WWF

NP

2011

NTFPs: Impetus for Conservation and Livelihood Support in Nepal

A Reference Book on Ecology, Conservation, Product Development and Economic Analysis of Selected NTFPs of Langtang Area in the Sacred Himalayan Landscape

Citation: Pyakurel D. & Baniya A. 2011. NTFPs: Impetus for Conservation and Livelihood support in Nepal. A Reference Book on Ecology, Conservation, Product Development and Economic Analysis of Selected NTFPs of Langtang Area in the Sacred Himalayan Landscape. WWF Nepal.

Cover photograph: *Daphne papyracea*

Published by:

WWF Nepal

PO Box: 7660, Baluwatar, Kathmandu, Nepal.

Email: info@wwfnepal.org

Web: www.wwfnepal.org

Photo Credit:

Photograph of Argeli paper making- Dr Suresh K. Ghimire

Cucurligo orchioides- Dr Bharat Babu Shrestha

Rauvolfia serpentina and *Aconitum ferox* - Mr Khilendra Gurung

Fruits of *Cinnamomum glaucescens*- Mr Pashupati Nath Koirala

Cordyceps sinensis, Morchella conica, fruiting part of *Sapindus mukorossi*, flowering twig of *Cannabis sativa, Acacia catechu, Acacia rugata, Azadirachta indica* and dried petiole of *Rheum australe*- Internet

Rest of all by Dipesh Pyakurel

Design and Layout: WordScape, 5526699

ISBN:

NTFPs: Impetus for Conservation and Livelihood Support in Nepal

A Reference Book on Ecology, Conservation, Product Development and Economic Analysis of Selected NTFPs of Langtang Area in the Sacred Himalayan Landscape

Dipesh Pyakurel

Ashok Baniya

FOREWORD

Non Timber Forest Products (NTFPs) are one of the important natural resources of the Himalayan region where majority of people depends on them as a source of food, fodder, fiber, medicine, condiment, dye, and other useful materials. Rural communities are highly dependent on a range of NTFPs for their subsistence needs which contribute up to 50% of their total annual family income. More importantly, these renewable natural resources has contributed to reduce human-wildlife conflict as people are seemed increasingly interested in cultivating economically viable, and ecologically friendly species which is deterrent to wildlife as well. However, the recent years has witnessed various challenges in sustainable conservation and management of NTFPs. Over harvesting due to trade pressure, livestock grazing/trampling, forest fire, habitat destruction are responsible for the depletion of many species. Sustainable management with community stewardship offers best solution to these problems.

Sustainable management of NTFPs requires precise scientific information which ultimately augments responsible management as well as responsible business practices, and more importantly enhance customary rights of indigenous people and local communities through increasing knowledge base existed. Unfortunately, lacking scientific information of majority of the prioritized NTFPs is a ground reality, and those available are not accessible to needy entrepreneurs and general people as well. So there is growing need to compile, synthesis of information with primarily focus on economic aspect including ecology, conservation, product development and economic analysis of selected NTFPs. The book entitled "NTFPs: Impetus for Conservation and Livelihood Support in Nepal" is an endeavor to address the problem. I am hopeful that this book would be beneficial to NTFPs development entrepreneurs, resource managers, researchers and general public as well who will get up-to-date information on science and development of selected NTFPs of Sacred Himalayan Landscape.

I take this opportunity to thank WWF UK, BMZ/WWF Germany for financial support in the publication of this book. Finally, I would like to thank all those who have directly or indirectly contributed to making this publication possible.

Anil Manandhar

Country Representative

PREFACE

A wide range of plants are being used by the communities residing in the rural areas of Nepal. All these plants or plant parts; except timber, firewood and fodder; that help to fulfill the basic needs and provide subsistence income to local communities are regarded as NTFPs (Non Timber Forest Products). In the recent years, NTFPs are mostly identified or defined as per their market value, and play a profound role in human well being. Nepal, with a wide range of climatic, altitudinal and geographical variation has numerous high-valued NTFPs, which are often underestimated and underused. This book is an attempt to reveal the potential of some NTFPs in improving the livelihoods of rural communities through enterprise development.

WWF Nepal has developed several publications related to conservation and sustainable use of NTFPs. This effort can be taken as the follow up of the previous publication of WWF entitled "A Manual of NTFPs of Nepal Himalaya". This publication developed in 2008 was written in Nepali language and covered the NTFPs of high hills (temperate to alpine region NTFPs). After the publication on 2008, it was felt that detailed information on NTFPs of mid hills was needed that can improve the livelihoods of rural communities residing in mid hill areas through entrepreneurship development, hence this publication. Few NTFPs are repeated in both the publications because this publication focuses on the NTFPs of Langtang area of Sacred Himalayan Landscape and exclusion of these NTFPs will not be comprehensive and will not reflect the overall picture of SHL area.

This is an effort of five years of NTFPs based research in SHL area, and studies related to entrepreneurship development. This book is based research experiences gained in Kangchenjunga Conservation Area Project during implementation of NTFPs project, different NTFPs related assignments in Langtang National Park and Buffer Zone Area Support Programme, and experiences from Dudhkoshi Sub Basin Project in Solukhumbu district. This book is also based on field based experience gained in most of the mid hills and high hill districts that have been supported by different organizations.

A wide range of individuals and organizations have supported during the publication of this book. We would like to acknowledge Mr Roshan Serchan-Program Manager SHL and Mr Ananta Bhandari –Program Officer SHL for reviewing and providing valuable suggestions. Similarly, we would like to thank Mr Neeraj Nepali, Mr Khilendra Gurung, Mr Sanjeev Shrestha, Mr Bhesh Raj Oli and Mr Hira Gurung for their support during different stages of publication.

Support of LNPBZSP, LNP and different community based institutions during the field visits are acknowledged with deep sense of appreciation.

There may be many shortcomings regarding the publication. Valuable suggestions for the betterment of the publication in later editions are welcomed.

CONTENTS

Dactylorhiza hatagirea

PART ONE

INTRODUCTION

Nepal is situated on the southern slopes of the central Himalayas between the latitudes 26022' and 30027' N and the longitudes 80040' and 88012' E (HMGN/MFSC 2002). Nepal has a unique topography ranging from lowlands in the Terai to the Himalayan highlands and can be divided into seven physiographical zones: Tibetan marginal mountains, Inner Himalaya, Himalaya, Midlands, Mahabharat range, Siwaliks and Terai (Hagen 1998). This, together with the monsoon rainfall along the south-facing slopes of the Himalayas, has resulted in compacting virtually all climate zones within an area of 147,181 sq. km. As a result, Nepal has a great diversity of life-zones and is home to a large variety of flora and fauna.

FLORAL DIVERSITY

Nepal's floral diversity is a reflection of its unique geographic position, undulating landscape, as well as its altitudinal and climatic variations. It incorporates the Palaearctic and the Indo-Malayan biogeographical regions and major floristic provinces of Asia (the Sino-Japanese, Indian, Western and Central Asiatic, Southeast Asiatic and African Indian desert), creating a unique and rich terrestrial biodiversity. The country's great diversity of flora is found from the dense tropical forests of the Terai to the deciduous and coniferous forests of the subtropical and temperate regions, and finally to the sub-alpine and alpine pasturelands and snow covered Himalayan peaks (Chaudhary 1998).

Nepal comprises only 0.09 per cent of land area on a global scale but it possesses a disproportionately rich floral diversity at genetic, species and ecosystem level (HMGN/MFSC 2002). The numbers of species recorded are: 465 species of lichens; 1,822 species of fungi; 687 species of algae; 853 species of bryophytes; 380 species of pteridophytes (cited from Chaudhary 1998, HMGN/MFSC 2002); 27 species of gymnosperms (Shrestha 1984-85); and 5,806 species of angiosperms (Koba *et al.* 1994). A list of 50 species has been added to angiosperms by Akiyama *et al.* (1998), taking the total number to 5,856 species under 203 families. Hara *et al.* (1978) and The World Conservation Monitoring Centre (WCMC 1994) estimated the number of angiosperms to be about 6,500. Nepal claims over 2.2 per cent of the biological wealth of the world's natural flowering plants (NARMSAP/TISC 2002). The Biodiversity Profiles Project (1995h) ranked Nepal as the country with tenth-richest flowering plant diversity of Asia. Globally, Nepal ranks 25th in biodiversity with 11 bioclimatic zones, 118 ecosystems, 75 vegetation types and 35 forest types (Stainton 1972).

IMPORTANCE OF NON TIMBER FOREST PRODUCTS

Non Timber Forest Products (NTFPs) consist of goods of biological origin other than timber or fuel wood derived from forests, other wooded land and trees outside forests (FAO 1999). Wickens (1991) considered NTFPs to be "all the biological material (other than industrial round wood and derived sawn timber, wood chips, wood-based panel and pulp) that may be extracted from natural ecosystems, managed plantations, etc. and be utilised within the household, be marketed, or have social, cultural or religious significance". *A narrower definition of NTFPs more appropriate for Nepal includes all biological material other than timber, fodder or phalloid* (Hammett 1993). NTFPs comprise a group of forest products and functions, and their heterogeneity reflects the diversity of forest species used. Along with biological resources derived from forests, NTFPs also include non-consumptive services to humanity such as ecological/environmental, cultural and religious, and tourism and recreation (Walter 1998). *This book deals with NTFPs that are derived from forests and are of plant origin.*

Dactylorhiza hatagirea

Aconitum bisma

Biological services of NTFPs include direct or products of different organisms such as bacteria, fungi, mosses, lichens, ferns, higher plants, wildlife and their products. Different plant parts are harvested as NTFPs, including roots, tubers, leaves, bark, twigs, branches, flowers, fruits, nuts, seeds, gums, saps, resins, latexes, and essential oils (Walter 1998). NTFPs provide important community needs for improved rural livelihoods; contribute to household food security and nutrition; help generate additional employment and income; offer opportunities for NTFP-based enterprises; contribute to foreign exchange earnings; and support biodiversity and other conservation objectives (FAO 1995). The importance of NTFPs was raised for the past few decades as a result of many factors such as the dependence of rural communities of NTFPs, site quality, new market preferences for natural products, increasing concerns about forests and biodiversity conservation, and occurrence of many NTFPs among the biological richness and ecological complexities of natural forests (Grimes *et al*. 1994).

Medicinal and Aromatic Plants (MAPs) include plants used to produce pharmaceuticals, dietary supplement products and natural health products, beauty aids, cosmetics, and personal care products, as well as some products marketed in the culinary/food sector. MAPs have been an important resource for human healthcare from prehistoric times to the present day. According to the World Health Organization, the majority of the world's human population, especially in developing countries, depends on traditional medicine based on MAPs (WHO 2002). About 50,000 and 70,000 plant species are known to be used in traditional and modern medicinal systems throughout the world (Schippmann *et al*. 2006). About 3,000 MAP species are traded internationally (Lange and Schippmann 1997), while an even larger number of MAP species are traded locally, nationally, and regionally.

MAPs are commonly known as *Jadibuti* or *Jaributi* in Nepal and are among the seven primary programmes formulated in the Master Plan for Forestry Sector (HMGN/ADB/FINNIDA 1988). Other six components of NTFPs include Sal seeds (*Shorea robusta*), Lokta bark (*Daphne bholua* & *D. papyracea*), Sabai ghas/Babiyo (*Eulaliopsis binata*), Pine resin (*Pinus roxburghii*), Kattha (*Acacia catechu*) and Bamboos and Canes (*Bambusa* sp & *Arundinaria* sp). MAPs are biggest and by far the most important component among NTFPs and its contribution to the rural economy and healthcare is far more than services offered by other NTFP sub-sectors. There are over 2,000 species of plants in Nepal which are known to be potentially useful, including about 1,600-1,900 species commonly used for medicinal purposes, both for traditional and modern healthcare (Ghimire *et al*. 2008b).

NTFPs had been considered secondary in importance to timber in the past. They were referred to as 'minor' because revenue generation from them as compared with timber was relatively low. Moreover NTFPs often remained confined to local economies and very limited knowledge existed about them, that too in dispersed and localised pockets. Only a few NTFP species entered trade or marketing channels. These products were also inadequately and inappropriately featured in statistics. But during the past two decades, the utility of NTFPs has emerged with particular interest because their exploitation has been considered to be less destructive to the ecosystem than timber harvesting and other forest uses, and the potential income from NTFPs could be considerably higher (Arnold and Pérez 2001). Other reasons for NTFPs to receive wider attention than timber are:

i. It is almost impossible to transport timber to nearby cities/markets from high hills and mountainous districts due to physiographic conditions and inadequate road networks. Transportation and trading of raw, semi-processed or processed NTFPs/MAPs are relatively easier due to lower volumes.

ii. Harvesting of NTFPs such as those of herbs and shrubs origin and parts of trees (leaves, flowers, fruits, seeds, exudates, etc) are ecologically less-destructive compared with cutting and felling of trees.

iii. NTFPs of herbs and shrubs origin may become harvestable in a year, compared with trees that may take decades to attain maturity and become harvestable.

iv. Considering the effort, time invested and risk factors, economic returns from NTFPs are far higher than that of timber.

v. Generally, poor people who are dependent on forest resources cannot wait for long periods to get returns from the management of their forests.

SOCIOLOGICAL ASPECTS

The role and contribution of NTFPs have been crucial in subsistence, livelihood support, rural economics and biodiversity conservation since times immemorial due to their richness of variety viz food, fodder, fibre, construction materials, medicines, dyes and other useful materials. The role is particularly important in the Himalayan region, where a large proportion of the rural population depends on NTFPs for subsistence livelihood. The traditional practice of collection and trade of NTFPs makes an important contribution to household economies (Edwards 1996). Apart from NTFPs collected for trade, these communities also use NTFPs as medicines. The wealth of knowledge on the use of various plants/plant parts is the basis of survival in the remotest areas where modern medicine is hard to find even today. As a result, the rural people of Nepal continue to depend on local therapy for their healthcare. Medicinal plants or their parts may be administered as a juice, paste, infusion, decoction, powder, smoking powder and by aromatherapy. The method of payment to the healer is very flexible and suited to the rural settings of Nepal. Food grains, clothes, vegetables, poultry etc can be used to pay the healer (Manandhar 2002).

Many wild plants are also eaten by different ethnic communities in Nepal. Ethnic groups such as Raute live in forests and depend on its products for food and shelter. Most people residing in rural areas are dependent on forest products for food due to limited income and insufficient land for cultivation. Plant parts that are important to human diet include roots, tubers, fruits, flowers, tender stems and seeds. Gittha/Vyakur (*Dioscorea* spp.), Kadam (*Anthocephalus cadamba*), Lapsi (*Choerospondias axillaris*), Bael (*Aegle marmelos*), Latte/Lunde ko sag (*Amaranthus* spp.), Kurilo (*Asparagus racemosus*), Chiuri (*Diploknema butyracea*), Koiralo (*Bauhinia variegata*), Katush (*Castanopsis indica*), Sisnu (*Urtica dioica*), Okhar (*Juglans regia*), Nigalo ko Tusa (*Drepanostachyum falcatum*), Niuro-Ferns etc are some of the forest products widely used as food (HMGN/MFSC/DMP 1982, Manandhar 2002).

Peoples residing in hills and mountains also use plants such as Allo (*Girardinia diversifolia*) and Ganja/Bhang (*Cannabis sativa*) as sources of fibre for clothing. Padamchal (*Rheum australe*), Majitho (*Rubia manjith*), Bot Dhayaro (*Lagerstroemia parviflora*), Okhar (*Juglans regia*), and Chutro (*Berberis aristata*) have long histories of being used as raw material for natural dyes. Making paper out of Lokta (*Daphne bholua* & *D. papyracea*), and Argeli (*Edgeworthia gardneri*) is a part of Nepalese culture in hilly regions. Bamboo and Cane have long been considered a source of wealth in Nepal, and are primarily used for construction and to make household items. Human have optimized the use of these NTFPs for their benefit and now they are indispensable social assets.

ECONOMIC ASPECTS

A growing interest in the utility and value of NTFPs has emerged in the last two decades in developing countries. In Southeast Asia, at least 29 million people depend on NTFPs for subsistence income. According to the International Centre for Integrated Mountain Development (ICIMOD), global trade in existing MAPs was valued at around US$60 billion in 2000, which is expected to grow to US$5 trillion by 2050.

Peters *et al.* (1989) reported the contribution of NTFPs such as fruits (US$300/ha/yr) and latex (US$16.5/ha/yr) comprised more than 90 per cent of the total (US$341/ha/yr) sustainable economic rent available from the forest. However, many studies also suggest the economic value of NTFPs from forest is probably not as high as estimated by Peters and his colleague (e.g., Godoy *et al.* 1993; Campbell & Luckert 2002). Godoy et al. (1993) reviewed 24 studies worldwide and suggested the median value for NTFPs to be US$50/ha/yr. However, the net value ranged US$0.75/ha/yr (Venezuela: experimental caiman harvest) to US$420/ha/yr (Iquitos, Peru: plants). This variation has been attributed to the biological and economic diversity of study sites, different methods and assumptions used and different products studied (Godoy *et al.* 1993). Chopra (1993) estimated the yearly value per hectare of NTFPs from deciduous forests of India to be US$117-144 (gross benefits from fruits, herbs and medicinal plants). In their valuation study of tropical moist forest foods to the Huottuja people in Venezuela, Melnyk and Bell (1996) provided the equivalent of US$4,696 per household per year in a small village and US$1,902 per household per year in a larger village (Cited from Ghimire and Nepal 2007).

Many researchers argue that adding economic value to forests through the extraction of NTFPs is thus a strategy for sustainable forest exploitation, capable of conserving biological diversity while providing economic incentives to rural communities (Nepstad & Schwartzman 1992). The high economic potential of NTFPs thus resulted in the 'conservation by commercialisation' hypothesis (cf. Arnold & Pérez 2001). This has led to an upsurge of initiatives aiming—through the setting up of local enterprises—at adding value to NTFPs locally through expanding and providing markets. However, very few of these initiatives have had demonstrated effects on the ecological or biological sustainability of harvesting. Only during the last few years, many authors have given equal attention to the ecological or biological consequences of NTFP harvesting (Ghimire *et al.* 2005). The economic incentives for local management only exist under a certain combined set of social, ecological and economic conditions. The sustainability of NTFP harvesting is thus challenged by many factors from both social and ecological perspectives, factors not considered in the economic perspectives developed in the early 1990s. It is now recognised that many interlinked dimensions--biological, ecological, socio-cultural, political and economic--must all be considered in order to achieve sustainable use of NTFPs (Cunningham 2001). Sustainability of use of NTFPs has been further linked to indigenous knowledge and management systems by recognising local knowledge and practices during the process of resource assessment and conservation management and legally securing their rights to manage their resources.

NTFPs are increasingly becoming popular in national markets as they are important ingredients of several herbal cosmetics, herbal tea, food, medicines, etc. The value of NTFPs has been recognised widely with its increasing contribution to the Nepalese economy (Edwards 1996). The collection and marketing of NTFPs is a major source of rural income and an important source of revenue to the government. In the mountainous regions of Nepal, 10-100 per cent of households are reported to be involved in commercial collection of NTFPs and medicinal plants, and in some rural hilly areas, it contributes up to 50 per cent of total annual family incomes (Olsen and Larsen 2003). While forestry contributes about 15 per cent to the Nepalese GDP, NTFPs make up about 5 per cent of the GDP (CECI 2006). It has been estimated that more than 161 species of plants are traded as NTFPs, with an annual transaction of Rs

2,500 million (Subedi 2006). About 80 per cent of the value and volume in trade is occupied by 20 high demand and high value products. Further, half the traded amount is covered by the transaction of five highly-traded NTFPs, thereby creating tremendous pressure on a few selected NTFPs (Olsen 2005). About 10,000 to 15,000 tonnes of plant products of more than 100 species are exported to India annually, i.e., 90 per cent of total NTFP trade (Edwards 1996).

The Department of Forest (DoF) collected about Rs 100 million as revenue from the sale of more than 33,000 tonnes of NTFPs in the fiscal year 2008/09 (GoN/MOFSC/DoF 2010). Most of them were exported to India in crude form or semi-processed form. But in the last few years, semi-processed or processed NTFPs are being exported not only to India but also to third countries. Essential oils are the major exported commodity among processed herbs. Essential oils are extracted from more than 18 plants, and about 12,800 kg was exported to third countries in 2004/05 (Prakrit 2007). Essential oils are exported to Japan, US, Germany, Belgium and 50 other countries. Similarly, handicraft items worth Rs 300 million were exported in 2004/2005 (Acharya 2062 BS). The data confirmed that NTFPs are among the major exports of Nepal. Nepal itself is consuming herbal products on an annual increment of 20 per cent (Ghimire *et al.* 2008a). Therefore, proper management, production and diversification of NTFPs and its derivatives in rural areas of Nepal can help alleviate poverty by creating income-generating opportunities locally.

CLASSIFICATION OF NTFPs

Wickens (1991) classified NTFPs into three broad categories i.e. (i) Vegetal Non Wood Forest Products (NWFPs); (ii) Faunal NWFPs; (iii) Forestry services. An attempt was made to improve upon the hitherto existing classifications by incorporating a separate category of "Forestry services". However, `wood' has been included within NTFPs and Bamboos and Canes do not receive adequate attention in the classification proposed by Wickens.

