhangje	
	5			
	6			
	7		Aching-La	Kangchenjunga
	8		Nakwa	
	9		Yangma	Omikhangri
Yamphudin	1	Pathibhara	Ekhim, Samethung	Mechi
	2		Chhimiya	Pathibhara
	3		Yangmutang	
	6		Chhibuk	Himalayan
	4	Kangchenjunga	Kartike	Laxmi
	5		Samethung	Timbu-Pokhari
	7		Makluwa	Kabeli
	8		Thungim	
	9		Kangchenjunga	Kangchenjunga

Source: Gurung 2006

PHOTOGRAPHS

Swertia chirayita

Bhale Chiraito

Farmer showing *Swertia chirayita*

Interviewing KCA staff at Yamphudin

Dried Chiraito ready for export

Interviewing local trader/farmer

Sector Office Yamphudin

Collecting Soil Sample

Talking with Local informants

Advanced Alainchi Stack under construction

Ramitae Danda

Shyam Danda