FAO (1995) make an effort to accommodate the missing links about NTFPs and proposed a more useful and balanced classification under four broad categories viz. (i) Live plants & parts of plants, (ii) Animal & animal products, (iii) Prepared/manufactured products, and (iv) Services

NTFPs classified into seven categories by The Master Plan for Forestry Sector was the first authentic classification proposed from the government level. The classification failed to incorporate wild food and dye-yielding plants which were major components of NTFPs. Since then, NTFPs were classified by different researchers, scientists, institutions and policy makers using different parameters. Mostly, NTFPs are classified according to: use category, parts used, habit, distribution, etc (Table 1.1).

Table 1.1: Classification of NTFPs

Category	Variables
Use	Food, Fibre, Medicine, Ornament, Construction, Dye, Lighting, Aromatic/Perfumery, Spices, Culinary, Washing, Basketry
Use purpose	Home, Commercial
Parts used	Root, Rhizome, Tuber, Stem, Bark, Twigs, Leaf, Flower, Fruit, Whole Plant, Seed
Habit	Herb, Shrub, Climber, Tree
Distribution	Tropical, Sub Tropical, Temperate, Sub alpine, Alpine

Table 1.2 shows the classification of NTFPs according to use category and distribution. NTFPs or MAPs that have either market value or are extensively used in any of the given categories are included in this table. There are plenty of other NTFPs and medicinal plants, the use of which is limited to certain communities or specific places. It is extremely difficult to document all those plants.

NTFPs that have a wide altitudinal range have been included in different eco-regions (eg: Jhyau can be found from lower subtropical to alpine regions and are therefore included in Hills and Mountains). Likewise, NTFPs that have more than one use value (eg: Okhar can be used as medicinal, food and dye) are included in different categories.

Corresponding scientific names, family, altitudinal range and used parts are given in annex.

Table 1.2: Classification of NTFPs

SN	Category	Terai & Siwaliks (up to 1000m)	NTFPs & MAPs Hills (1000m to 3000m)	Mountains (above 3000m)
1	Medicinal and Aromatic Plants	Aank, Akashbeli, Amala, Ander, Asuro, Bael, Barro, Batulo pate, Bhringaraj, Bojho, Chiuri, Curry leaf, Dhaturo, Dhayaro, Dronpuspi, Ghod tapre, Ghyu kumara, Gurjo, Harro, Indrajau, Indreni, Kakadsinghi, Kantakari, Kauso, Khas khas, Kurilo, Laghu patra, Museli, Neem, Pipla, Raj briksha, Sarpagandha, Simal, Sindure, Tatelo, Titepati, Tulasi, Tunni	Akarkara, Akashbeli, Chiraito, Chutro, Bajradanti, Ban jira, Batulo pate, Bhutkesh, Bojho, Budo okhati, Dale chuk, Devdar, Dhasingre, Dhatelo, Dhaturo, Dhayaro, Dronpuspi, Eklebir, Gamdol, Ghoda Marcha, Ghyu kumari, Guchi chyau, Hadchur, Indreni, Jhyau, Jiwanti, Kurilo, Kaladana, Lauth salla, Malagiri, Pakhanved, Pudina, Satuwa, Siltimur, Sugandhakokila, Sugandhawal, Thulo okhati, Timur, Titepati, Tulasi, Tunni	Attis, Bhutkesh, Bhuin chuk, Bish, Bishma, Dhupi, Dhupjadi, Jatamansi, Jhyau, Kakoli, Kutki, Laghu patra, Lauth salla, Maharangi, Maikopila, Ninejadi, Nirmasi, Padamchal, Padam puskar, Panch aaule, Sarmaguru, Somlata, Sunpati, Talispatra, Yarsa gumba,
2	Fibre	Bhang, Babiyo, Ketuki	Allo, Babiyo, Bhang	
3	Paper		Lokta, Argeli, Furke pat	
4	Dyes	Bot Dhayaro	Chutro, Jamanemanro, Majitho, Okhar (husk), Kafal, Dale chuk	Padamchal, Bhuin chuk
5	Bamboos, Rattans, Vines	Bamboos, Bet	Nigalo	Nigalo
6	Wild Food (including spices, culinary)	Bael, Bayar, Bhyakur, Chiuri, Curry leaf, Jamun, Kadam, Kurilo, Sajyon, Siplikan, Tejpat	Ainselu, Bhyakur, Gunyalo, Kafal, Katush, Jhuse til, Koiralo, Kukur daino, Lapsi, Latte, Lude, Malo, Nigalo, Niuro, Okhar, Siplikan, Sisnu, Tarul, Tejpat, Unyu, Timur	Ban lasun, Jangali jira, Jimbu, Padamchal
7	Resins		Khote salla	
8	Soaps/ Detergents	Rittha, Sikakai	*Sedum* sp, Pangar	
9	Others	Bhorla, Dar, Chhatiwan, Khayar, Pawan, Sajiwan, Sal seed, Simal, Rudraksha	Bilaune, Kaulo, Amriso, Nagbeli, Rudraksha	Bhoj patra


Nardostachys grandiflora


Neopicrorhiza scrophulariiflora


Ephedra gerardiana


Dactylorhiza hatagirea


Saussurea gossypiphora


Aconitum ferox


Hippophae salicifolia


Fritillaria cirrhosa


Panax pseudo-ginseng


Rhododendron anthopogon


Jurinea dolomiaea


Swertia multicaulis


Juniperus indica


cordyceps sinensis


Hippophae tibetana

Gaultheria fragrantissima

Paris polyphylla

Parmelia sp.

Anacyclus pyrethrum

Zanthoxylum armatum

Maharanga emodi

Princepia utilis

Taxus wallichiana

Girardinia diversifolia

Juglans regia

Drepanostachyum falcatum

Swertia chirayita

Pinus roxburghii

Mentha piperata

Morchella conica

NTFPs of Mid Hills (contd.)

Valeriana jatamansii

Edgeworthia gardneri

Daphne bholua

Thymus linearis

Thysanolaena maxima

Cinnamomum glaucescens

Selinum tenuifolium

Persea odoratissima

Cedrus deodara

NTFPs of Siwalik and Terai

Diploknema butyracea

Justicia adhatoda

Cannabis sativa

NTFPs of Siwalik and Terai (contd.)

Sapindus mukorossi

Acacia catechu

Cucurligo orchioides

Asparagus racemosus

Acacia rugata

Aegle marmelos

Acorus calamus

Mallotus philippensis

Piper sp.

Bombax ceiba

Holarrhena pubescens

Phyllanthus emblica

Rauvolfia serpentina

Azadirachta indica

Jatropha curcas

SUSTAINABLE MANAGEMENT OF NTFPs

Sustainability Issues

The increasing demand for natural products in the sectors of food, cosmetics, wellness and medicinal ingredients poses major ecological and social challenges. High pressures on current and expanding commercial harvest of wild resources can threaten the survival of populations and species, while also endangering local ecosystems. Governments, development organizations, businesses and consumers have begun to recognise that diminishing availability and loss of these wild resources threatens health and economies on a broader scale and undermines the livelihoods of collectors who often belong to the poorest social groups.

For centuries, collection of wild NTFPs for trade has been possible without major negative effects. However, during the past few decades, these resources have been highly exploited for trade (Edwards 1996, Olsen & Larsen 2003). Harvesting usually takes place before the plants mature. Moreover, bark is harvested by cutting plants of all size classes within the available area. These practices not only hamper the regeneration of the concerned species, but also pose threats to their long-term survival. Overharvesting of selected plants for commercialisation with no proper care or management has contributed to the depletion of many valuable NTFPs from the wild.

Sustainable management of NTFPs is important because of their value as a perennial source of subsistence income and to conserve biodiversity. Over harvesting and premature collection along with habitat destruction, open grazing, forest fire and soil erosion are major threats to the sustainability of NTFP conservation. Conventional conservation strategy that had been adopted earlier restricts local communities from the use of resources, where chances of overexploitation are high unless the community understands sustainability issues. Therefore, an integrated approach is required for proper and sustainable management of NTFPs. The approach should include factors like understanding the ecology of targeted species and surroundings, resource inventory, assessing market dynamics and demand/supply chain, and empowerment of communities.

Advancement of technologies has resulted in improved cultivation practices for agricultural products but most high valued NTFPs are collected from the wild. This is likely to continue because little is known about the growth and reproduction requirements of most NTFPs, which are derived from many taxonomic groups for which there is little or no experience of cultivation. The time, research and experience leading to the domestication and cultivation are costly, and only few NTFPs or MAPs have large and reliable markets required to support these inputs (Medicinal Plant Specialist Group 2007). Likewise, inadequate land for agriculture and minimum chances of other income generating activities in the mountainous regions of Nepal results in a high degree of dependency on wild NTFPs for survival.

Most high-valued NTFPs are collected from the wild without paying attention to the quantity and quality of harvested material. Being the least benefitting groups, collectors often tend to harvest more than the harvestable quantity to get more money. Similarly, competition among collectors compels them to collect NTFPs prematurely, resulting in their gradual disappearance from the wild.

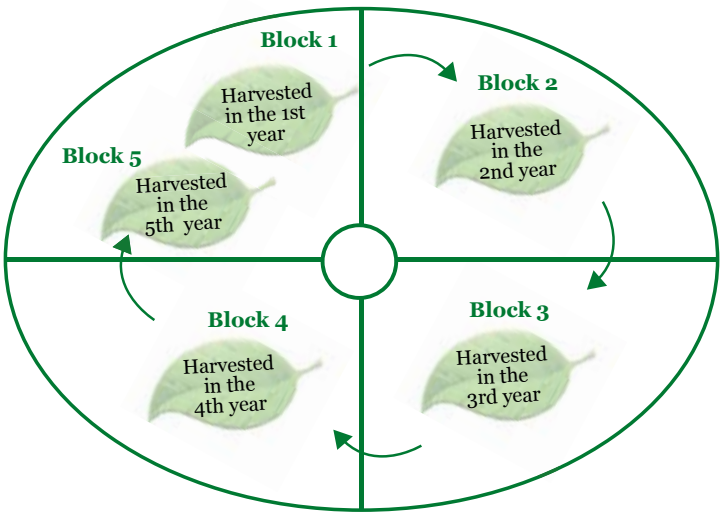
Soil erosion and forest fires are issues that occur mostly by anthropogenic causes. Integrated approach on afforestation by applying appropriate bioengineering tools and selection of appropriate species in eroded areas will be effective to reduce soil erosion. Forest fires can be prevented by raising awareness and construction of fire lines in forests. Local resource managers (CF executive members) or government officials (District Forest officers, Rangers) must impose heavy penalties on repeated breaching of local laws regarding forest management.

Sustainable Management Procedure

Nearly 15,000 species of the world's MAP species are threatened due to over-harvesting, land conversion and habitat loss (Schippmann et al. 2006). Wild collection of NTFPs and MAPs must therefore follow sustainable management procedures. There are four basic steps for sustainable management and collection of wild NTFPs: a) identification and management of collection area; b) resource assessment; c) sustainable harvesting procedures/guidelines; and d) cultivation/domestication of viable NTFPs and MAPs.

a) Identification and Management of Collection Area

National Forests or Community-Managed Forests are areas where NTFPs are collected from. Collection areas are often demarcated with the help of mountain ridges, gorges, rivers and tributaries, or village boundaries. Management of collection areas should be based on the ecology and habit of specific NTFPs, i.e. separate management strategies should be adopted for different species. Collection areas should be divided into several blocks depending on the availability of the resource and life cycle of the targeted species. For example, the collection area for Lokta must be divided into seven blocks, as the plant takes seven years to mature, whereas blocks of three will be sufficient for Chiraito which matures in 3 years. NTFP Collection and grazing should be done on a rotational basis, encouraging younger plants to regenerate and grow.



Diagrammatic representation of CF or collection area and its division into blocks; in this case, the resource that was harvested in the 1st year from Block 1 will be re-harvested in the 5th year.

b) Resource Assessment

Resource assessment is an essential component of an adaptive management process and includes the distribution, inventory, identification of population, and total natural harvestable stock. Distribution of targeted NTFPs should be assessed with the help of direct observations and consultations with community members, collectors, herders, healers and community elders. Ecological parameters like phenology, aspect, slope and altitudinal range must be recorded during field surveys and later be cross verified with relevant literature. Resource inventory should be carried out within the collection area and should include analyses of frequency, density, abundance, ratio of juvenile to small to mature individuals, regeneration status, weight of harvestable plant or plant part, and estimation of potential and annual yield from the area. The estimated productivity

for the next five-ten years can be caclulated on the basis of data obtained on regeneration, population, and phenology, but this requires at least two consecutive field visits. The collection area should be open to collectors only after the targeted species matures. Collection permits can be issued to a household or an individual depending upon the quantity of resources, number of collectors, and collection period.

Community level monitoring is anticipated after the completion of each collection season to assess the status of targeted NTFPs and surroundings. The monitoring team is expected to document field observations and the records can then be used to analyze the harvest impact and help in altering the harvestable amount, if the collocation process has had adverse effects on the population of targeted NTFPs and associated species.

c) Sustainable Wild Collection

Wild collection must be backed by adequate scientific knowledge on ecology and phenology. Each NTFP and MAP has different ecological niches and their maturing time differs according to the species. *Plants or plant parts should be harvested only after maturity, or when the plant reaches a stage of senescence*. Harvesting of the whole plant, bark and root/rhizomes is considered to be most destructive for the sustainability of NTFPs in the wild. If the whole plant has to be harvested, dispersal of its seed must be ensured. For tree species whose bark has to be harvested, only one-third of the bark should be harvested. Small part of root or rhizomes must be left in the collection area to facilitate natural regeneration. Harvesting of leaves, flowers, and fruits are considered to be less destructive. However, in all cases, a rotational harvesting system must be followed and only a certain per centage of harvestable quantity must be harvested, as per the regeneration potential of the plant.

d) Cultivation/ Domestication of Viable NTFPs

Most traded NTFPs are of wild origin and collected from all available sources. While few species are very hard to domesticate (for example, Jatamansi, Kutki, Sunpati etc), most can be domesticated or cultivated in private or fallow lands, which is well exemplified by Chiraito, Sugandhawal, Timur and Kurilo. Chiraito is found in about 50 districts and extensively cultivated in the eastern regions of Nepal. It is estimated that about half of the exported Chiraito is covered by the cultivated produce. There is the possibility of cultivating some high-valued NTFPs as Sarpagandha, Kuth, Lauth Salla, Akarkara, Kurilo, and Sugandhawal which are threatened due to over-exploitation. Cultivation and domestication of these resources will ease the pressure on wild species; therefore, cultivation techniques should be disseminated to interested farmers. Examples of the cultivation of some important NTFPs in the mid-hills of Nepal are given in Part Two.

Stages of Resource Assessment

ENTERPRISE DEVELOPMENT

It has been reported that more than 90 per cent NTFPs collected/cultivated from Nepal are exported to India in raw form. Not much has changed since Edwards (1996) reported the facts on this trade a decade and a half ago. The conversion of bulky raw NTFPs to low volume semi-processed or processed products are yet to be institutionalised in Nepal. This compels us to buy finished products at higher prices from India and third countries, despite the source being Nepalese hills and mountains. Having said so, the establishment of large forest-based industries in rural areas is unlikely because of inadequate transportation facilities. The industries can be set up in regions with access to transportation but most raw materials come from hilly and mountainous regions, which face the same problem. Further, the supply of raw material is limited and industries might have to compete with the colossal presence of multinational companies, which seems rather idealistic. Large-scaled forest-based industries do not seem viable, at least in the current scenario.

Forest-based small-scale industries are the most feasible option in the Nepalese context. Small scale industry requires low capital, is relatively less prone to national political changes, raw material supply is adequate for cottage industries, and creates employment generation opportunities at local level. Production of these items for local and national consumption and export will aid in reducing the national trade deficit. Potential NTFP-based enterprises that can be set up at the local level include handmade paper, essential oil, Allo fibre, incense sticks, handicraft items from bamboos and canes, ayurvedic products, and juice production. Some forest-based enterprises running successfully and holding potentiality in rural areas have been explained in detail below.

Production of essential oils has accelerated during the last decade with the active involvement of community-based organizations (mostly community forests) and government and non-governmental organizations. Simple to sophisticated distillation units are installed in different parts of the country. Various financial mechanisms exist for these units. For example, they are either financed by communities or CBOs themselves or by traders and business firms. They also receive partial or full funding from government-owned mechanisms and I/NGOs. Apart from partial and full financial support in installing the distillation units, I/NGOs working in NTFP sector are supporting CBOs right from resource identification, stock analysis, product development, and market linkage. A strong marketing network with both forward and backward linkages has been established for essential oils. Exporters in Kathmandu have regular communications and links with producers and village-level traders. The role of village-level traders, however, is limited. Some exporters have their own production facilities. Major importers of essential oils include Germany, Japan, France, the US, and Belgium. The world's total production of essential oils is estimated at about 100,000-110,000 tonnes (Farooqi and Sreeramu, 2001). Nepal has a negligible per centage in terms of global production despite its rich diversity in aromatic plant species.

Handmade paper is the fifth largest export commodity from Nepal in the handicraft category and is exported to 60 countries—major importers being the US, UK, France, Japan, and Switzerland. Handmade paper products have registered a steady and healthy growth in exports over the last decade. According to market research, the total market size of handmade paper in the European Union is estimated at € 24.5 million. There exists a nationwide network of handmade paper industries in Nepal that produce unfinished paper. Local paper manufacturers are involved in paper making in rural areas. They often enter into legitimate contracts with forest user groups, who harvest the bark and sell it to local industries. These papers are bought in Kathmandu where final products like postcards, gift items, lamp shades, notepads, files, visiting cards, photo albums, calendars, and diaries are manufactured and sold through chains of retail outlets in urban areas or exported.

Fibre from Allo is also manufactured in the hills and coarse clothes are manufactured from the fibre. Other enterprises associated with NTFPs include Bael and Seabuckthorn juice, Ainselu wine, Bamboo and Cane products, and ayurvedic preparations from medicinal plants. These products are mostly consumed within the country and are rarely exported.

Pre-requisite for NTFP-based Enterprises

A strong mechanism is needed for the production and export of semi-processed or final NTFP-based products. Incentive of any kind (tax waiver for local products or extended use of local products) from the government is a prerequisite for any enterprise to run successfully. Establishment of forest-based enterprises will help in income generation and employment creation, lowering transportation costs, and decreasing the trade deficit by extended use of local products.

Identification of NTFPs, along with their availability and market for finished products, are the basic requirements for a successful enterprise in this sector. NTFPs have to be identified and selected according to market demands. Enterprises should be established for those NTFPs whose market is already established. Resource quantification is important for entrepreneurship development, for which scientific study is required. Resources can be harvested only after the estimation of annual yield. Sometimes the resources will also have to be outsourced from adjacent resource available areas. Resource inventory should be performed for the CFs which could be the probable source for raw materials. A well-worded contract is necessary for outsourcing of resources from adjacent CFs to avoid any misunderstanding.

The entrepreneurs in this case are supposed to be the communities living in the rural hilly regions of Nepal. Several consultation meetings have to be conducted to make the communities aware on reduced transportation costs, employment creation, and income generation opportunities after the establishment of the enterprise. The will of the community is very necessary for a successful community-based enterprise. I/NGOs working in the NTFPs sector often have a tendency of forceful implementation of such enterprises without the community's willingness. This has resulted in failure and permanent closure of enterprises in most places. For a successful enterprise, communities need to invest in it, as this generates a sense of ownership among them.

The needs of communities are also major factors towards the establishment and successful operations and this should be assessed. Apart from a few high-valued NTFPs (eg: Yarsagumba, Attis, Bikhma, Kutki, Jatamansi, Satuwa, Chiraito, etc), harvesting of NTFPs is tedious and people used to harvest low-valued NTFPs only when there were no other income generating activities. Similarly, a growing trend of migration and foreign employment has created a shortage of manpower in the hilly regions. Several handmade paper industries were also closed down because of a scarcity of collectors across Nepal.

A proper business plan has to be developed to commence any venture as it acts as a guideline to production activities. The arrangement of timelines; responsibility assignments of collectors, raw material suppliers and entrepreneurs; methods of extraction or production; sustainable harvest quantities; final product quantities; and financial assumptions have to be clearly identified and defined in the business plan. The plan should be in understandably simple Nepali, avoiding technical terms as far as possible. A business plan is also mandatory for registration of the industry.

The production of semi-processed or processed products requires raw materials other than locally-available NTFPs. Contact details of other raw material vendors should be made available to rural entrepreneurs. Marketing of the product is the most important

component in the 'farm to fork' concept. Most forest-based cottage industries, despite a regular supply of raw materials, failed to continue operations because of a weak marketing system. A clear marketing strategy should be developed prior to the commencement of any enterprise. Efforts should be made so that traders can invest in these enterprises, or their direct involvement should be encouraged. Trade channels should be strengthened to ensure optimum benefits for all actors involved—from collectors to traders of all levels.

Detail assessment of per unit cost of NTFPs needs to be assessed so that collectors can urge to get an optimum price for their product. Development of a Market Information System (MIS) will be effective as it gives collectors a rough idea on the prevailing price of NTFPs, which will also let them know they are not being cheated.

The rate of migration of rural Nepalese citizens to Gulf countries is very high. It has been reported than unskilled labour in those countries earns less than Rs.9,000 a month. An unskilled labourer in Nepal earns Rs.200-250 per day. Most forest-based enterprises offer rates above the aforementioned minimum wage to their workers. Similarly, the price of low-valued NTFPs also covers the prescribed rates. Therefore, institutionalization and establishment of NTFP-based cottage industries in rural areas across Nepal can help reduce the flow of migrant labourers.

Collective Marketing from Cooperatives: A market for manufactured products should be guaranteed by linking the product to the market. There are a number of NTFPs that are traded in smaller amounts. Collectors are not certain whether their collected NTFP can find a market or not. The establishment of collective marketing centres or cooperatives will ensure the sale of NTFPs of any kind and quantity. Establishing a sales outlet or collective market centre (especially for NTFPs) with the support of cooperatives in areas where there are roads will ensure a market in the long run.

Economic Analysis

Most NTFPs collected from Nepal are traded raw whereas only a few products go for value addition. There are different steps of value addition and different stages are in trade. For example: Lokta and Argeli are traded raw (bark), semi-processed (white paper sheet), and as finished paper products. Similarly, Kutki is sold immediately after the harvesting (in the field/collection site); after the removal of smaller rootlets and attached particles (sun dried); and after grading to different size classes.

Economic analysis on every step of the semi- or processed product is not well performed, compelling collectors and traders to sell NTFPs on haphazardly. There are several studies done on the value chain analysis by I/NGOs but the data is not comprehensive in terms of product's economic analysis. Economic analysis for each step during value addition or processing is necessary as it enables collectors/traders to bargain for an optimum price for processed NTFPs. This book attempts to present the cost benefit analysis of major NTFPs during their value addition.

REVIEW OF POLICIES AND REGULATIONS ON NTFPs

NTFPs have received high importance in Nepal's forest policies and in overall development planning. The Poverty Reduction Strategy Paper (PRSP), Interim Plan (2007/08-2009/10), new government's policy and programmes, annual budgets, manifestos of political parties, donor documents--including country strategy papers and programme documents of bilateral projects and INGOs, and more recently the documents of Community Forestry Users Groups (CFUGs) highlight the importance of NTFPs in conservation, rural livelihoods and poverty reduction (Banjade and Paudel 2008).

Worldwide forest policy put emphasis on NTFPs since late 1990s when Peters et al. (1989) estimated that NTFPs could fetch higher economic returns than timber. Since then, forest polices started shifting toward minor forest products that primarily focus on timber. The potential of NTFPs improving livelihoods and economic standards of rural communities--together with conservation issues--forced the nation to formulate policies on NTFPs and MAPs.

Nepal has a well-established policy and legal framework supporting biodiversity conservation and community approaches to conservation, management and sustainable use of natural resources. Nepal's strong tradition in promoting management of natural resources and conservation is also reflected in its existing plans, policies and laws. Nepal is a signatory to the Convention of Biological Diversity and has accordingly formulated a National Biodiversity Strategy (HMGN/MFSC, 2002). The NBS reflects a shift in Nepal's biodiversity conservation management towards a more holistic, ecosystem-oriented approach to conservation and sustainable use of forest resources.

The National Conservation Strategy (HMGN/IUCN 1988) highlighted the necessity of establishing appropriate policies, regulations, and management approaches to ensure sustainable extraction of medicinal plants. The Master Plan for the Forestry Sector highlights the need to increase the supply of NTFPs and MAPs to facilitate their conversion into useful commodities for local and foreign markets (HMGN/ADB/ FINNIDA 1988).

The first Nepal Environmental Policy and Action Plan (NEPAP I) advocated that forestry research should address issues relating to the utilization of NTFPs (HMGN 1993). The second Nepal Environmental Policy and Action Plan (NEPAP II) (HMGN/ MoPE 1998) identified NTFPs as a source of income for rural communities. NEPAP II recommends that community-owned land that is suitable for purposes other than forestry can be utilised under community management for the production of NTFPs.

The Government of Nepal's three-year interim plan (2007-2010) revises, implements, and places a priority on the Herbs and Non-Timber Forest Product Development Policy (2004). The interim plan has two major working policies for the management of NTFPs/MAPs:

- To conduct action research programmes to acquire more knowledge on conservation, cultivation technology, promotion and marketing of high-value NTFPs

- To introduce various partnership models among households, communities, cooperatives and NGOs and promote investment from different stakeholders for the development of NTFP-based industries.

The Government of Nepal has given legal protection to 17 plant species, lichens and asphaltum (rock exudates) under the Forest Act, 1993 and Forest Regulations, 1995 (amendment 2001). Similarly, 13 species and one family are protected under the Convention on International Trade in Endangered Species (CITES)' appendices (Chapagain and Dhakal 2002).

Kutki (Neopicrorhiza scrophulariiflora) has been prioritized by the Government of Nepal for conservation and economic development (DPR, 2006). Initially, it was banned for collection and export from Nepal, but the ban was lifted with the following provisions: (a) careful differentiation between Neopicrorhiza scrophulariiflora and Picrorhiza kurrooa, the latter being included in CITES Appendix II, with identification verified and certified by Department of Plant Resources; and (b) District Forest Office (DFO) issue of collection permits by ensuring that there is sufficient amount of available stock of Kutki in its growing site.

ROLE OF WWF IN PROMOTING NTFPs IN LANGTANG AREA

The Sacred Himalayan Landscape (SHL) is a trans-boundary conservation area covering 39,021 sq. km, of which about 73.5 per cent falls in Nepal, 24.4 per cent falls in Sikkim and Darjeeling of India and the remaining 2.1 per cent falls in Bhutan. The SHL extends from Langtang National Park in central Nepal through the Kangchenjunga region in eastern Nepal and India to Toorsa Strict Nature Reserve in western Bhutan. The northern boundary of the landscape coincides with Nepal's international boundary with the Tibet Autonomous Region. This landscape holds a unique identity of the Eastern Himalayan Ecoregion Complex. The landscape's environmental and cultural characteristics blended with social, political and economic variances give it extra diverse and distinctive features. Similarly, the landscape includes and retains two globally important contiguous ecoregions in the Eastern Himalayan Alpine Scrub and Meadows and the Eastern Himalayan Broadleaf and Conifer Forests. SHL includes a diverse array of ethnic groups and human cultures, while also supporting ecological services critical for maintaining biodiversity and human lives and livelihoods.

Within the Sacred Himalayan Landscape complex, Langtang National Park represents some of the best examples of graded climatic conditions in the Central Himalayas. The complex topography and geology with elevation gradient have resulted in rich biodiversity. LNP has 18 types of ecosystem which include rhododendrons, esohygrophytic juniper shrub lands, upper alpine rhododendrons, upper sub alpine rhododendron shrub lands, lower sub alpine Fir forests, and lower sub alpine forests. Nearly 3,689 species of flowering and non flowering plants, 33 species of mammals and 246 species of birds have been recorded from the national park area (LNP report 2004). The park's rich vegetation is characterised by Sal (*Shorea robusta*) forests in the southern part, which is gradually taken over by hill forests consisting of chirpine (*Pinus roxburghii*), rhododendrons and Nepalese alder (*Alnus nepalensis*). The temperate zone is covered mainly by oak forests fading to old growth forests of silver fir, hemlock and larch in the lower sub-alpine zone. A total of 21 endemic plant species have been recorded from the park including *Rhododendron cownianum, R. lowndesii, Larix nepalensis*. Of the 172 useful plant species recorded within the park, 91 species are used for medicinal purposes (Yonzon, 1993).

In 2007, the Department of National Parks and Wildlife Conservation and WWF Nepal began the Langtang National Park and Buffer Zone Support Project (LNPBZ SP) to fulfill the vision outlined by the Sacred Himalayan Landscape (SHL) Strategic Plan-Nepal (2006-2016), which was approved by the Government of Nepal in October 2006. In light of fulfilling the SHL vision, this project works to conserve the biodiversity within the park, enhance livelihood opportunities, and sustain the diverse cultures and traditions by integrated management of land, forest and water resources.

Scientific Research on NTFP in Langtang National Park

Various scientific studies on the status of flora have been carried out since the Park was established in 1976. The studies can be divided into two distinct time periods: before SHL programme implementation, and during SHL programme implementation.

Before SHL Programme Implementation: During the period from 1965 to 2006, about a dozen studies on biodiversity had been carried out. Some of them include studies by Banerji (1965), Hara (1966), Stainton (1972), Dobremez (1976), Department of Medicinal Plants (HMGN/MOFSC/DMP 1976), preparation of Lanagang National Park Management Plan (HMGN/UNDP/FAO 1977) and so on.

After SHL Programme Initiation (2007 onwards): As it is unlawful to collect plants and their parts within the National Park's forests, a study on potential NTFPs including MAPs with the prospects of commercialisation is a wastage of resources. Given this context, scores of studies were/are confined in the Buffer Zone—areas peripheral and adjacent to core areas—where existing laws (Buffer Zone regulation, 1988) give some concession to collect NTFPs from the Buffer Zone community forest, and processing and trading them.

With financial and technical support from SHL/LNPBZ SP, the subsequent studies on NTFPs were focused on the identification and selection of potential NTFPs, resource assessment and management, trade pattern and value chain analysis, and more importantly, preparing business plans to set up enterprises. Some studies are primarily focused on local community forests, with sufficient information provided by the already-prepared Forest Operational Plan, while others are confined to the district level to collect more generic information on NTFPs.

Potential of NTFP Promotion in Rasuwa

Studies carried out in Rasuwa on NTFP status and its multiple dimensions reveal that this area is endowed with huge potential in terms of cultivation and trade. The Syabrubensi-Rasuwagadhi (16km) road under construction is likely to herald ample avenues for trade and commerce of NTFPs and is likely to pose challenges of illegal collection and trade of these valuable treasures.

Subsequent studies primarily employed various techniques to assess the status of NTFPs and MAPs. Most studies included rapid vulnerability assessment (RVA), which incorporated basic criteria like ecology (degrees of abundance, growth rates, modes of reproduction, habitat and its diversity), life forms and parts used, and more importantly harvesting methods considering particular ages/size classes. After the RVAs, species were prioritised based on various criteria such as the demand for the product and its market price, domestic value addition potential, geographic coverage, rotational period, regeneration capability, conservation status, ethno-botanical use, and processing techniques.

The study suggests that Titepati leaves (*Artemisia indica, A. vulgaris*), Timur leaves and barks (*Zanthoxylum armatum*), Angeri leaves (*Lyonia ovalifolia*) and Ketuki leaves (*Agave americana*) has huge potential to be used as insecticides and pesticides against conventional chemical fertilizers. Likewise, Banmara (*Eupatorium adenophorum*) and Titepati are being used to make bio-briquettes.

MAPs like Sughandawal (*Valeriana jatamansii*), Chiraiyta (*Swertia chirayita*), Timur (*Zanthoxylum armatum*), Padamchal (*Rheum australe*), Satuwa (*Paris polyphylla*), and Kurilo (*Asparagous racemosus*) are recommended to be cultivated on private lands through seedling production in a nursery.

Fruits of Delechuk and Bhui Chuck (*Hippophae salicifolia* and *H. tibetana*) are recommended to be processed to make juice, herbal drinks and jam in the aoristic hotspots of Langtang National Park.

Potential of NTFP Promotion in Sindhupalchowk and Nuwakot

Gultheria fragrantissima, Swertia chiraiyta, Daphne papyracea and *Edgeworthia garneri* are potential NTFPs found in Nuwakot and Sindhupalchowk districts in the Buffer Zone of LNP. Studies carried out in Buffer Zone Community Forests of

Gaukharka VDC of Nuwakot district and Ichowk VDC of Sindhupalchowk suggest that Dhasingre is the potential NTFP of that region. Similarly, handmade paper enterprises can be set up in the area, which is rich in Argeli.

NTFP Promotion to Reduce Human-Wildlife Conflict

The conflict between the park and its people arises mostly from the damage of crops by wild animals, mostly wild boars, porcupines, monkeys, and deer. Farmers of Langtang, Bridim, Timure, Ramche, Syabru and other high mountains areas complain of the damages of crops which jeopardizes the relationship between the park and its community. To address these problems, and in a quest for crops unpalatable to animals, communities cultivate *Swertia chiraiyta*, which has multiple advantages including, among others, deterrent character, sale of whole plant parts, high prices in nearby markets, and more importantly, low technology needed for cultivation.

NTFP Promotion as a Tool of Conservation to Contribute to Sustainable Livelihoods

Some people argue with the notion that conservation is an anti-development paradigm. This is not true. Research documenting the status (ecology and distribution), market availability of NTFPs, and garnering financial support to establish enterprises show that conservation is contributing towards enhancing sustainable livelihoods of the poor in local communities. With particular reference to Rasuwa district, chiraiyta farming and running essential oil enterprises is gaining momentum these days, and farmers are enthusiastic about the positive impacts from these enterprises. Ultimately, resource conservation is for, by, and of the community.

Chiraito cultivation: Before the establishment of the Park, people depended on medicinal plants which were one of the most viable livelihood strategies and used to walk six days to sell them in Ason, Kathmandu. Public awareness on cultivating viable medicinal plants created an environment conducive to organize and work together. With support from SHL-LNPBZ SP, two nurseries were established—one in the Core Area, and the other in the Buffer Zone. A nursery with an annual capacity of 300,000 seedlings was established in 2009 in Brabal, Syabru. This nursery is benefitting more than 50 marginalized farmers who were earlier troubled by wild animals. Once abandoned, fallow land is now being cultivated with Chiraiyta seedlings.

Similarly, the Lokil nursery in Bhorley is supporting at least 105 farmers living in the Buffer Zone. Given the growing demand of Chiraitya seedlings and seeing the success of these nurseries, farmers are now willing to establish small scale nurseries of their own.

Essential oil enterprise: Wintergreen—once regarded as bedding material—is now an important raw material for herbal enterprise in the Buffer Zone. A distillation plant within Syaubari Community Forest has been installed which provides direct employment to two people, and indirect employment to 35.

When the bio-diversity monitoring plan for this forest was prepared in 2007, this plant emerged as a dominant understorey herb in the Syaubari Community forest. After preliminary assessment, an intensive resource assessment was carried out with support from ISSC MAP project. The resource assessment of Dhasingre (*Gaultheria fragrantissima*) suggests that it is viable to establish an essential oil processing industry—it is estimated that around 500kg of oil can be extracted on a sustainable

basis from the whole forest annually. The distillation unit can be used in multiple ways as Zanthoxylum oil and Artemisia oil can be extracted from the same unit. The enterprise is entitled to the Syaubari Buffer Zone Community Forest, which is accessible as it is linked to a road that also links Bhorley VDC of Rasuwa district. Of the total investment, LNPBZ SP—a joint undertaking project of WWF Nepal and DNPWC—provided a grant of Rs.280,000, with Natural Resource Industries contributing the same amount, and the remaining expenses borne by the community.

The Way Forward

Communities—as local harvesters/collectors, middlemen, traders, and more importantly, resource managers—are key players in overall management of NTFPs including medicinal and aromatic plants in a sustainable and acceptable way. It is evident that local communities feel stewardship over resources if they are trusted with resource management responsibilities. Besides, the business community is more responsible to ensure that traded commodities are derived from resources which are sustainable enough to recover in a definite time period.

It is also obvious that communities should be well-equipped with basic technical knowledge (biological and ecological information), improved harvesting tools and techniques, extent and quality of products, regeneration status, and market channels and price paradigms.

The socio-cultural dimensions are as equally important as ecological/biological aspects in designing sustainable management of NTFPs. Further, sustainable use of NTFPs is associated with local knowledge and practices in resource assessments and conservation management, ensuring the persistence of NTFP population and maintaining positive rates of growth.

In a nutshell, the conservation and management of NTFPs is both a science as well an art that demands active involvement of a series of stakeholders, ranging from the producer to the end consumer, with their respective perspectives and behaviours.

SCOPE OF THIS BOOK

The scope of this book is to provide in-depth information on the ecology, cultivation, trade and economic analysis of some NTFPs that can potentially alleviate poverty in the mid- and high regions of Nepal, with specific focus on the Langtang National Park and its surrounding areas. This book is expected to be useful for researchers, development organizations, educated farmers, as well as entrepreneurs and traders as it will give an insight on most market-related aspects. This book attempts to review and compile existing information about high-valued NTFPs of Langtang and adjoining regions. However, this book is restricted to important species that have high medicinal, conservation and economic values. It will provide comprehensive information on habit, habitat, uses, cultivation and/or domestication techniques, value addition, product development and economic analysis of such NTFP species. Information furnished in this book is based on the research experience gained through the Darwin Initiative Project implemented by Kangchenjunga Conservation Area Project (2006-2008), ISSC-MAP project implemented by WWF in KCA and LNPBZ area, and resource assessment works in LNPBZ area. Similarly, the book also contains information on surveys on NTFP inventory and entrepreneurship development conducted in different parts of Nepal. Besides, a thorough review of existing literatures on NTFPs has also been made. Relevant scientific names of the species were verified with the reference of Press *et al.* 2000.

PART TWO

PRIORITIZED NTFPs OF LANGTANG AREA

This chapter deals with the details of selected NTFPs/MAPs of Langtang area, with emphasis on their availability in Langtang National Park and Buffer Zone area, prospects of value addition at local level, and trade. Further, the selection of these NTFPs were backed by previous studies or publications like HMGN/MFSC/DPR (1997), Gurung (2007), Pyakurel (2008), Pyakurel (2010), and Sharma (2009). The following NTFPs are presented in alphabetical order (Devnagari list) in the upcoming chapters: Argeli (*Edgeworthia gardneri*), Allo (*Girardinia diversifolia*), Kakoli (*Fritillaria cirrhosa*), Chiraito (*Swertia chirayita*), Timur (*Zanthoxylum armatum*), Dhasingre (*Gaultheria fragrantissima*), Padamchal (*Rheum australe*), Bhang (*Cannabis sativa*), Lokta (*Daphne bholua, D. papyracea*), Satuwa (*Paris polyphylla*), Seabuckthorn (*Hippophae salicifolia, H. tibetana*) and Sugandhawal (*Valeriana jatamansii*). Details of each NTFP are given in the following order wherever applicable: habit, habitat and distribution, uses, chemical composition, life cycle, cultivation and domestication, sustainable management, value addition (technology and equipment, processing), supply chain, economic analysis (unit production cost, fixed capital, pre-operating cost, initial working capital), major issues in entrepreneurship and trade, and conservation status and royalty. Cultivation and harvesting seasons are highlighted in bold and italics for each NTFP because they are often confusing but are determinants in good management.

It should be noted that most NTFPs here are already traded, both within the country and abroad. Few species like Kakoli and Padamchal are not yet traded in the mainstream but hold high potential for wild collection and trade. Their value addition is still restricted to cleansing and grading but holds high potential in improving rural livelihoods. These species have been included as an effort towards their conservation and sustainable use in the upcoming days.

ARGELI

Edgeworthia gardneri (Wall.) Meisn.

Edgeworthia gardneri (**Common names**: Argeli, Aryoli, Arkale pat, Tinhange, Tinpate, Lokati, Pahenle; **English name**: Nepalese paper bush; **Synonym**: *Daphne gardneri* Wall.; **Family**: Thymelaeaceae) is an evergreen shrub found in temperate regions of Central and Eastern Nepal. The inner bark of Argeli is used for the manufacturing of Nepalese handmade paper. Similarly, the semi-processed bark of Argeli is exported to Japan to print the Japanese currency, passports, and postal tickets. Apart from this, the bark is used by local communities to make ropes.

Habit

E. gardneri is a multi-branched evergreen shrub or a very small tree, often reaching height of 3-4m. It is often found in small- or medium-sized clusters. Three branches arise from each node, giving it the local name 'tinpate'. Leaves are short-stalked, elliptic to lanceolate, acuminate, glabrous above and pubescent beneath, and crowded near the end of branches. Flowers are yellow, scented, and densely crowded in peduncled heads. Flower clusters are 2.5-5cm in diameter and each cluster contains 30-50 flowers. Flowering and fruiting occurs from November to July (Polunin & Stainton 1984). Argeli propagates by seeds, root turions and stem cuttings.

Habitat and Distribution

E. gardneri is a fast-growing shrub and often attains maturity in three years. It either occurs as shrubberies in open places, or as a second storey shrub in temperate forests. It is found within the altitudinal range of 1500m to 3000m and distributed in Uttar Pradesh, Central and Eastern Nepal, Northern Myanmar and up to South West China (Polunin & Stainton 1984). It is found extensively in Parbat, Myagdi, Lalitpur, Nuwakot, Rasuwa, Sindhupalchowk, Kavrepalanchowk, Ramechhap, Dolakha, Okhaldhunga, Solukhumbu, Tehrathum, Ilam, Panchthar, and Taplejung (Ghimire et al. 2008a).

E. gardneri has been recorded from Gaonkharka VDC (Nuwakot district), Ichok VDC (Sindhupalchowk district), and Golphubhanjyang, Helambu and Laharepauwa VDCs (Rasuwa district) in the Langtang National Park and Buffer Zone Area.

The plant is also found in the forests of *Rhododendron arboreum, Quercus semecarpifolia, Alnus nepalensis, Lyonia ovalifolia,* and *Arundinaria maling*. It generally favours north-west and south-west slopes. Soil moisture, humid climate

Edgeworthia gardneri: a) colony; b) flowering twig; c) flower, close up

and partial shade are basic requirements for its optimum growth but it thrives well in all types of soil. *E. gardneri* can withstand temperatures up to -15°C (Ghimire *et al*. 2008a).

Uses

Medicinal and Socio-Ecological Uses: The juice of the root and stem is used for eye disorder, while its bark and leaves are used as poison for fish (Manandhar 2002). The roots are sometimes used to treat pimples and skin diseases (Basnet 1999). Argeli is a fast growing plant and with its well-developed root system, it binds the soil, preventing soil erosion. It can, therefore, be used as a bio-fencing plant in erosion-prone areas and to restore greenery. The stems, after the bark is removed, can be used as wood fuel. The unprocessed bark is used to manufacture rope in rural areas.

Traditional Commercial Uses: Handmade paper is manufactured from the inner bark of Argeli. The trade in the crude inner bark of the plant has been conducted for more than two decades. Argeli is preferred less than Daphne spp. due to the difficulty in digestion, and a yellow colour on the paper which reflects its inferior quality. Further, the quality of paper has been reported to be lower than the paper obtained from Lokta. However, improved processing methods have been developed to enhance the quality. Due to limited supply, entrepreneurs often mix Alaichi (*Amomum subulatum*)/Babiyo (*Eulaliopsis binata*) with Lokta and Argeli. The semi-processed bark of Argeli is used as substitute to 'Mitsumata', a major raw material for the paper used in the production of the Japanese currency, postal tickets, and passports. Semi-processed bark is exported to Japan not only from Nepal but also from China and Thailand.

Chemical Composition

Biscoumarin-edgeworthin is isolated from stem bark along with daphnoretin (Rastogi and Mehrotra 1993b). These compounds inhibited the lyase activity of DNA polymerase.

Life Cycle

E. gardneri is a fast-growing shrub found in the temperate regions of central and eastern Nepal. It may live till the age of 30 under proper management (NSCFP 2001). It propagates both sexually and asexually. Flowering occurs from November to April and fruiting from April to July. However, there could be a slight variation in flowering and fruiting due to altitudinal variation. *E. gardneri* is a bisexual plant and bees and Lepidoptera (moths and butterflies) facilitate in pollination. The plant takes five to six years to attain maturity when propagated by seeds, but maturity may be altered by surrounding environment, altitude and ecological niche (the status of an organism within its environment and community).

E. gardneri also propagates via stem cutting and root turions, which is more prolific than sexual propagation. 'Suckers' protrude from the underground stems which have root turions in them. The commercial collection of *E. gardneri* includes cutting the stem slightly above the ground level. Coppices arise from the cuttings and often attain maturity within three to four years (Prajapati *et al.* 2000), taking less time than sexual propagation. It is, therefore, considered that sustainable harvesting can accelerate the population of *E. gardneri*.

Domestication and Cultivation

The domestication of Argeli is not widely practised because of its wide availability and distribution. However, cultivation has started in a few districts like Dolakha, Kavrepalanchowk and Ramechhap on a trial basis. It can be cultivated from seeds, stem cuttings and transplantation of underground stems (with root turions).

Propagation by Seeds: Seeds can be collected during July/August after maturity and should be collected from a plant which is at least five years old. Seeds should be cleaned by removing the outer attached flower parts. Alternatively, seeds can be cleaned by soaking in running water and removing attached particles. Seeds should be wrapped in a thin cloth after drying them in the sun. Care should be given during storage as moist seeds might develop fungus, hindering germination in the following year. Seeds can be stored in soil (50cm deep) to keep the physiological process running. This type of storage needs regulated temperature i.e. 20°C for first 2-2.5 months and 3°C for next 3-3.5 months (Bird 1991).

Seeds can be sown in nursery beds during February-April (*Falgun-Chaitra*) but can be sowed immediately after collection too. After sowing, the seeds must be covered by a thin layer of soil and hay or straw or other improvisations to retain moisture and to protect them from birds. The nursery bed needs regular watering but lodging should be prevented. Sown seeds may start germinating in a month's time. The cover should be removed and new roofing is needed about 2.5 feet high from the ground. Regular weeding is needed for optimal growth. Seedlings can be transferred to plastic bags or be left as such in the beds. But crowded seedlings must be transplanted to polybags or to open nursery beds. Germinated seedlings can be transplanted to the field in July (*Ashadh*) before the monsoons. The plants mature and can be harvested after five to six years of plantation.

Propagation by Stem Cuttings: It has been recorded that Argali propagates effectively and efficiently from stem cuttings than from seeds. Propagation from stems is an extremely simple process. Stems 10cm long and with 2-3 nodes are cut from mature plants. They are cut in an incline and placed in nursery beds or polybags during March-April (*Chaitra*). Growth-promoting hormones (Rootex-3) can be applied to the cut stem for early root sprouting. The cut stems should be watered regularly. Seedlings can be transplanted to the field after three small leaves appear on the stem. Transplantation is usually done during or prior to the monsoons (*Ashadh*). The distance between two rows should be 1m and distance between two plants 70cm. The cultivation plot needs to face either south or south-west. Seedlings are vulnerable in the first year; therefore, care should be taken during winter. The plant might be infected by diseases in the first year. The diseased plants have to disposed by burning them. Bio-pesticides can be applied to control pests (Ghimire *et al.* 2008a). The plants become mature and harvestable after three to four years of propagation.

Sustainable Management

Premature and over-harvesting, unscientific harvesting methods, open grazing, and forest fires are major threats to the sustainability of Argeli.

Harvesting Time: Argeli bark must be harvested before the growing season, i.e. during the winters before the appearance of flowering buds its sustainalbility and regeneration. However, collectors do not prefer to harvest bark during winter as it is very hard and very difficult to remove during the season. Collectors harvest the bark immediately after the rains. But the bark must be harvested during winters for the production of semi-processed bark.

Harvest Techniques: Proper harvesting of bark accelerates the sprouting of coppices and maintains healthy population in the wild. Bark should be harvested from mature tillers of a cluster. Bark from very old plants are difficult to digest and that from young plants yield paper of inferior quality. Further weight loss during drying is higher for young plants. It is believed that plants more than 1.5m in height are considered mature. The harvestable plant must be at least 1inch in diameter and 10 to 20cm above the ground level to yield superior-quality bark. The stem should be cut with a sharp knife inches above the surface with the cut side facing north or shade to minimize moisture loss. The coppices will appear from the cut stem and will be harvestable in three years if harvested properly. The bark is removed from the cut stem (in the field) and transported to houses for removing the outer bark. Barks are then sun-dried or smoked and stored or transported to paper-manufacturing sites.

Intensity of Harvests: Resource assessment (stock analysis and regeneration status) is essential for sustainable management of NTFPs as it quantifies the amount to be harvested on a sustainable basis. The District Forest officer (in case of National Forests), the Community Forest executive committee (in case of Community Forest) or the Warden (in case of Conservation Area and National Park Buffer Zone Areas) issues collection permits considering the quantity, population and regeneration potential. Harvest quantity varies in different places. Therefore, harvesting about 30 per cent of a mature plant is considered sustainable because of the fast-growing nature of Argeli. About 1 per cent of mature plants should be left untouched to promote sexual reproduction and maintain genetic variation. A rotational harvesting system is recommended, while the collection area must be divided into four blocks and harvesting of mature tillers from each block is optimum.

Value Addition

The value addition to Argeli is generally two ways: first, by making paper which is common throughout Nepal; and second, by producing semi-processed bark. The production of paper from the bark of Argeli has been practised for more than 20 years in Nepal. This process requires relatively simple technology.

- **Outer bark removal and drying**: The outer bark is removed with the help of a knife after harvesting. Collectors also remove black spots and fungal spots during the cleansing process. The cleaned barks are sun-dried or smoked and either stored or transported to the nearest handmade paper industry or purchase centre.

- **Cleansing**: A second-level cleansing process is generally carried out in the factory where the remaining black and fungal spots are removed after soaking the bark in water for about four hours. The cleansed bark is cut into smaller pieces, which are easier for digestion.

- **Digestion**: Argeli bark is boiled in water with caustic soda and bleaching powder. For example, 10kg of dried bark is boiled in about 50litres of water. One kilogram of caustic soda (10 per cent of the bark) is mixed in the mixture of hot water and bark. Caustic soda eases the digestion process. One kilogram of bleaching powder (10 per cent of the bark) is mixed to bring whiteness to the bark. After 30 minutes of cooking, the bark is turned upside down. The bark is boiled for three to four hours with continuous stirring and is regarded as cooked when the strips are soft enough to be worn out with fingers.

- **Washing and Rinsing**: Caustic soda is washed off by keeping the barks on top of a stone and rinsing with tap water for at least four hours or left overnight. The barks are dried after removing all ash particles and other impurities.

- **Beating**: The bark is beaten by a wooden mallet on a flat stone. During this process, inferior quality bark is discarded again. The beaten mass is kept in a tolung (wooden basin) for stirring using a firke (wooden utensil to stir). Electric beaters are used for stirring in areas where electricity is available. The mixture is finer and even when stirred with an electric beater. Hydro beaters are also used instead of traditional beaters. These are as efficient as electric beaters and can be used in places where electricity is not available.

- **Scooping**: The papermaker squats in the basin and scoops water from the basin into the vessel. The beaten mass is then mixed with water while stirring with a wooden stick. The papermaker pours six or seven pots of pulp (according to the weight of the paper) regularly on the surface of big frame (20 inches by 30 inches) moulds under which finely-meshed Indian net is stretched. The frame is gently lifted leaving the pulp on the mat. Regular practice and great skill is needed for perfect papermaking.

- **Drying**: The moulds are placed at about right angles to sunrays and are dried by the sun and wind, which often takes half a sunny day. After drying, the paper is loosened from the frame to get a cleaner and more homogenous white paper (Pyakurel 2007).

- **Pressing**: Pressing is done only in a few areas. The paper sheets are placed in a machine that press them and produce finely-pressed paper.

(Top row left to right) Cut stumps of Argeli; Sun-dried bark; Bark soaked in Water for paper making. (Middle row left to right) Cleansing and making small strips of bark; Boiling the bark; Beating the bark with the help of a hydro beater. (Lower row left to right) Beaten bark; Worker making paper; Paper drying in the sun.

Whole process can be summarized as below:

Argeli collectors

Argeli harvesting

Harvest the inner bark
↓
Clean the outer skin
↓
Dry in the sun
↓
Store in dry place

Buying dry Argeli from collector

Paper makers

↓
Sort the Argeli as per whiteness and thickness of bark
↓
Bleach in the sun by soaking a bunch of Argeli in a clean stream or river
↓
Clean and remove unwanted skin
↓
Cook with caustic soda first and then bleach in powder solution according to weight of bark
↓
Clean in cold water
↓
Second cooking (optional)
↓
Clean or remove caustic soda completely from cooked bark
↓
Beat the bark
↓
Making the pulp
↓
Making paper by pouring required quantity of pulp in frame, which will be floating in a pond of clean water
↓
Lift the frame from the pond with balance
↓
Dry in the sun
↓
Level making in semi-dried paper
↓
Peel dried paper from frame
↓
Pile the sheet of paper
↓
Sorting
↓
Pack in plastic bags in piles of 1 kori (200 sheets) in one bag
↓
Store in flat and dry surface

Product Range

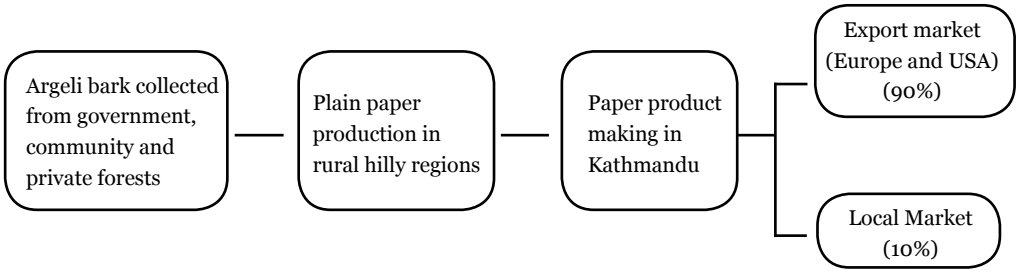
Available technologies in rural areas limit the production of 20 inch by 30 inch plain sheets in these regions. Paper manufacturers in Kathmandu make more than 200 items from these plain sheets including diaries, lamp shades, photo frames, posers, calendars, and envelopes. These products are sold in Kathmandu and other major cities and also exported abroad. Handmade paper is the fifth largest exported commodity amongst handcraft items from Nepal (Handpass 2003).

Contrary to this, semi-processed bark is exported to Japan, where it is processed to make Japanese currency, postal tickets, passports and other items. However, this export market is not institutionalised because only one company is involved in the export of semi-processed bark. Secondly, countries like China, Korea and Thailand are exporting bark on much larger scales and it is difficult for countries with limited supply like Nepal to compete with them. Still, it has been reported that bark extracted from *E. gardnerii* growing in the Nepal Himalayas are of superior quality and close to Japanese "Michumita". Therefore, there are still "silver linings in the black cloud" in terms of the export of semi-processed bark.

Handmade Paper Supply Chain

Handmade paper is a product in which all the elements of the supply chain are based on local resources. Papermaking uses local raw materials, labour and expertise (technology). Value addition takes place both in urban as well as in rural areas. Income is shared by both rural and urban people. Therefore, the promotion of quality paper/ product-making has great potential to alleviate rural poverty in hilly regions of Nepal.

Handmade paper making is a seasonal business in the hills. Typically, this begins in November and ends in June before the monsoons begin. Raw paper made in the hills is brought to Kathmandu and/or other major cities and sold to paper product manufacturers, who in turn make various stationery and handicraft items and export them to Europe and the US. Ninety per cent of paper products made in Kathmandu are exported; the remaining 10 per cent are sold locally (Handpass 2003). Paper product making in Kathmandu continues all year round. A simplified supply chain for Argeli paper making in Nepal is given below:



Supply Chain of Argeli Paper (Adopted from GTZ 2007)

Economic Analysis

Handmade paper industries are located in the vicinity of areas where resources are available. These industries often dictate the price of raw bark, which varies according to place. On average, one kg of dried Argeli bark costs Rs.35. The quantity of bark harvested by the collector varies according to the distance of resources and availability in the forests. In general, a collector collects six to seven kgs of dried bark in a day, earning about Rs.210-250 per day. When calculated with the reference of Nepalese per capita income, the collection of Argeli bark is a good source of alternative income generation.

Unit Production Cost

The unit production cost for one kori (200 sheets of 20 inch by 30 inch paper) of 20 gm Argeli paper is given in table 2.1.1. Prices of raw materials are based on actual prices of September 2010. All calculations are outcomes of long term observations (of authors) in handmade paper factories. Production costs may vary as the costs of raw material (bark, caustic soda, and bleaching powder) and manpower are not fixed. Further, paper production in rural areas is often expensive because humans or mules have to carry the raw materials (caustic soda and bleaching powder) to the factory and finished products back from the factory due to lack of roads. Similarly, the cost of wood fuel is not uniform and can alter the overall expenditure.

Table 2.1.1: Unit Production Cost

Description	Rate (Rs)	Quantity	Amount
Bark cost per batch	35	10kg	350
Royalty	5	10kg	50
Fuel (estimated)	35	2 bhari	70
Caustic Soda (Rs)	75	1kg	75
Bleaching Powder	70	1kg	70
Labour	1.5	1 tau	300
Cost per Tau (200 sheets of 20 grams each)			915
Risk and uncertainty cost (about 5 per cent of subtotal)			45
Market and sale			
Transportation cost	15	4	60
Total cost			1020
Price (selling) at Kathmandu			1100-1200
Profit margin per tau excluding the fixed costs (Rs.)			**80-180**

Source: Pyakurel, 2007

Fixed Capital

The cost of various assets and capital is given in table 2.1.2. Minimum capital required for the commencement of Argeli handmade paper industry should incorporate the cost of fixed assets, pre-operating expenses and required initial working capital. A total of Rs. 75,300/- is estimated as fixed costs for the production of 400 frames. However, it should be noted that the price given is indicative and may not be accurate as many factors like accessibility and transportation facilities, quality of items, and purchase centres etc govern the price of each item.

Table 2.1.2: Fixed Capital Requirement

Description	Number	Rate	Amount (Rs)
1 Land and Improvement			
1.1 Water supply (3/4" Polythene Pipe)	1 roll	3,500	3,500
1.2 Land Development		3,000	3,000
2 Building			
2.1 Factory, store and office; A single storey, double partitioned, wood fenced, 400 sq ft base			15,000
2.2 GT sheet roofing (7 ft X 16 number) including nails	16	800	14,400
3 Equipments			
3.1 Drum	2	1,500	3,000
3.2 Frame	400	75	30,000
3.3 Bucket	2	150	300
3.4 Jug	4	25	100
3.5 Tolung	2	200	400
3.6 Firke	2	50	100
3.7 Dabilo	2	100	200
3.8 Wooden hammer (to beat pulp)	4	100	400
3.9 Knife, Khukuri, Khurpi etc	8	75	600
4 Furniture			
4.1 Chairs	5	300	1,500
4.2 Bench	2	400	800
4.3 Cupboard	1	2,000	2,000
Total Fixed cost			**75,300**

Pre-operating Costs

Industry registration, market linkages and transportation, and lodging and fooding costs during industry registration at the district headquarters and during market linkages in Kathmandu have been taken into account as pre-operating costs. All these costs are highly variable; therefore, it is very difficult to estimate actual pre-operating cost. Being a cottage industry, the total capital is low; therefore, 20 per cent of the fixed capital has been estimated to be pre-operating costs, which comes to around Rs.15,000.

Initial Working Capital

It is difficult for entrepreneurs from rural areas to visit Kathmandu-where almost all buyers of paper sheets are located—regularly. Therefore, a quarterly-based sale is recommended. A rough estimation of 60 days work (in three months) and per day capacity of 2 kori requires Rs.122,400 as initial working capital (Rs 1,020 per Kori X 2 kori per day X 60 working days).

Therefore, Rs.212,700 is required to commence a handmade paper industry including the working capital for the first three months.

Major Issues of Entrepreneurship and Trade

The major obstacle for entrepreneurs is the unavailability of skilled manpower and collectors at factory sites. Factories are often situated in rural areas where migration for work is a very big issue. It is very hard to find working groups (or youths) in villages and further, due to globalization, people are less interested in the collection of NTFPs.

The market for Argeli handmade paper is not as established as that of Lokta paper and traders do not prefer the former. Recently, paper was made mixing the barks of Lokta and Argeli in different proportions—Lokta, Argeli and Elaichi; and Lokta, Argeli and Babiyo—but the new compositions are still not as accepted as pure Lokta paper. There are even more hurdles in the trade of semi-processed bark. China, Korea and Thailand are exporting semi-processed bark in bulk and modern technology enables them to produce bark of a higher quality than produced in Nepal.

Conservation Status and Revenue

Argeli is fast growing and widely distributed in national and community forests throughout central and eastern Nepal. Therefore, there are less threat towards its conservation, though excessive collection of the bark for trade decreases its population in the wild. Similarly, unscientifically-harvested bark—removing the bark right from the root-is very destructive. Other threats include deforestation, forest fires, premature collection, and other anthropogenic causes (Ghimire *et al.* 2008a).

The global and national status of Argeli is not known. Bark is collected from natural forests for trade with the permission of the respective District Forest Offices (Ghimire *et al.* 2008b). The government of Nepal has allocated Rs. 5 per kg as revenue for dried inner bark. A revenue projection of Rs. 5 per kg of Argeli is unscientific. Instead, it should not be more than Rs. 2 per kg because the plant is easy to propagate, has a wide altitudinal range, and its national status is not threatened. Contrary to this, Lokta is harder to propagate and its natural population is decreasing throughout Nepal due to unsustainable harvesting practices.

ALLO

Girardinia diversifolia (Link) Friis

Girardinia diversifolia (**Common names:** Allo, Chalne sisnu, Lekali sisnu, Thulo sisnu, Bhangre sisnu, Ullu sisnu; **English name**: Himalayan nettle, Stinging nettle; **Synonyms**: *Girardinia armata* Kunth, *Girardinia heterophylla* Decene., *Urtica diverisfolia* Link; **Family**: Urticaceae) is a herbaceous perennial shrub found in sub-tropical and temperate regions of Nepal. The stem bark of Allo contains fibres with unique strength, smoothness and silk-like luster. The fibre is used to make clothing since times immemorial. The fibre, thread and woven clothes are commercially traded in a few districts of Nepal.

Habit

G. diversifolia is a robust shrub reaching up to a height of 2m. Leaves are stalked, alternate, dentate, and palmately divided with three distinct nerves running to three lobes. A mature leaf measures 10 to 24cm by 7 to 18cm. Leaf blades and stalks contain long awl-shaped bristles and stinging hair. Flowers are sessile and borne on axillary- and terminal-branched spikes. Female spikes may reach up to 40cm in length whereas male spikes are shorter but more branched (Polunin and Stainton 1984, Manandhar 2002). Flowers are green to yellowish-green in colour, while flowering occurs in July-August and fruiting from September to early November.

Habitat and Distribution

G. diversifolia shows wide distribution in the southern belt of the Himalayas. It has been recorded from Northern Pakistan, Kashmir, North-west India, Nepal, Sikkim, Bhutan, Southern and Eastern Tibet, Sri Lanka, Northern Myanmar, China and Malaysia. It is distributed throughout Nepal at altitudes between 1200 to 3000m in moist, forest areas with semi- or no shade, along streams and tributaries, and on the edges of cultivated land (Polunin and Stainton 1984). The plant prefers light (sandy), medium (loamy) and heavy (clay) soils. The plant prefers acid, neutral and basic (alkaline) soils.

It was documented from Ghyangphedi VDC (density of 6,850 individuals per ha), Shyapru VDC (density of 5,000 individuals per ha), Langtang VDC (density of 4,800 individuals per ha) and Helambu VDC (density of 8,900 individuals per ha) from the Langtang National Park and Buffer Zone Area (Gurung 2007). Similarly, it was recorded from Urleni VDC, Shikharbesi VDC, Gaonkharka VDC, Ichok VDC and beyond Khangjung in LNPBZ area (HMGN/MOFSC/DPR 1997, Sharma 2009, Pyakurel 2010).

G. diversifolia is found in forests with *Alnus nepalensis, Rhododendron arboreum, Juglans regia, Viburnum mullaha, Quercus* spp., *Myrica esculenta, Taxus wallichiana, Aesculus india*, and *Cinnamomum glaucescens*. Its associated shrub species are *Zanthoxylum armatum, Princepia utilis, Daphne* spp. *Edgeworthia gardneri, Drepanostachyum falcatum*, and *Elsholtizia* spp.

Allo: a) Habitat of Allo, b) Young Allo, and C) Mature Flowering Allo

Uses

The tender vegetative shoots and inflorescence are cooked as a vegetable. Roasted seeds are pickled. Roots are diuretic, aperients and tonic. The ash of the plant is applied in cases of ringworm and eczema. The root is mixed with *Centella asiatica* (Ghodtapre) and boiled for about 10 minutes, strained, and the liquid—about four teaspoons twice a day—is used to treat gastric trouble. The juice of the root—about six teaspoons twice a day—is used to treat constipation. Fresh leaf juice is applied to treat headaches and joint aches. It is also considered to be useful in fever (DMP 1982, Manandhar 2002). The leaves are also used as tonic for cattle and root paste is applied on swellings (Ghimire *et al*. 2008b). Warm root juice is given to drunks for cooling effect in Dang (Rajbhandari 2001).

Residents of hilly areas and ethnic groups have for centuries extracted and spun the fibre to weave durable jackets, porter headbands or straps, fishing nets, ropes, bags, mats, coarse clothing material, and blankets. Allo is known for its strength and durability. It is often lighter and more delicate-looking than its wild contemporaries, jute and hemp.

Each hectare of Allo yields around 600kg of fibre. Fibre is extracted on a commercial scale in some districts. Allo is traded either raw (dry bark), or semi-processed (coarse fibre), or in processed form (cloth). Dried bark is traded anywhere between Rs.80 to 100 per kg; coarse fibre between Rs.350 to 380 per kg; and handmade cloth at Rs 350 per kg.

Chemical Composition

The plant demonstrates the presence of 5-hydroxytryptamine and histamine biologically (Rastogi and Mehrotra 1993a). The fibre of *G. diversifolia* contains 86.5 per cent cellulose and tannin.

Life Cycle and Growth

G. diversifolia is a perennial shrub (or sometimes annual) and propagates by seeds, root offshoots (new plant arising from root of old plant) and root suckers. Plants can be dioecious or monoecious, though the annual form is generally monoecious. Male and female parts are present in different spikes of a monoecious plant. Pollination is anemophilous.

Cultivation

Allo is a fast-growing plant and is widely distributed in sub-Himalayan tracts of Nepal, which is why little effort has been paid towards its cultivation. Despite its economic importance, it is least preferred by farmers because of the stinging nettles. Further, farmers rarely cultivate species which are abundant in forests. However, it can be cultivated.

The plant propagates best by seeds rather than by root offshoots. Allo can be grown on any type of land and can therefore be sown directly in the field. The seeds collected during November to February (*Kartik-Magh*) are directly sown during monsoons (*Ashadh- Shrawan*). Weeding is not necessary because Allo itself grows as a weed. However, weeding for the first few weeks is recommended. The plants can be harvested in a year. During harvesting, a few mature plants should be left behind to facilitate seed dispersal and to promote natural regeneration. Allo is harvested by cutting the stem inches above the ground. The underground root develops offshoots and gives rise to a new plant.

Sustainable Management

Premature and over-harvesting of Allo to fulfill commercial demands are the identified threats to its sustainability. People harvest Allo immediately after the monsoons and sell (to fulfill their needs during *Dashain*, the greatest festival of Hindus) without paying much attention to sustainability issues. Forest fires, open grazing, and anthropogenic activities like clearing the forest for cultivation are other factors affecting the plant's sustainability in the wild.

Harvest Time and Technique: Allo become harvestable after fruiting between August and October (*Bhadra-Ashwin*). Collectors prefer harvesting Allo during winter because the cold reduces the stinging effect. Collected plants should be thoroughly shaken to allow seed dispersal. The plants are cut with a knife inches above the ground and put in a *doko*[1]. Forceps are used to hold the stem. Alternatively, collectors wear gloves during harvesting to be protected from the nettles. Allo harvested without uprooting the roots can regenerate within the next year. Further, it was also observed that proper harvesting increases the vitality of the plant and improves the quality of fibre.

The dead outer bark is removed and the inner bark is peeled off. The dry bark is generally soaked for a few days in water before peeling it. The harvested bark is sun-dried for few days during which more than half its weight is lost. Moisture in the air and the bark itself may develop fungus; therefore, care should be taken during storage. The dried bark are bundled and stored in a dry place, before being sold to cloth manufacturers. Collectors themselves also weave the fibre sometimes.

Harvest Intensity: As Allo is widely available, its harvest is often carried out without resource inventory. But resource inventory is necessary for sustainability and maintaining a healthy population in the wild. Collection areas are divided into at least two blocks and mature plants are allowed to be harvested from one block every year. Ninety per cent of mature Allo can be harvested from a block, as per the guideline published by DoF for NTFPs. Harvest quantity and collection area needs to be altered if natural hazards like erosion or forest fires destroy the natural population.

Value Addition

Processing of Allo bark for the manufacture of fibre includes the following process:

Digesting/Cooking: The dried bark is soaked in water for one to two days prior to cooking. Bigger bark is separated by hand to make it into smaller pieces. The bark is put in a copper vessel with boiled water and ash or *Kamero*[2] (white soil consisting lime) and kept on boil for three to four hours. Generally, 5kg of dried bark is boiled with 7-8kg of ash or *Kamero*. About 10-12 kg of firewood is required to cook 5kg of bark. The fibre is relatively softer when boiled with *Kamero*. The bark is left overnight in the copper vessel after cooking. Cooking time is reduced to two hours for freshly-collected bark.

Alternatively, an improved cooking method has been proposed and been adapted in some districts. The bark is soaked in water with 4 per cent sodium hydroxide and 0.5 per cent sodium sulphide and cooked for two hours. This consumes less firewood (almost 40 per cent less) and the fibre is softer and relatively cleaner. But communities prefer to use ash because it does not callus the hand.

Beating and Washing: The cooked bark is cleaned in water by continuously beating it with a wooden mallet. Cleansing requires a lot of water, which is why it is usually done in streams and tributaries. It takes four hours to clean 5kg of bark and in turn yield 1kg of fibre. A person can wash up to 18kg of bark in a day.

[1]Doko (डोको): local weaved basket often made from Nigalo (Drepanostachyum falcatum)

[2]Kamero (कमेरो): White soil containing lime

Cleansing: The washed bark is mixed with paddy husk, maize flour, or in a white clay solution and dried in the sun for five to six hours. The process softens the fibre and brings extra whiteness. Coarse fibre is cleansed again by repeating the earlier process. Finally, the fibre is separated manually. It takes more than one man-day to clean a kg of fibre.

Bleaching: A mixture of 200gm calcium hypochlorite and 200gm sodium bicarbonate is poured in 20 litres of water and a kg of woven thread is kept in the solution for 24 hours. The threads are washed until the smell of the chemicals is completely washed away. This process removes black spots and other attached particles from the threads and turns them to a dull white colour.

Drying coarse fibre

Alternatively, bleaching can be done by soaking the threads in 2 per cent calcium hypochloride solution for two hours. The threads are washed thoroughly and sulphuric acid is diluted to make a 0.005 per cent solution. The threads are soaked in this solution for another one to two hours.

For the final bleaching process, the threads are dipped for three hours in a warm (70oC) solution of about 20 litres of hydrogen peroxide. The threads finally become white.

Spinning: Spinning is either done with a self-constructed hand spindle made of wood or with a spinning wheel. A hand spindle is slower than the wheel but is preferred because it is light to carry and women find it handy and suitable for spinning during their leisure time or during other activities (Thapa, 2005). It takes one man-day to weave threads for 1.5kg of fibre. The threads are either sold to entrepreneurs, or collectors themselves weave them to make coarse clothes.

Spinning is also done with the help of sophisticated machines. Machine-woven thread is smoother and finer. However, these machines are not readily available and most urban entrepreneurs buy dried bark or coarse fibre from villages and spin them in the spinning industries.

Weaving: Bleached white threads are coloured using natural or chemical dyes. The threads are sometimes mixed with cotton threads to make the fabric smoother. Two people are required to fix the loom (weaving machine). The fitness of the yarn depends largely on the skill of the spinner and also on the quality of the fibre. The yarn thus spun is woven on a back-strap loom.

Product Range

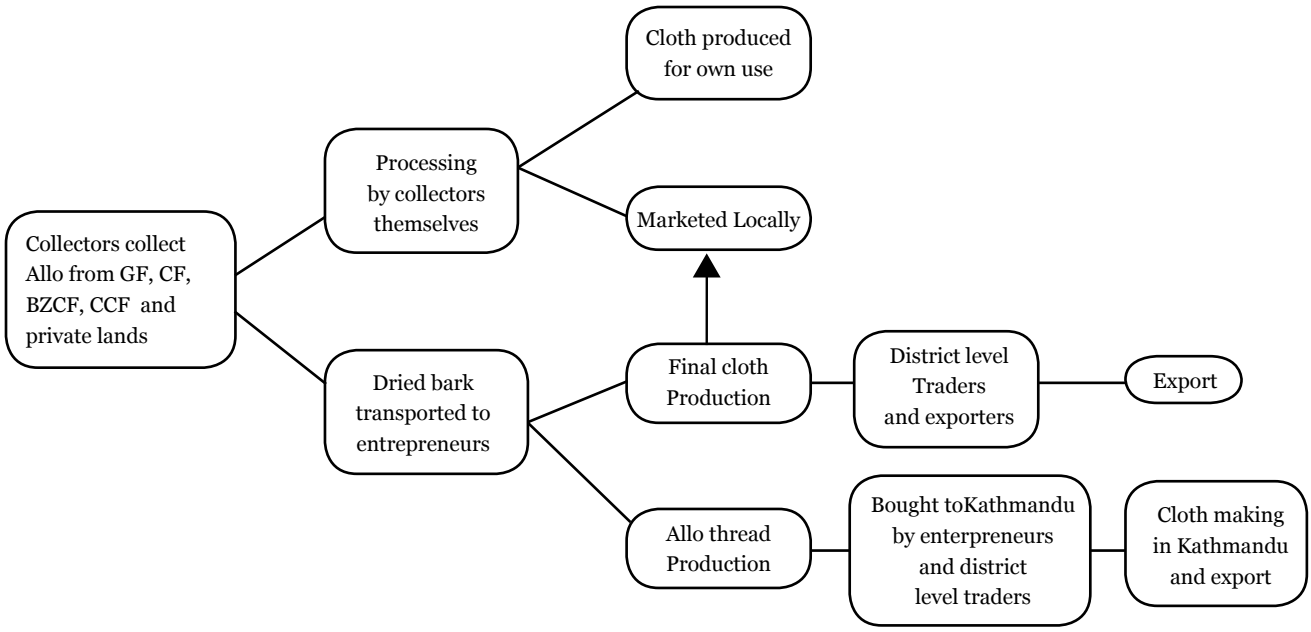
Products made from Allo are consumed in the national market and are exported to different countries like the US, Germany, Switzerland, Japan and other European countries. A wide range of clothing products like coats, shirts, pants, caps, handkerchiefs, bags, towels, mats, and curtains are made from Allo fibre.

Allo Marketing Pattern and Supply Chain

The trading of Allo begins with the collection of bark from forests and ends with the export of woven fibre. There are three tiers of actors—micro, meso and macro level players—in the value chain. At the micro level, there are the collectors, cloth and thread makers, wholesalers and retailers. At the meso level, there are CFUGs, CCFUGs, BZCFUGs and Allo cloth associations. At the macro and policy level, there are institutions such as the Department of Cottage and Small Scale Industries (DCSI), Department of Forests (DoF) and the Ministry of Industry, Supplies and Commerce

(MoISC), which formulate and implement policies. The structured and predetermined role of these major stakeholders and interactions among them influence the value addition and price mechanism of the enterprise.

All the elements in the supply chain are based on local resources. Handmade paper making is a seasonal business in the hills that begins in October and ends in January (*Ashwin-Poush*). Allo thread or woven clothes are brought to Kathmandu and sold to entrepreneurs or exporters. Entrepreneurs often weave fine clothes in Kathmandu themselves and sell to the domestic market or export them. Therefore, value addition takes place both in urban and rural areas. Income is shared by both rural communities and urban entrepreneurs. The promotion of quality yarn and cloth production has great potential to alleviate rural poverty in the hilly regions of Nepal. A simplified supply chain for Allo thread and cloth making in Nepal is given below:



Supply Chain of Allo thread and cloth (Size of box does not represent the volume).

Economic Analysis

A collector can collect about 25kg of fresh bark per day but the quantity depends on the availability of the resource in the wild. The quantity is generally reduced to a fifth after drying in the sun; therefore, five kg of dried bark is collected per day, which brings in an income of about Rs.400 to Rs. 500 (at the rate of Rs.80 to 100 per kg). About 2kg of Allo fibre is extracted from dried bark and finally 1.4kg of yarn is produced from that. Table 2.2.1 presents the assumption in tabulated form which was developed by Thapa (2005).

Table 2.2.1: Assumption on productivity and costing of Allo

- One person can collect 100kg green plant per day
- About 25 kg fresh bark yield from 100kg green plant
- About 5kg of dried bark (20per cent of 25kg fresh bark)
- 2kg Allo fibre from dried bark (40per cent of 5kg dried bark)
- About 1.4kg yarn (70per cent of 2kg Allo fibre)
- A person can weave about ½ kg yarn from fibre using the foot pedal spinning wheel (Khutte Charkha)
- About 1kg yarn can make cloth of 350cm by 63.5cm
- About 12 kg of fuel is needed to process 1 kg processed fibre.

Based on the above assumption, a cost benefit analysis of Allo is given below.

Table 2.2.2: Cost-benefit analysis for 250kg of stripped green bark

A	**Investment**				
	1 Collection of Allo	1,000 kg	10	200	2,000
	2 Stripped green bark	250 kg	5	200	1,000
	3 Dry bark	50kg	3	200	600
	4 i) Cooking dried Allo in Ash	50kg	2	200	400
	ii) Cost for fuel wood	8 bhari		80	640
	5 Beating, washing and drying fibre after cooking		5	200	1,000
	6 Soaking fibres in water and mixing white clay/rice husk or grounded maize		5	200	1,000
	7 Drying fibres, beating and cleaning	20 kg	2	200	400
	8 Yarn and spinning time	14 kg	28	200	5,600
	9 Preparation loom for weaving		2	200	400
	10 Weaving cloths	49m	5	250	1,250
Total variable cost					**14,290**
B	**Income**				
	1 Selling Cloth	49m		350/m	17,150
	2 Total profit excluding the cost of fixed assets				**2,860**

The rate and price given above are indicative. Entrepreneurs are advised to consult collectors, general workers, skilled labour and buyers about the rates before commencing any venture.

Fixed Capital

Foot-pedal spinning wheels, knives, copper vessel, wooden mallet, and ropes are required for Allo processing and a lumpsum of Rs.15,000 has to be kept aside to purchase these. Processing of Allo is not carried in closed houses; therefore, the costs of land improvement and factory construction have not been included in the fixed capital mentioned above.

Initial Working Capital

It is difficult for entrepreneurs from rural areas to visit Kathmandu regularly. Production of 200m cloth in a cycle is recommended. About 1,000kg stripped green bark is required to manufacture 200 m cloth. Therefore, it is estimated that Rs.57,000 is required to operate an Allo industry (reference from table 2.2.2).

Pre-operating Costs

Industry registration, market linkages and transportation, and costs during industry registration at district headquarters and during market linkages in Kathmandu have been kept as pre-operating costs. All these costs are highly variable and it is difficult to estimate the actual costs. Being a cottage industry, Rs.15,000 is kept aside as pre-operating costs.

Issues

A long term and timely supply of dried bark to processing industries is hindered by road conditions, and strikes—a transient feature, but a regular one. Processing industries weave threads by improved traditional machines, the fibre of which is not smooth. Therefore, it is difficult for Allo products to act as substitutes for imported fabric.

Processing of Allo is time-consuming and making the thread and weaving clothes is difficult as well as labour-intensive. The improved processing technology is limited to a few urban areas and most enterprises in rural hills use traditional processing and weaving techniques. Government agencies or I/NGOs need to develop improved processing techniques to distribute throughout the nation.

Conservation Status and Revenue

The national and global status of *G. diversifolia* is not known. Its status in Nepal is not threatened and is abundant throughout the sub-Himalayan tracts of Nepal. The bark is harvested from national forests with the permission of District Forest Office paying Rs.5 per kg as revenue.

KAKOLI

Fritillaria cirrhosa
D.Don

Fritillaria cirrhosa (**Common names**: Kakoli, Ban Lasun, **English name**: Fritillary, **Family**: Liliaceae) is a bulbous herb found in the high Himalayan regions of Nepal. The bulb of *F. cirrhosa* is used to treat asthma, bronchitis and tuberculosis in the Tibetan medication system and is mostly traded raw to Tibet.

Habit

F. cirrhosa is a glabrous herb that reaches a height up to 45cm. Stems are unbranched and leafy on the upper half. Leaves are sessile, linear to narrowly oblong; lower leaves are opposite, while upper leaves are in whorls with coiled tips. One or rarely two flowers bloom, each five to ten cm in length, drooping, variable in colour ranging from maroon, green or yellowish with dull purple blotching, and terminal subtended by whorl of leaf like bracts. Fruits are green capsules (Ghimire *et al.* 2008b). Bulbs are hairless, globose with membranous scale, fleshy, covered with whitish papery tunic, and are 2cm in diameter. Flowering occurs from May to July (Polunin and Stainton 1984).

Habitat and Distribution

F. cirrhosa is an east Himalayan element and is distributed in Sikkim, Nepal, Bhutan, South and East Tibet and Northern Myanmar. Despite being an east Himalayan element, it is fairly common throughout Nepal within the altitude of 3000-4600m (Ghimire *et al.* 2008b). It was recorded from Darchula, Jumla, Humla, Bajura, Dolpo, Mustang, Manang, Gorkha, Rasuwa, Dolakha, Solukhumbu, Sankhuwasabha, and Taplejung. *F. cirrhosa* was recorded from Langtang valley at 4100m; Kyangjin Kharka at 3400m and Gosainkunda at 4400m inside Langtang National Park and Buffer Zone area (Ghimire *et al.* 2008b, Pyakurel 2008, Gurung 2007).

It is found on open steep slopes, alpine meadows and scrublands. It is mostly found within the bushes of *Rhododendron anthopogon*. Other associates of *F. cirrhosa* are *Rhododendron setosum, Berberis* sp., *Rosa sericea, Meconopsis* sp., *Aconitum* sp., *Juniperus indica*, *J. communis, Caragana gerardiana, Saussurea* sp, *Iris* sp., and *Potentilla* sp. etc.

Uses

Kakoli is used in a wide range of traditional, medicinal and commercial products.

Traditional and Medicinal Uses: Boiled or roasted roots are edible. The Tamangs of Rasuwa district chew the fresh gynoecium. Bulbs are sweet, bitter, refrigerant,

Fritillaria cirrhosa (from left to right): Habitat which is often open scrubland at subalpine and alpine regions; entire plant; and a flowering twig

galactagogue, expectorant, aphrodisiac, diuretic, antipyretic and tonic (Baral and Kurmi 2006). It is heated over a fire and eaten to treat asthma, bronchitis, and bleeding during cough, possibly caused by tuberculosis. A paste of the bulb is applied to check bleeding from wounds and to treat pimples (Manandhar 2002). In Dolpo, bulbs are used as tonic to increase memory and reduce mental disorders (Ghimire et al. 2001). In Langtang, the plant's juice is taken to cure stomach pain and gastritis (Prasai 2007). The bulbs also have a folk history of use against breast and lungs cancer in China (Duke and Ayensu, 1985).

Commercial Uses: Bulbs are traded mostly to Tibet. In Manang, the bulbs are collected from highlands of Manang and Lamjung and traded to Tibet via Rui Pass at Rs 550 per kg (dry) in June-July 2006.

Chemical Composition

Fritillaria causes marked contraction of isolated rat-phrenic nerve diaphragm preparation. Imperialine and alkaloids cevanin (melting point-272°), cevacin (melting point -178°), and a compound (melting point -145°) are constituents of *Fritillara* (Rastogi and Mehrotra 1993b).

Life Cycle

Kakoli is an annual herb. The seed gives birth to a new plant (seedlings) during March-April and attains maturity during June-July. The flowers are hermaphrodite and entomophilous. Seeds mature during late September-October. Seeds are shed to the ground and the aerial parts of the plant die but the bulb remains dormant, well protected inside the soil during the hardy snowy winter. Winter lasts for about six months in alpine regions and as soon as snow melts in March next year, both seed and bulb give rise to a new plant. It has been observed that vegetative reproduction occurs only in the specific habitat (ecological niche).

Cultivation

Being found in high Himalayas and needing very harsh conditions for germination and growth, its cultivation has not been practised widely. However, there have been a few attempts to cultivate it *ex situ*. The plant can be grown in a nursery through seeds and tubers (Shrestha and Shrestha 2004) but cultivation through seeds is discussed here. However, the potency of the bulb might be less for cultivated species as it is only possible to cultivate in lower altitudes than in its original habitat. Furthermore, its cultivation is still experimental and commercial cultivation is yet to commence.

Seeds are collected during late September-October. They are well dried and kept in dry place. Seeds are sown in prepared nursery beds during March-April, almost immediately after the snow melts. Nursery beds are covered with straw to protect from the intense cold during night time. The plant starts germinating within two to three weeks and is then transplanted to the field. The plant prefers light (sandy) and medium (loamy) soils and requires well-drained soil but moist conditions in the soil must be maintained. The plant prefers acid, neutral and basic (alkaline) soils. It can grow in semi-shade (light woodland) or no shade.

Sustainable Management

Premature collection of bulbs for trade is a major threat for the sustainability of Kakoli. Bulbs mature in late September-October but collectors begin harvesting from June-July. This practice is destructive because both sexual and asexual reproductions are hampered.

Overharvesting is another issue towards the plant's sustainability and a strong government mechanism should be in place for its collection in the wild. District Forest Offices should issue collection permits only during September and forbid collection and trade before September. If the rule is found to be breached, both the buyer and seller should be jailed or fined or both. As most District Forest Office staff are stationed in district headquarters and range posts, it is very difficult to regulate the mechanism. Therefore, highland communities should take the responsibility of NTFP management (allocating harvesting time, quantity of harvest, harvest area) and also regulate transhumance (shifting the livestock to resourceful area for grazing) activities. Transhumance is common in the Nepali highlands and is one of the threats to high Himalayan NTFPs and MAPs as tampering with feet and grazing will hinder the growth of young plants.

Harvest limit can be quantified after evaluating the stock. Collection area can be divided into three blocks, and the collection of 35-50 per cent of mature plants (i.e. bulbs) from one block in a season will ensure the longevity of Kakoli in the wild.

Value Addition and Economic Analysis

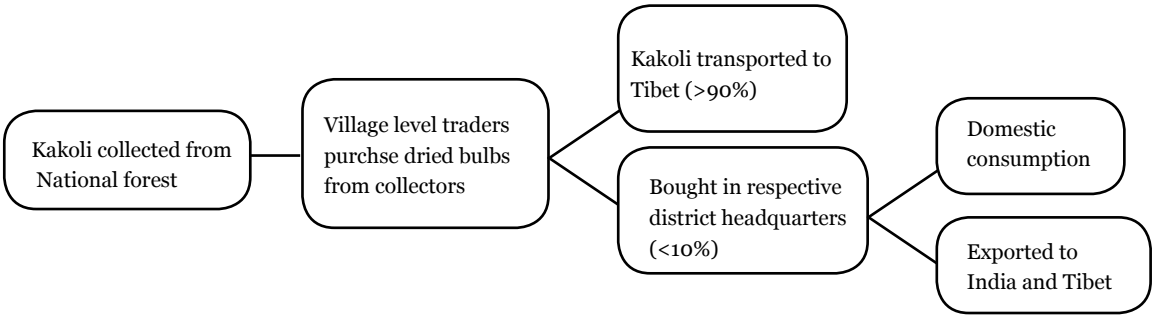
The value addition to Kakoli is limited to cleansing, drying, and packaging of bulbs. Attached soil and other particles are removed by cleansing in stream water. The bulbs are dried in the sun till they are completely dry from the outside. The weight of the bulb is reduced to half after drying. Dried bulbs are kept in jute sacs and stored in a dry place.

Drying bulb

A person can collect about 3-4kg of Kakoli in a day. The weight of mature bulbs is reduced to half after drying whereas nearly two-thirds of the weight can be lost for prematurely-collected tubers. Considering the collection of mature bulbs, 3-4kg of fresh Kakoli bulb yields 1.5-2kg of dried bulb. If a person spends about a month for collection, then s/he will collect 45-60kg of dried bulb and can earn Rs 24,750-Rs 33,000 in a month (excluding the cost of food).

Market Chain

The market chain for Kakoli is not well established and is often dictated by Tibetan traders. It has been estimated that more than 90 per cent of the collected Kakoli is transported illegally to Tibet and less than 10 per cent are bought to respective district headquarters and to the national market. Collectors or village level traders transport Kakoli to the Tibetan border where Tibetan traders purchase dried bulbs mostly. Informal discussion with Tibetan and Nepalese traders in Rui Pass (Manang) during June-July 2006 revealed that Kakoli is purchased from collectors at Rs. 500-600/kg (dry) and sold to Tibetan traders at Rs 2200-2500/kg (dry). Of the 10 per cent that follows the legal route, a negligible quantity is consumed within the country to make Ayurvedic preparations and the rest is exported to India or to Tibet. A simplified market chain for Kakoli is given below:



Simplified market chain of Kakoli

Major Issues

The trade of Kakoli is not institutionalised and is often dictated by Tibetan traders. Collectors are compelled to sell on the price offered by village traders or Tibetan traders. Kakoli is transported to the nearest Tibetan border and traded without paying tax (via District Forst Office). It is difficult for the government to establish check posts or range posts on the border due to harsh conditions but some initiative should be taken to regulate the illegal trade of Kakoli and other NTFPs/MAPs. Trans-border trade is possible only during the summer; therefore, the establishment of temporary check posts will help regulate the illegal trade of NTFPS/MAPs. Establishment of such temporary posts will ensure the collection of revenue for the government from Kakoli and other important herbs.

Socio-economically, Kakoli is among the least-studied high-valued Himalayan plants of Nepal. Its uses in treating asthma, bronchitis and tuberculosis are based on the Tibetan medication system. The chemical analysis of *F. cirrhosa* will create a new intervention towards the development of new products, as well as allowing exporters to extract and analyze the chemical contents and bargain for prices accordingly.

Conservation Status and Royalty

Kakoli's global status is not known but is categorized as a vulnerable species in Nepal (CAMP 2001). Its major threat is the unsustainable harvesting of bulbs for trade. Premature collection without paying much attention towards the plant's sustainability not only hampers the regeneration of Kakoli, but also poses threat to its long-term survival. Bulbs are collected from natural forests with the permission of the District Forest Office after paying Rs 5 per kg as tax to the District Forest Office.

CHIRAITO

Swertia chirayita (Roxb. ex Fleming) Karsten

Swertia chirayita (Roxb. ex Fleming) Karsten (**Common names**: Chiraito, Tite, Pothi chiraito, Tikta; **English name**: Chireeta; **Synonyms**: *Gentiana chirayita* Roxb. ex Fleming, *Swertia chirata* (Wall.) C.B. Clarke, *Swertia purpurascens* (D.Don) C.B. Clarke, *Agathotes chirayta* D. Don ex G. Don, *Ophelia chirayta* D. Don ex G. Don; **Family**: Gentianaceae) is a perennial herb found in the temperate regions of Nepal. *Swertia chirayita* is one of the highest export revenue-earning medicinal plants of Nepal. Apart from the collection from wild, it is now cultivated in several eastern districts of Nepal.

Habit

Swertia chirayita is a biennial or perennial herb of seasonal growth. It usually has a single stout elongated stem, the size of which ranges from 60cm to 150cm with branching at tip. However, in a few cases, branching from the root has also been recorded. The colour of the stem is greenish-brown when the plant is young and turns from light-brown to light-violet as the plant attains maturity. The stem is cylindrical at the base and quadrangular upwards. Roots are generally small, 5-10cm in length, light-brown, somewhat twisted and gradually tapering, and bear a few rootlets or their remnants. Leaves are ovate, elliptic or broadly lanceolate, sessile, opposite, acute, 3-5 nerved, and 1.6-10cm by 0.3-3cm in size. Leaves growing near the base are often larger than those growing near the tips. Flowers are greenish-yellow and are borne in small clusters. Each flower contains numerous minute seeds. *S. chirayita* has a tendency to cover a wide space in a given area. It is unable to exhibit thick stocking. The whole plant is intensely bitter in taste. Flowering takes place from July to October and fruiting from September to November (Polunin and Stainton 1984, Ghimire *et al.* 2008a, Ghimire *et al.* 2008b, Pyakurel 2008).

Habitat and Distribution

S. chirayita is endemic to the temperate Himalayan region and is distributed between the altitudes of 1500m to 3000m in Kasmir (India), Nepal and Bhutan (Bhatt *et al.* 2006). The plant prefers North- and North-West-facing moist habitats in forests, rangelands and around cultivated lands, but is mostly found on South-West facing slopes of mixed broad-leaved forests. It is distributed from east to west, but is more common in the eastern hills both in terms of quality and quantity. The Chiraito population in the wild mainly consisted of juveniles, followed by rosette stages and adults (Pyakurel 2008). Major associates of Chiraito are *Anaphalis* sp, *Desmodium* sp, *Anemone obtusiloba*, *Elsholtzia* spp, *Fragaria* spp, and *Oxalis corniculata* (Ghimire *et al.* 2008a, Pyakurel 2008).

Different stages of Swertia chirayita: A-Juveniles; B- 'rosette" stage & C-Mature S. chirayita. It often takes more than two years for S. chirayita to reach maturity

S. chirayita is distributed naturally in 50 districts of Nepal, namely Taplejung, Panchthar, Ilam, Sankhuasabha, Bhojpur, Tehrathum, Solukhumbu, Okhaldhunga, Ramechhap, Dolakha, Sindhupalchowk, Kavrepalanchowk, Nuwakot, Rasuwa, Dhading, Gorkha, Myagdi, Parbat, Rolpa, Jajarkot, Rukum, Bajhang, Bajura, Jumla, Dadeldhura, and Baitadi.

Table 2.4.1 shows the density of *S. chirayita* in different VDCs inside the LNPBZ area. The density of *S. chirayita* in Laharepauwa VDC was high because locals had dispersed Chiraito seeds in 20 hectares of forest to complement natural regeneration, and the study was concentrated in that patch (Pyakurel 2008).

Table 2.4.1 Density of Chiraito in different VDCs of LNPBZ area (Pyakurel 2008)

SN	Place / VDC	Density (individuals/ha)
1	Laharepauwa VDC	39,000
2	Ghyangphedi VDC	8,700
3	Shyapru VDC	6,650
4	Birdim VDC	5,100
5	Ramche VDC	13,550
6	Helambu VDC	2,000

It was also documented from Dhunche, Urleni and Sikharbesi VDCs of Langtang National Park and Buffer Zone Area (Gurung 2007, Pyakurel 2008 and Sharma, 2009).

Uses

Chiraito is one of the most important medicinal plants of the mid-hills and is used to treat various ailments. It has historical, ethno-botanical, medical as well as economic values for local communities. Chiraito is an integral part of Ayurved, Yunani, Chinese and Tibetan medication systems. It is also used in herbal medication system in the US and UK (Joshi and Dhawan, 2005). The entire plant is reported to have medicinal properties but it is the root that is most potent (Kirtikar and Basu 1984).

Medicinal Uses: Chiraito is useful to treat more than 15 diseases, disorders and ailments locally and through Ayurvedic and Allopathic medicines. The dried plant is soaked in a glass of water (150-200ml) overnight and the extract is taken orally to treat fever, asthma, cold and cough. Crushed seeds are considered most effective to cure these ailments. The plant's juice is drunk with water to treat jaundice, headache, malarial fever, stomach disorder, gastric, ulcer and anthelmintic medicine. The plant is also used for the treatment of cuts and wounds (Ghimire *et al.* 2008a). Chiraito immersed in half a glass of water overnight is taken twice a day to treat diabetes and a teaspoon decoction thrice a day is used to treat fever in Nubri Valley, Gorkha (Pyakurel and Gurung 2006). The paste of the plant is used to treat various skin diseases (Manandhar 2002).

It is also used as a tonic, febrifuge, antidiarrhoetic and as a cure for various liver problems. The plant is also used to control the blood sugar levels. The plant shows antipyretic, sudorific, antiperiodic, anthelmintic, anti-inflammatory and hepatoprotective actions and is used in urinary and liver disorders (CSIR 1986).

Commercial Value

S. chirayita is one of the highest export revenue-earning medicinal plants of Nepal and is a source of cash income for poor farmers. Its multiple uses in diverse systems of traditional medicines mean that the demand for the plant by pharmaceutical industries

has increased dramatically. Bulk of Chiraito originating from Nepal is traded to Indian markets. According to an estimate, about 45 per cent of Chiraito in the Himalayan region is collected from Nepal (Joshi and Dhawan 2005). Olsen (2005) estimated a minimum volume of 373 tonnes (valued at US$876,000) and maximum of 1,878 tonnes (valued at US$4,411,000) of crude *S. chirayita* is being traded from Nepal annually. It is harvested from October to November but is traded throughout the year, as it can be stored up to three years. The national consumption for Chiraito is only 5 per cent of the total production, with 95 per cent going to international markets (India, Tibet, Germany, Sweden, Italy, Holland, and the US). Chiraito is also being used by the brewing industry because of its intense bitter taste (IUCN, 2004).

Chemical Composition

The plant contains bitter secoiridoid, in particular amarogentin and amaroswertin. Amarogentin is a monoterpene glycoside and is the bitterest substance isolated till date, with a bitterness index of 58,000,000 and is used to some extent as an alternative bitter agent to quinine in liquor industries (Keil *et al.* 2000). Several xanthones have been isolated from *S. chirayita*, such as swerchirin, chiratol and 7-O-methyl swertianin (Ghimire *et al.* 2008b).

Life Cycle and Growth

Life cycle varies within cultivated and wild species. It has a life span of three years but sometimes lives up to eight years (Ghimire *et al.* 2008a). In general, it takes three years to flower. The plant remains vegetative during the first few years (or only the first year) and produces a crown of leaves forming a rosette. After one or two years, an erect above the ground stem arises from the rosette. Plants regenerate only by seeds (reseeders) but vegetative propagation was also recorded in very few instances (Ghimire *et al.* 2008a). Chiraito is bisexual and pollination is entomophilous, i.e. by bees (Khoshoo and Tandon 1963). Viability of seed lasts for 9 to 12 months (Barakoti 2000).

Being deciduous, Chiraito sheds its leaves and flowers at the end of the growing season and remains dormant during winter. A new leaf arises from the apical meristem at the commencement of spring. The plant remains in the rosette stage for the second year of its life cycle. In the second year, a long stout stem arises from the root and starts flowering and fruiting. Plant growth varies according the surrounding environment, ecological niche and life cycle stages.

Life cycle of Swertia chirayita (Concept adopted from Ghimire et al. 2008a)

Domestication and Cultivation

The Agricultural Research Station (ARS) in Pakhribas initiated the cultivation of Chiraito since 1993 and initiated propagation, cultivation and management techniques in the eastern region of Nepal. ARS published a cultivation manual for Chiraito, while the Department of Plant Resources (DPR) is involved in policy development and advocacy for the plant. Dabur Nepal—a multinational company—has started to produce and sell Chiraito seedlings on a mass scale. The Asia Network for Sustainable Bioresources (ANSAB) is involved in promoting the trade of the plant and policy intervention.

Seeds are the most effective and efficient means of propagation for commercial cultivation. Propagation can be done by leaf, stem or roots but are not as effective as seeds. Hence, propagation by seeds is discussed in this book.

Collection of Seeds: Seeds are collected from mature plants at the end of the growing season during November (*Kartik-Mangsir*). Germination rates were found to be very low for seeds collected before September. Seeds are removed from attached particles (which are often parts of the plant or dust particles) and after drying in the sun or by air for a few days are kept in a cotton sac and stored in a cool dry place. Seeds remain viable for less than a year; therefore, seeds collected the previous year are sown in the next. The viability of seeds varies with the maturity of the plant and is reported to be high (up to 90 per cent germination) in seeds collected during November (Bhattarai and Basnet 2000).

Pre-treatment: Prior to sowing, seeds are pre-treated with water for 24 to 48 hours to increase the germination rates (Barakoti 2000). Seeds pre-treated with 50-100 ppm (parts per million) Gibberellic acid show 72-90 per cent germination, compared to 12-40 per cent germination on treatment with water (Prasad 1999). Similarly, seeds pre-treated with cold water (3^{o}C) for 15 days show good germination rates of 91 per cent (Raina *et al.* 1994).

Seed Sowing: A suitable soil for Chiraito is to mix sand, forest soil and compost in proportions of one-third each properly, and covered in a nursery bed about 8 cm thick. Pre-treated seeds can be sown in the beds during April-May (*Baisakh*) or June-July (*Ashadh*), but the former months are best for germination (Barakoti 2000). Chiraito seeds are very small; therefore, 1 gram of seed is mixed with a handful of sand or nursery soil before sowing. Nursery beds are covered with mulch (straw or hay) to retain moisture and to protect the seeds from birds and intense sunlight. The beds are also regularly watered. Seeds start germinating within two to six weeks of sowing. After germination, the mulch is removed and beds are covered with roofing, above 1.5-2 ft from the bed. The roofing is often made by interwoven mats of *Drepanostachyum falcatum* (Nigalo) or modern mats (please specify). Seedlings are transferred to plastic polybags after two months (4-6 leaf stage) of germination, or transplanted directly to the field after three months (6-8 leaf stage) of germination.

Transplantation: It is suggested that the plant be transplanted only in spring the following year. A distance of 25 to 45cm between two plants and 30 to 60cm between two rows is recommended. The plant thrives in fertile sandy-loam soils of acidic nature with temperate climate on North, North-East and South-East facing slopes (Bhatt et al. 2006).

Alternatively, most farmers directly sow the seeds in the fields without any pre-treatment. However, an innovative and simple yet efficient and economic technique was developed in recent years. This method involves mixing the seeds with a mixture of cow dung and water and spraying the mixture directly to the cultivation site using a homemade spray. Cow dung helps the seeds stick on slopes and also provides nutrition.

Farmers in Eastern Nepal believe that Chiraito grows well in recently-burnt forest areas. Slash and burn practices are therefore common in the eastern hills, but scientific verification for such practices is lacking. Further, the practice provides little benefit to the farmers and causes more harm to the environment. Intervention at the local and government level is essential to control this practice.

Sustainable Management

The bulk of the demand for Chiraito is still supplied from wild plants. The plant's cultivation is confined to eastern Nepal still and shares a negligible per centage of the total trade. Little effort has been made to develop proper agro-techniques, which hinders the success of cultivation and development of Chiraito (Barakoti 2004). There is great concern on the sustainability of wild harvesting. Long-term availability of the plant's natural population in the wild is greatly challenged by over- and premature harvesting, habitat destruction, and slash and burn practices. As the whole plant is traded, individual specimens are uprooted indiscriminately resulting in a low plant density in many natural populations (Ghimire *et al.* 2008b). Unsustainable harvesting of the entire plant has reduced the possibility of seed development for future generations and reduced overall genetic diversity (Pant 2004). Today, the natural distribution of Chiraito is localised in the Himalayas, limiting the occurrence of its natural population in specific habitats. A policy on the management of Chiraito should emphasize on the protection and encouragement of larger existing populations and maintaining them as a gene bank and pollen source (Ghimire *et al.* 2008b).

Collection Time: Chiraito should be harvested after the plant matures (after the plant flowers or bears fruits). Ideally, only mature plants should be selectively harvested by uprooting the whole plant during October and November (Kartik-Mangsir). Harvesting Chiraito after it matures will ensure seed dispersal to maintain the wild population. The plant shows maximum growth during the flowering and senescence stages, indicating that these two stages are optimum for harvesting. But for long term survival of populations, it is recommended that plants be harvested during the senescence stage when most reproductive stages are over (Ghimire *et al.* 2008b).

Harvest Technique: Harvesting of Chiraito generally involves collecting the whole plant by digging the soil. Uprooting practices might have a negative impact on other associated species, sensitive taxa and other components of biodiversity. Appropriate training on harvesting techniques will be effective to minimize these impacts. Collected plants should be thoroughly shaken to allow seed dispersal. Harvesting should be selective and only be permitted from populations: (i) with a high density, (ii) that are evenly distributed in space, and (iii) for which reproductive potential will not be affected by plant removal.

In some places, harvesting is done by cutting the parts above the ground, leaving behind the roots. A curved axe or *Aansi* (*Hansiya*) is used to cut the plant just above the ground, leaving the root in the field to promote vegetative propagation. This method is generally applied for cultivated specimens, and is useful in those places where early snowfall occurs. Early snowfall compels collectors to collect the plant early before seed dispersal. However, this type of product is least preferred by traders (Pyakurel 2008).

Dried chiratio of different size

Harvest Quantity: Resource inventory in collection areas enables resource managers (generally CFUG executive committee members from community-managed forests) to allocate a maximum harvest limit. A rotational harvest system should be applied when the plant is harvested from the wild. Areas where the plant is found, either forests or cultivated areas, should be divided into at least four blocks; harvesting the plant from one block a year will ensure optimum productivity for years. For Chiraito, harvesting 70 per cent of mature plants from each block is considered sustainable.

Value Addition

Value addition is rarely practised for Chiraito. Attempts have been made to press dried Chiraito to reduce its volume for export, produce extracts and test samples from different districts to analyse and determine the bitter content principle.

The whole plant is sun-dried and care is taken so that all plant parts including the leaves are intact. The plant needs to be dried properly as it may develop fungal growth if stored when wet. Perfectly-dried Chiraito is bundled in 1kg, and 40 small bundles measuring 1m each are collected to be a bundle of 'one mun, equivalent to 40kg', the conventionally-traded quantity for Chiraito. Sorting and grading is practised by few traders. Almost all Chiraito collected is traded to India in this form without further value addition. Chiraito extract has been isolated in the laboratory but its commercialisation is yet to happen.

Chiraito Marketing Pattern and Supply Chain

The trading of Chiraito starts with its collection from the forests and ends with its export to India. There are three tiers of actors viz. micro, meso and macro level players in the value chain. The micro level is made up of collectors, farmers, village and district level traders, and exporters. Meso-level actors include CFUGs, CCFUGs, and BZCFUGs. Macro and policy level institutions include the District Chambers of Commerce and Industry, District Forest Offices, Department of Forests (DoF) and Department of Plant Resources (DPR), which formulate and implement policy. The structured and predetermined roles of these major stakeholders influence the price mechanisms of Chiraito.

Trading of chiratio

All elements in the supply chain are based on local resources. Chiraito is collected from government forests or community-managed forests or cultivated and harvested during October-November. Collectors or farmers sell Chiraito to village-level traders, who sell it to district-level traders (after bearing transportation costs). The district traders then sell the plant to regional markets, often in the Terai (southern flatlands of Nepal that shares a border with India), and in Kathmandu. Regional traders export crude Chiraito to the Indian market while very little is exported to Asian, European, American and African nations. A simplified supply chain for Chiraito in Nepal is given below:

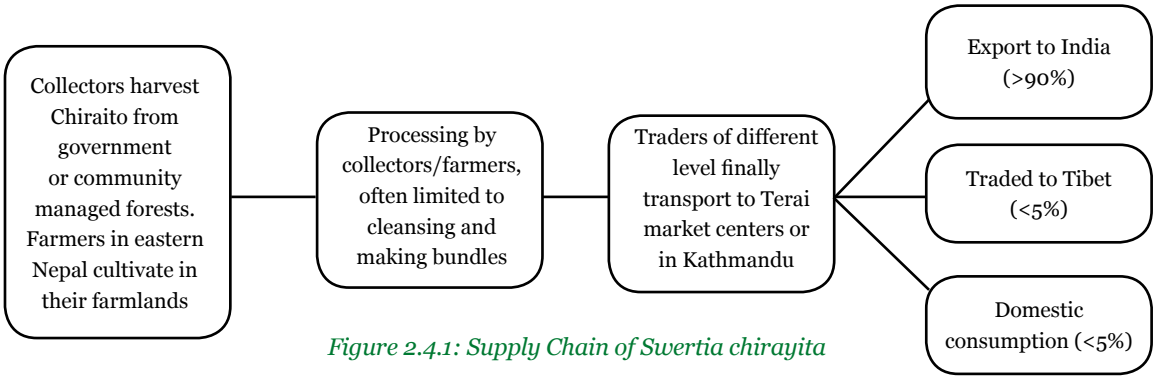


Figure 2.4.1: Supply Chain of Swertia chirayita

Economic Analysis

The price of Chiraito is determined by international demand and quality, both of which are ever-fluctuating. Fluctuations in market price have been identified as one of the risk factors for traders (ANSAB 1997), making it difficult to predict profits. The amount of Chiraito collected is based on its availability in the wild, and generally, a collector can collect 2-3kg of dried Chiraito in a day. One kg of Chiraito cost Rs. 400 (taken from November-December 2009).

Cost for Cultivation

The costs for cultivating Chiraito involve preparing the nursery, purchasing polythene pipes, preparing the land, managing the water supply, and purchasing seeds and fertilizers. Prices given in the tables below are indicative and may be subject to change. Land rent is not included in the estimate.

Table 2.4.2 Cost per hectare for First Year

1	Nursery preparation	10 persons	200	2,000
2	Pipe and other items	L/s		10,000
2	Land preparation	60 persons	200	12,000
3	Seed	0.2 kg	10,000	2000
4	Compost fertilizer	10 tonnes	500/tonne	5,000
5	Plantation in the field	60 persons	200	12,000
6	Weeding and composting	60 persons	200	12,000
7	Regular watering	60 man days	200	12,000
	Subtotal for first year			**67,000**

Table 2.4.3 Cost per hectare for second year

1	Compost fertilizer	10 tonnes	500/tonne	5,000
2	Weeding and Composting	60 persons	200	12,000
3	Regular watering	60 man days	200	12,000
Subtotal for second year				**29,000**

Table 2.4.4 Cost per hectare for Third year

1	Compost fertilizer	10 tonnes	500/tonne	5,000
2	Weeding and Composting	60 persons	200	12,000
3	Regular watering	60 man days	200	12,000
4	Harvesting	30 man days	200	6,000
5	Drying and storage	20 man days	200	4,000
	Subtotal for third year			**39,000**

Table 2.4.5 Total cost, productivity and profit

1	Total cost			135,000
2	Chiraito production	1000 kg	400	400,000
3	Total profit			265,000
4	Profit per year per hectare			88,300

Major Issues

Chiraito is mostly collected by smaller farmers or poorer villagers for whom the collection and trade of wild NTFPs is a major source of income. They collect Chiraito from the wild and sell it to village-level traders. In most cases, collectors do not even know the exact price and are compelled to sell at whatever rates the village trader offers them. The establishment of agricultural cooperatives and collective marketing from these cooperatives will ensure optimum benefit for the collectors.

Among the 30 recorded *Swertia* species from Nepal (Chassot, 2003), 17 species are used for various purposes (most of them have medicinal properties) and 12 species are traded under the name "Chiraito". Knowingly or unknowingly, collectors often collect more than one species of Chiraito and mix them with *Swertia chirayita. Swertia alata, S. angustifolia, S. bimaculata, S. ciliata, S. dilatata, S. paniculata, S. petiolata* and *S. tetragona*—collectively known as '*bhale chiraito*'—are mixed with *S. chirayita* for trade. These *Bhale Chiraito* accounts for 20 per cent of the total trade volume. Adulteration of up to 5 per cent has been reported to be common and is accepted by traders, but excess adulteration reduces the price of Chiraito. In some cases, collectors mix *Exacum* spp, *Androphis paniculata, Ainsliaea latifolia*, and *Slevolgia orientalis* with *S. chirayita*, which has affected the export of Chiraito in the past.

Conservation Status and Royalty

S. chirayita falls under the IUCN and CAMP threat category "vulnerable". It has been categorised as being critically-rare and endangered in the Indian Himalayas (Joshi and Dhawan 2005). The government of Nepal has proclaimed a regulation act for the proper harvesting of *S. chirayita*, which is suffering from premature collection. The regulation came under act in 1995 and it forbids both collection and trade from May to September. If the rule is found to be breached, both the buyer and seller can be jailed or fined or both (HMGN/MOFSC/FDP 1995). The government of Nepal prioritises Chiraito as having potential for economic development and has set a high priority on its research and cultivation. The plant is collected from natural forests with the permission of the respective District Forest Offices, with collectors paying a royalty of Rs. 15 per kg. The government of Nepal earned Rs.133,640 in revenues by issuing collection permits from different District Forest Offices in the fiscal year 2066/67. Royalty is not required to be paid for cultivated species, the cultivated areas and estimated productivity need to be verified by rangers of District Forest Offices, National Parks or Conservation Area Offices.

TIMUR

Zanthoxylum armatum DC.

Zanthoxylum armatum (**Common name**: Timur; **English name**: Nepal Pepper, Prickly Ash, **Synonyms**: *Zanthoxylum alatum* Roxb., *Zanthoxylum violaceum* Wall.; **Family**: Rutaceae) is a common plant found in the sub-tropical and temperate regions of Nepal. Eight species of *Zanthoxylum* have been reported from Nepal of which *Z. armatum* is the most-widely used species. It has a wide range of traditional, medicinal and commercial uses. Essential oil is extracted from the dried fruits of Timur and is sold in national and international markets.

Habit

Z. armatum is a shrub or small tree often reaching up to 5m in height, with a corky bark and numerous long straight spines on brachlets and leaf-stalks. Leaves are opposite, pinnately compound with narrowly-winged stalks, while the leaflets appear in pairs of two to six, are ovate to lanceolate and up to 8cm in length, toothed, and sparsely gland-dotted. Flowers are green or yellow in colour and appear in short branched lateral clusters. Flowers are very small—about 1mm each—and are unisexual. Ripe capsules are about 3-4mm in length, globular, red, wrinkled, and aromatic. The seeds, which are shiny-black with an aromatic husk, change to red in colour after maturity (Picture 2.5.1). Branchlet leaves and fruits are also aromatic. Flowering occurs in April-May and fruiting from July to November (Stainton and Polunin 1984, Ghimire *et al.* 2008b). Fruits take six to eight months to mature.

Habitat and Distribution

Z. armatum appears as shrubberies in cleared forests, degraded slopes and on the edges of cultivated land. It grows naturally in well-drained soils. It has the ability to survive in soils with low fertility and can resist strong acidity. It generally prefers moist, semi-shade or light-shade conditions, and hardly thrives in dense forests with maximum crown cover. It grows well in farmlands and wastelands than in natural forests. The plant cannot withstand hailstones and storms during flowering. *Z. armatum* is found in hot valleys in Kashmir, North-West India, Nepal, Sikkim, Bhutan, North India, China, Taiwan, and Philippines. It is distributed throughout Nepal within an altitudinal range of 1100m to 2500m. Mid-Western districts like Rolpa, Rukum, Salyan, Pyuthan, Dang, Surkhet, Gulmi, Baglung and Jajarkot are reservoirs of Timur and commercial farming has begun in these districts. In natural forests, it is associated with plants such as *Berberis aristata*, *Castanopsis indica*, *Castanopsis tribuloides*, *Pinus roxburghii*, *Pyracantha crenulata*, *Pyrus pashia*, *Quercus lamellosa*, *Quercus lanata*, *Quercus leucotrichophora*, and *Rhododendron arboreum* (Kunwar 2006, Ghimire *et al.* 2008b, Gurung and Pyakurel 2010). The plant has been documented from Laharepauwa VDC, Dhunche, Thulo Syapru, Gaonkharka VDC, Ichok VDC, Ghyangphedi VDC, Ramche VDC, Helambu VDC, Birdim VDC, Langtang VDC of Langtang National Park and Buffer Zone Area (Gurung 2007, Pyakurel 2008).

Habit of Timur: Left- Entire plant, Middle-A fruiting twig; and Right-Fruit close up

Uses

The bark, leaves, fruits and seeds of Timur have traditional and commercial uses.

Traditional Uses: The branchlets of Timur are aromatic and are used for cleaning teeth. Its fruits are pickled and used as spices. The fruits are also used for treating cough and cold, tonsillitis, headaches, fevers, toothaches, altitude sickness, dizziness, diarrhoea and dysentery (Bhattarai *et al.* 2006). The root is boiled in water for 20 minutes and the filtered water is taken as an anthelmintic. The juice of the leaves is used to treat abdominal pains. Its leaves' paste is applied for leukoderma and the paste of immature fruits is applied to cuts and wounds. The latter is also used in cases of cough. Two or three Timur seeds and a small clove of garlic are chewed for indigestion. A paste of the seeds is kept between the teeth for 10 minutes to relieve toothaches. Crushed seeds are boiled in water and used to treat fever and coughs. The seeds are also roasted in clarified butter for stomach troubles (Manandhar 2002). The fruit is crushed and the resulting powder is used to treat stomach disorders in Langtang region (Prasai 2007).

Timur bark is used to poison fish. The paste of the fruit is widely used to repel leeches, lice, bedbugs and fleas (Shrestha *et al.* 1995). The fruit and leaves of Timur, Asuro (*Justicia adhatoda*), Titepati (*Artemisia indica*), and Banmara (*Eupatorium adenophorum*) are mixed with cow urine and water and kept in a vessel for about a month. The resultant mixture is a very good insecticide.

Timur is extensively used in the Indian system of medicine, as carminative, stomachic and anthelmintic. The bark is pungent and stick from the plant is used in preventing toothache. The fruits and seeds are employed as an aromatic tonic in fever, dyspepsia, and expelling roundworms (Kalia *et al.* 1999).

Commercial Uses: Zanthoxylum oil is extracted from steam-distillation of dried fruits. This oil has a wide range of therapeutic uses (analgesic, anti-inflammatory, anti-rheumatic, astringent, carminative, diuretic, and stimulant). It is also used in the production of pharmaceutical products (to prepare medication for various ailments like joint and muscular pains, neuralgia, rheumatism, sprains, cold and cough, headaches, toothaches, and stomach ache), as a flavouring agent (used in the confectionery industry to manufacture cold drinks), and in the perfumery industry as a fragrance. The essential oil of fruits of *Z. armatum* exhibited good antibacterial, antifungal and anthelmintic activities (Mehta *et al.* 1981).

Timur is traded all over Nepal due to its wide range of domestic uses. Prices may vary according to location but the dried fruit of the plant is generally traded at Rs.60-80 per kg. Zanthoxylum oil is traded at Rs.3500-4000 per kg (*Price in Kathmandu in September 2010*).

Chemical Composition

The essential oil consisted mainly of oxygenated monoterpenes (75%) and monoterpenes (22%). Among the oxygenated monoterpenes, linalool (57%) was the major component followed by E-carveol (2.6%), Terpin-4-ol (2.3%), Phellandral (1.3%), α-terpineol (1.1%) and E-linalool oxide (1%). Other oxygenated monoterpenes were represented in the range 0.1– .8%. Among the monoterpenes, Limonene (19.8%) was the major component followed by myrcene (1.3%) and other monoterpenes were present in the range 0.1–0.4%. The oil is also characterised by the presence of an aromatic ester, E-methyl cinnamate, in appreciable quantity (5.7%) and sesquiterpene (E-caryophyllene) and oxygenated sesquiterpene (E-nerolidol) accounting ~ 0.6% (Tiwary *et al.* 2007).

Minor constituents are present as methyl salicylate, (E)-methyl cinnamate, 1, 8-cineol, β-phellandrene, myrcene, p-cymene, cis-linalol oxide, trans- linalol oxide, 4- terpineol, cryptone, phellandral, carvone, caryophyllene oxide, trans-β-ocimene, γ-terpinene, α-terpinolene, sabinene, β-fenchyl alcohol, piperitone, 1-cyclohexane-1-carboxaldehyde, β-caryophyllene, and α-humulene (Gurung 2009).

Life Cycle

Timur is a fast-growing shrub and propagates both by sexual (from seeds) and vegetative (from stem cuttings) reproduction. Natural regeneration takes place by seeds but the germination rates are very low (about 15-20 per cent). Layering and cutting are therefore employed for commercial cultivation. Wind and insects are the means of pollination. The plant shows extensive vegetative propagation by root offshoots. It attains maturity in four to five years when propagated from seeds and three to four years when propagated from cuttings; it is however believed that 10-year-old plants yield better seeds.

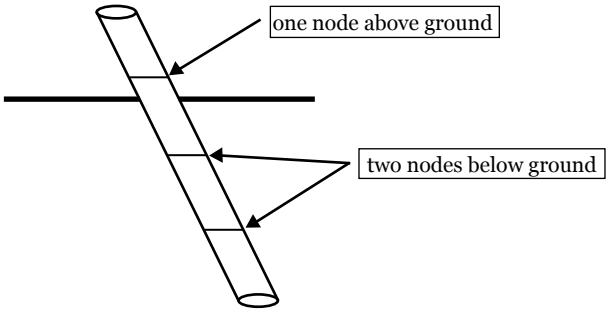
Cultivation

Timur farming is suitable on the southern slopes of wastelands, farmlands and forests within an altitudinal range of 1200-2200m in moderate climate and moist conditions. Wasteland with sandy loam soil of pH 6.5-7.0 is best suited for Timur cultivation. Soil with 1.31-4.2 per cent of organic matter, 0.16-0.26 per cent of nitrogen, 246-271kg of phosphorus, 389-504kg of potassium per hectare is good for Timur.

Propagation by Seeds: Seeds collected in late October-November are dried in the shade. Healthy and large red fruits are selected and collected as seedlings. A homogenous mixture consisting of one part each of compost manure, soil, and forest soil (about 8cm thick) respectively is placed in nursery beds. Seeds are pre-treated with cold running water for 24 hours to stimulate germination. Pre-treated seeds are sown in the beds during March-April and a layer of straw or hay is placed over them. The beds are watered on alternate days to maintain moist conditions for better germination. Regular weeding is needed; else, weeds retard the germination of the plant. The seeds begin germinating within three to four months of sowing. Seedlings are generally transferred in plastic polybags or left as such in the nursery beds. However, seedlings from densely-germinated areas must be transplanted to polybags. Seedlings can be transplanted to the field after 6-10 months, or after attaining a height of 15-20cm. As Timur is a spreading dense shrub, a distance of 2-3m between two plants should be maintained.

Propagation by Stem Cuttings: Timur can be propagated vegetatively using the cuttings of mature stems. Thumb-sized cuttings with at least three nodes (each 15 cm long) are cut during March-April and planted in nursery beds or polybags. For easy rooting, the base of stem is dipped in a 2-3 per cent solution of growth promoting hormone. Of the three nodes, two are laid below the soil level and one is exposed above. Nursery beds are covered with plastic to maintain soil temperature for quick rooting. The root begins to appear in March-April and the cuttings are ready to be planted in July-August after attaining heights of 15-20cm.

About 6 tonnes of compost manure is required for cultivating a hectare of Timur. About 1,000 seedlings (either borne from seeds or from stem cuttings) are planted in a hectare. Weeding is done twice or thrice in the first year, with additional compost manure. The plant begins to flower and fruit from the third or the fourth year and continues to yield for the next 20 years. About 1,200 kg of is produced from a hectare on average but the quantity may vary (*Cultivation method adopted from Kunwar 2006*).



Diagrammatic representation of stem cuttings. Stems should be dipped in soil with 30-45 per cent inclination

Sustainable Management

The collection of fruits and seeds without adopting any scientific management system leads to a decrease in the wild population of Timur. The quality and quantity are both hampered unless a sustainable harvest system is applied. Potential areas where Timur can be cultivated (scrubland, forest edges) should be conserved within national and community-managed forests.

Harvest Time and Method: It is recommended that fruits be harvested from October to late November from plants that are at least three to four years old. Collection during this period will ensure higher oil extraction from the fruits. An optimum time for harvesting is when the fruits begin to fall on the ground, a biological indication. Picking the fruits by hand should be encouraged for sustainable production. Fruits can be harvested by also shaking the plant. Plastic or a piece of cloth is placed on the ground to collect the fruits. In some places, fruits are harvested by cutting the branches—a practice that should be prevented. An adult person can collect up to 4kg of fruits per day from natural forests and 5kg of fruits from cultivated crops.

Harvest Intensity: The harvesting of fruit is considered to less destructive than harvesting other parts of the plant. Timur is a fast-growing plant and propagates well by sexual and vegetative methods. Therefore, harvesting 90 per cent of the total yield is regarded as sustainable. Nevertheless, care should be given to proper management. Only fruits should be harvested without harming the branches or the plant.

Post Harvesting: Harvested fruits are cleaned and dried in the shade. All essential oil-containing plants or plant parts are dried in the shade to retain the volatile oil as direct exposure to sunlight causes the oil to evaporate from plant parts. Fruits are dried in the shade to also prevent fungal growth. Fruits are stored when they are hard, indicated by ruptured coverings. Dried fruits are stored in jute bags and kept in well-ventilated dry rooms.

Dried Timur ready for trade

Value Addition

Zanthoxylum oil is extracted from dried fruits of Timur. Fruits are mostly transported to processing units by district-level traders, or distillation unit operators (or managers) themselves visit district headquarters or market centres and transport the fruit to processing units.

Technology and Equipment

The extraction of essential oil involves steam distillation. Distillation is the separation of components from a mixture of two or more liquids by virtue of differences in their vapour pressure. There are three basic types of oil distillation methods: a) hydro distillation, b) wet steam distillation, and c) dry steam distillation. The charge (technical term used for the material that has to be distilled, Timur fruits in this instance) is totally immersed in boiling water in the hydro-distillation process. Water is boiled below the charge and wet steam passes through the plant material in wet steam distillation; charge and water being separated by a porous grid (Picture 2.3.4). Dry steam distillation is the most advanced type of distillation where steam is supplied from a separate boiler and pressure in the vessel can be maintained at all times.

Operators of wet steam distillation units need to understand the loading and unloading of plant material, time taken for extraction, and maintain the heat—which is relatively easier. Extraction using dry steam distillation method requires competency because the unit is sophisticated and operators have to maintain steam pressure at all times during the distillation process along with other basic skills needed to extract oil from a wet steam distillation unit.

Distillation unit (DU) consists of a vessel, boiler, condenser, receiver (oil separator), and a steam pipeline with valves. DU manufactured from stainless steel or mild steel can be used. While the former is more expensive than the latter, the yield and quality of oil is better. Both types are fabricated in Nepal but sophisticated units are still imported from India. A stainless steel DU is expected to last more than 20 years whereas a mild steel DU lasts about 10 years.

Zanthoxylum oil is generally extracted from stainless steel distillation units. The capacity of the DU depends on the volume of raw material, accessibility and economic feasibility. However, for Zanthoxylum oil extraction, a distillation unit with a capacity of 1,000L is generally used commercially. This unit can distill nearly 300kg of fruit at one time.

Two types of distillation units: (left) A wet steam distillation unit. (right) A dry steam distillation unit. The DU on the left is made in Nepal and installed in Ghunsa of Kanchenjunga conservation area, whereas the DU on the right is made in India and installed in Syaubari BZCF of Langtang National Park Buffer Zone Area

Processing

Timur fruits are sealed inside the DU vessel. Wet steam DU consists of an attached boiler in the lower part of the vessel where water is transformed into steam after heating. There is a separate boiler in a dry steam DU where steam passes from a pipe to the vessel. The boiler is heated using wood fuel. It takes about two to three hours for the fruits to be macerated. Steam charged with Zanthoxylum oil is passed from the vessel to the condenser through the lid. The charged steam is cooled in a condenser that contains parallel tubes or zigzag pipes for steam flow, with cold water flowing around the tubes or pipes. Distillation process lasts for about five to seven hours. Care should be taken towards maintaining the temperature. The quality of Zanthoxylum oil deteriorates if the temperature exceeds 1000C.

The vapourized water and essential oil are transformed into liquid which flows from the condenser to an oil separator. Zanthoxylum oil is lighter than water and floats at the top in the oil separator. The oil is separated from water and foreign particles removed by filtration with a clean cotton or muslin cloth. The amount of water present in the essential oil is separated twice, once during the first extraction and then during the transfer to the container. Oil is stored in a high-density polythene container or epoxy-coated metal or aluminium containers. Essential oil should be stored in a dark and cool warehouse. Most essential oil deteriorates through oxidation and polymerisation upon prolonged exposure to air and light. Without such precaution, the essence becomes less intense, grows darker and more viscous, develops a bleaching effect, and eventually changes into a brown, odourless resin.

Whole distillation process can be summarised as follows:

Procurement of Timur fruits, firewood, packaging and labelling materials

↓

Storage of purchased materials with care

↓

Raw materials are put in the vessel

↓

Water is put in the boiler

↓

Boiler is heated and temperature is maintained

↓

Steam is subjected into raw materials and under the influence of steam, essential oil is extracted from the fruits

↓

Both water and essential oil vapourised

↓

Vapour is condensed in an adjacent condenser and the liquid drained into a separator

↓

Separation of essential oil and water

↓

Filtration of essential oils to remove dust particles

↓

Packaging, labelling and storage of essential oils

Zanthoxylum Oil Supply Chain

The supply of essential oil is based on local resources such as the supply of raw materials, labour and expertise. Essential oil production is a product in which all elements in the supply chain are based on local resources. Value addition takes place both in urban as well as in rural areas. Income is shared among rural collectors, urban traders, and middle men. Oil production thus has great potential to alleviate rural poverty in the hill districts of Nepal. Like other NTFP-based enterprises, processing of Zanthoxylum oil is also a seasonal business.

The market channels for Timur are not as well-established as that of Lokta or Chiraito. Most of the collected Timur is transported to district headquarters or nearby market centres. They are either traded in retail at Haat bazaars (weekly market centres in villages which are very common in rural Nepal), or district-level traders sell to oil entrepreneurs within the district, or sell outside the district to nearby Terai cities or in Kathmandu. The oil extracted from hilly regions and the Terai is transported to Kathmandu or Nepalgunj and sold to herbal product companies or to traders/ exporters. Herbal product companies produce different healthcare products and sell within the domestic market. The traders sell the oil to exporters who are mostly based in Kathmandu or Nepalgunj. Finally, the oil is exported to India or to a third country. It is estimated that more than 90 per cent of the total Nepali production is exported, while only 10 per cent is consumed domestically. A simplified supply chain for Zanthoxylum oil in Nepal is given in below:

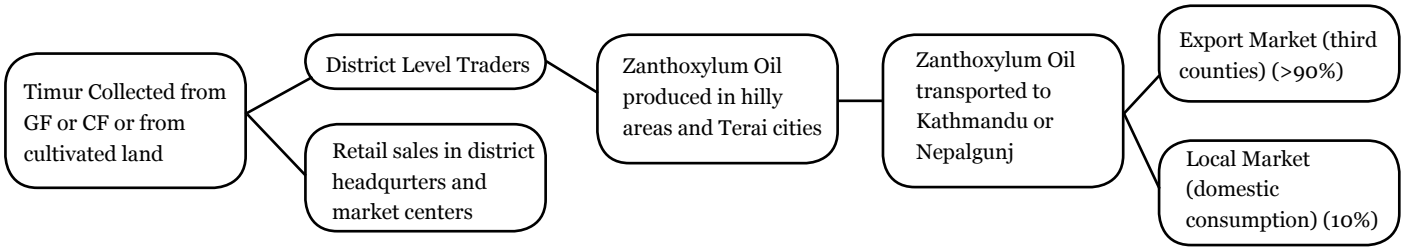


Figure 2.5.2: Supply Chain of Zanthoxylum oil

Economic Analysis

Timur fruits yield up to 3 per cent Zanthoxylum oil, but on average 2.3 per cent oil has been extracted at the commercial level. The price of Timur is not uniform but a kg of Timur costs Rs.60-80 on average (as of September 2010); a collector can therefore earn Rs.240 to Rs.320 per day for Timur collected from the wild (based on the assumption that an individual can collect a maximum of 4kg a day). Wild collection of Timur is a supplementary income-generating activity and the amount provides substantial support for disadvantaged groups and farmers with low land holdings. Additionally, for wild Timur, the only investment is labour.

Unit Production Cost

The unit production cost for one batch of Zanthoxylum oil is given in table 2.5.1. Production costs may vary according to the costs of raw materials (wood fuel and fruits) and manpower. Prices of raw materials here are based on actual prices in September 2010.

Table 2.5.1: Estimated unit production cost for Zanthoxylum oil

Description	Rate (Rs)	Quantity	Amount
Fruit cost per batch	70	300 kg	21,000
Royalty (Royalty is waived for cultivated Timur)	8	300 kg	2,400
Fuel (estimated)	35	8 bhari	280
Unit Operator	300	1	300
Helper	250	1	250
Miscellaneous (water, cleaning of DU)	100		100
Sub Total			24,330
Per kg production cost (@2.3 per cent oil content, 6.9kg of oil extracted from a batch)	3,526		
Market and Sale			
Risk and uncertainty cost (about 10 per cent of factory cost)			350
Transportation cost	Lumpsum		35
Direct cost (per kg)			3,911
Price (selling) at Kathmandu			4,300
Profit margin per kg excluding the fixed costs (Rs)			389

Timur after the first cycle of extraction is often traded in *haat bazaars* and even in Kathmandu.

Fixed Capital

Fixed capital requirement for installing a DU is variable because of the difference in costs of various types of units. A stainless steel wet steam DU made in Nepal with a capacity of 1,000L stainless steel costs about Rs.250,000, whereas a dry steam stainless steel DU made in India costs about Rs.500,000. Diesel and electric boilers are feasible in areas where both transportation and electricity is available. Costs of these modern units are higher than units with conventional direct heating systems, and operation costs may also vary. These facilities are difficult to install in rural areas; the estimation in table 2.5.2 is therefore based on the cost of a 1,000L wet steam stainless steel. It has been estimated that about Rs.397,350 is required for the purchase of a DU and establishing an oil-extraction factory.

Table 2.5.2: Estimated fixed capital cost for establishing SS wet steam DU of 1,000L capacity

	Description	Number	Rate	Amount (Rs)
1	**Land and Improvement**			
1.1	Water supply (3/4" Polythene Pipe)	1 roll	3,500	3,500
1.2	Land Development		5,000	5,000
2	**Building**			
2.1	Factory, store and office; A single storey, double partitioned, wood fenced, 500 sq ft base			50,000
2.2	GT sheet roofing (10 ft X40 number) including nails	40	1,200	48,000
3	**Equipment**			
3.1	SS wet steam DU: 1000L capacity	1	250,000	250,000
3.2	1000L water tank	1	12,000	12,000
3.3	Bucket	2	150	300
3.4	Jug	2	25	50
3.5	HDPE containers	4	500	2,000
3.6	Weighing balance	1 set	2,000	2,000
3.7	Wooden mallet	2	100	200
3.8	DU transport and installation			20,000
4	**Furniture**			
4.1	Chairs	5	300	1,500
4.2	Bench	2	400	800
4.3	Cupboard	1	2000	2,000
	Total Fixed cost			**397,350**

Pre-operating Cost

Industry registration, market linkage costs, operator training and other hidden costs are allocated under pre-operating costs. All these costs are variable and it is very difficult to estimate actual pre-operating costs. Here, Rs.20,000 has been assigned as operator training costs and Rs.15,000 as other costs, which sums up to Rs.35,000 as pre-operating costs.

Initial Working Capital

Resource inventory determines total productivity, and production quantity in turn determines required working capital. Rural entrepreneurs do not always have enough working capital to run units throughout the year. Furthermore, the extraction of oil from Timur is expensive because of higher raw material prices. Therefore, production and sale should be planned in a way that 10 batches of Zanthoxylum oil is extracted (6.9kg per batch; refer to table 2.5.1) in a single production cycle and sold at a time that enables entrepreneurs to prepare for the next extraction cycle. By multiplying Rs.3,911 (production costs per kg) with 69kg (production in 10 batches), Rs.269,859 is required as initial working capital. The total investment for the establishment of a Zanthoxylum oil processing industry—including production of first 10 batches of Zanthoxylum oil—thus comes down to Rs.702,209.

A comprehensive business plan has to be developed for any venture as it provides guidelines to production. The arrangement of time line, responsibility assignments, methods of extraction, sustainable harvest quantities, amount of oil to be produced, financial assumptions, and profit need to be clearly identified and defined in the business plan. A business plan is also obligatory for industry registration.

Major Issues in Entrepreneurship and Trade

The major obstacle for entrepreneurs is the unavailability of collectors in rural areas. Factories are often situated in rural areas where migration is a big issue. It is difficult to find working groups (or youths) in villages where people are increasingly less interested in the collection of NTFPs.

Essential oils have a well-established market both nationally and internationally. There is no intense competition in this market for producers because of the high demand for these oils. Industry demand continues to grow at a fast pace which further increases the gap between demand and supply. Nepal has experienced frequent changes in policies, rules and regulations in many of its sectors. If Nepal or importing countries create a policy that is unfavourable for exports, the industry will be adversely affected. In such a situation, essential oil entrepreneurs have to make strategic alliances and begin lobbying to develop a more favourable environment for exports. Several unnecessary checkpoints on highways are also a constraint, as these checkpoints are responsible for the harassment of traders. The government should develop a system where goods once checked at the first checkpoint or District Forest Office should be sealed and traders provided with necessary documents. The documents shown at other checkpoints should be valid and traders need not have to demonstrate and verify the goods at every checkpoint.

Conservation Status and Royalty

The global and national status of Timur is not known. It has been prioritised by the government of Nepal for economic development. Fruits are collected from national forests for trade with the permission of District Forest Offices after paying a royalty of Rs.8 per kg. The Forest Regulation Act 1995 and its 2005 amendment have exempted royalty from NTFPs cultivated on private land. Timur is among the highest revenue-generating NTFPs of Nepal.

DHASINGRE

Gaultheria fragrantissima Wall.

Gaultheria fragrantissima Wall. (**Common names**: Dhasingre, Patpate, Machhino, Limbuni Phul; **English name**: Fragrant Wintergreen; **Synonym**: *Gaultheria fragrans* D. Don; **Family**: Ericaceae) is an evergreen shrub found in upper-tropical and temperate regions of Nepal. Wintergreen oil is extracted by steam distillation of aerial twigs of the plant. The oil has a wide range of commercial uses and is consumed within the country as well as exported to international markets.

Habit

Gaultheria fragrantissima is a robust shrub reaching up to 2m in height. Leaves are evergreen, aromatic, ovate to lanceolate, acute, 5-10cm long, smooth above and dotted with bases of bristles beneath, and bristly-toothed margins. Plants have numerous axillary spike-like clusters of small fragrant white or pink globular short-stalked flowers. Flower clusters are shorter than the leaves. Fruits are dark-violet or blue in colour, fleshy in texture and about 6mm in diameter. Flowering occurs from April to July and fruiting from September to December (Polunin and Stainton 1984, Ghimire *et al*. 2008b).

This species is highly variable in the size and shape of leaves as a result of habitat differences. Plants growing in the understorey of forests or on the margins of forests grow as large shrubs or small trees with large leaves. But the plant is often a small shrub with narrow leaves when it grows on sunny slopes or in thickets.

Habitat and Distribution

G. fragrantissima is endemic to the Himalayas, distributed from Uttar Pradesh in India to South-East Tibet and up to Myanmar. It is found in forests, shrubberies and on rocky dry slopes (especially on newly-cut slopes), but also grows well in degraded, open and moist slopes within an altitudinal range of 1500m to 2700m (Polunin and Stainton 1984). Dhasingre grows in areas which receive rainfall between 700 to 1000mm. Its population gradually decreases from the east to the west in Nepal and is limited to small scattered patches in Mid- and Far-Western Nepal. It has been recorded from Taplejung, Panchthar, Sankhuasabha, Solukhumbu, Okhaldhunga, Ramechhap, Dolakha, Lalitpur, Makawanpur, Gorkha, and Jajarkot. It was recorded from Dhunche and Laharepauwa VDC of Rasuwa district; Gaonkharka VDC of Nuwakot district; and Ichok VDC of Sindhupalchowk district within the Langtang National Park and Buffer Zone Area.

Dhasingre was found to be growing as an understorey shrub in forests with Khote Salla (*Pinus roxburghii*), Angeri (*Lyonia ovalifolia*), Chilaune (*Schima wallichii*) Lali Guras (*Rhododendron arboreum*), Banjh (*Quercus lanata*), Uttis (*Alnus nepalensis*), and Laurels.

Gaultheria fragrantissima (From left to right): Habitat of Dhasingre; A mature plant; A flowering twig (Photographs taken at Laharepauwa VDC, Rasuwa district on November 2008)

Uses

In Langtang, Dhasingre leaves are boiled in water and are used for massage, while its unripe fruits are chewed or its juice drunk to treat stomach troubles (Manandhar 2002). Its leaf juice is also used to cure body and joint pains (Pyakurel and Gurung 2006) in Manaslu region. Leaves are used as fodder and in traditional rituals. Warm leaf juice is applied externally to treat inflammation and swellings (Ghimire and Nepal 2007). Locals also use the plant as fodder and cattle beds during the dry season. Its ripe fleshy berries are also eaten by children.

Wintergreen oil is used as a flavouring agent in the confectionery industry and to manufacture soft drinks. It is also used in cosmetics (especially to manufacture hair oils), perfumery and pharmaceutical industries. Wintergreen oil is antiseptic, aromatic, carminative, and a stimulant. The oil also has several aromatherapeutic uses. It is used in the treatment of rheumatism, gout, stiffness due to old age, scabies, and neuralgia. It is particularly good for athletes too, as it revitalizes and provides energy following muscular pains. An overdose, however, may cause degenerative changes in the liver and kidneys. Wintergreen oil is also ingested to treat hookworms (HMGN/MOFSC/DPR 1997). The plant's leaves and the oil are anti-inflammatory, analgesic, vermicidal and antiseptic (CSIR 1986).

Chemical Composition and Properties

Wintergreen oil is pale-yellow, yellow or pinkish in colour and has a strong aroma. The oil has a characteristically-sweet odour that displays a peculiar creamy-fruity top note and a sweet-woody dry out. The oil is soluble in 2 to 3.5 volume of 80 per cent alcohol. Wintergreen oil contains Methyl Salicylate (96-99 per cent of total volume). Other constituents are α pinene, myrcene, δ-3-carene, limonene and sesquiterpenes as δ-cardinene and 3.7-guaiadiene (Gurung 2009). It also contains β-sitosterol, quercetin-3-galactoside, Ursolic acid, and Triacontane (CSIR 1986).

Life Cycle

G. fragrantissima is a perennial shrub that can live for more than 30 years. The flowers are hermaphrodite and are entomophilous. Seeds are widely dispersed by birds. The plant shows good germination from both seeds and stem cuttings. It takes three to four years for the plant to mature from seed propagation while it takes only two to three years to attain maturity from underground stem propagation.

Cultivation

Dhasingre is not cultivated yet because of its high regeneration qualities and wide availability in the wild. The plant has high natural regeneration capacity. Old plants that have never been harvested have slender branches with few leaves, while harvested plants' branches are spread out with more leaves. Its roots have a unique physiological water holding capacity to extract nutrients from stony soils.

Regenerating Dhasingre in natural habitat

The plant prefers a moist but not boggy (swampy/marshy) humus-rich soil but can also grow in light (sandy) and medium (loamy) soils. Dhasingre is a moisture-loving species and requires lime-free soil. The plant prefers acid and neutral soils and can grow in very-acidic soils too. Though it can stand gentle

snowfall after it matures, Dhasingre is not a very hardy plant and even mature plants are destroyed by hailstones. Plants in the genus *Gaultheria* are notably resistant to honey fungus. Dhasingre can grow in areas with full-shade (deep woodlands) or semi-shade (light woodlands). It mostly favours south and south-west facing slopes and thrives on slopes with an incline up to 70° (Pyakurel 2010).

Propagation by Seeds: Seeds are collected from mature plants and cleaned in water. Clean seeds are then dried in the sun and after they dry completely, they are stored in a well-aerated dry place. Seeds have prolonged viability and are sown in nursery beds during summer the following year.

Dhasingre seeds require a period of cold stratification. After four to ten weeks of pre-chilling, the seeds are sown in lime-free compost (usually forest humus) in nursery beds during June-July (*Jestha-Ashadh*). The beds are kept moist but water-logging is prevented. Under moist conditions in nursery beds and an average temperature of 20°C, seeds usually germinate within one or two months. It is important to water with care and ensure that they get plenty of ventilation. Watering them with a garlic infusion can also help prevent damping off (a plant disease caused by a fungus, usually as a result of excessive moisture). Seedlings are transplanted to polybags after attaining a height of about 3cm and kept as such for the first year. The seedlings are planted in fields keeping a distance of 80cm between two plants in May-June the year after. Seedlings are susceptible to spring frosts so they might need protection during their first few years outdoors. The leaves remain very small for the first few years.

Propagation by Cutting: Dhasingre can be propagated with the help of stem cuttings, a method that shows good germination rates. Half-ripe stems, each 3-6cm long, are cut in July-August and dipped in polybags. Stems can be treated with the hormone Rootex for early rooting. Polybags are kept in partial shade and are regularly watered. The cuttings grow roots in late August-September or March-April the following year, while leaves develop during April-May. Larger clumps can be replanted direct to their permanent positions during May, though it is best to keep smaller clumps and grow them in polybags until they have rooted well (adopted from http://www.pfaf.org/user/default.aspx).

Sustainable Management

Dhasingre is a colonizer and spreads in a wide area under favourable conditions. Its artificial regeneration (cultivation) has not started yet. There is no management plan for the development of the plant. People are now aware about the use of this species but proper harvest techniques are not known to all. A sustainable harvest plan is therefore needed for proper management and maintaining a healthy wild population. Collection of aerial twigs and leaves for essential oil production in Nepal has a history of more than a decade.

Harvesting Time: Harvesting of leaves and aerial twigs of Dhasingre starts after five to six years of plantation and can be sustained for as long as 30 years. Dhasingre is a fast-growing plant and shows rigorous growth under proper harvesting techniques. The plant is therefore harvested twice a year throughout Nepal. While the first harvest occurs during April-June, the second harvest is done from August to October. However, to maintain a healthy wild population, a single harvest during the summer is recommended. The plant can be harvested in all seasons except during the rains and winter, if harvested once a year.

Harvest Method: Care should be taken while harvesting Dhasingre. Aerial twigs about 30cm long have to be harvested from mature plants only (plants that are at least five to six years old), leaving the young ones untouched. Harvesting a twig longer than

this does not yield a higher per centage of oil and furthermore, vegetation propagation is hindered. Aerial twigs have to be cut with a knife or locally-available equipment. Flowering and fruiting twigs should not be harvested, along with older twigs and younger plants. Immature and over-harvesting of Dhasingre can lead to a decline of its population in the wild.

Harvest Intensity: A rotational harvest system is recommended for Dhasingre. The size of each block should be determined according to the availability and size of the collection area. There should be at least three blocks from which to harvest Dhasingre. Up to 90 per cent of aerial twigs from all mature plants in one a block can be harvested, leaving the flowering twigs to facilitate sexual reproduction and maintain genetic variability. The plant will maintain its population from vegetative propagation in two to three years due to its fast-growing nature.

Value Addition

Wintergreen oil is extracted from leaves and aerial twigs of Dhasingre. It is recommended to extract Wintergreen oil using dry or wet steam distillation methods.

Left- Harvestable Dhasingre; Right- Harvesting Dhasingre for wintergreen oil production

Processing

A distillation unit made of mild steel is generally used to extract the oil. The volume depends on the accessibility to roads and availability of resources. The processing of Wintergreen oil involves the same technology as that of Zanthoxylum oil and readers are requested to refer to Page 59 for detail. Regarding the volume of processing, production, accessibility and economic feasibility, a distillation unit with a capacity of 2,000-2,500L needs to be installed. This unit can consume nearly 500kg of leaves in one batch of production.

Leaves are generally collected two to three days before the extraction. Twigs are separated according to their size and stored in a cool dry room. The separation of twigs is not practised widely. Semi-hard twigs are beaten gently with a wooden mallet (this quickens the distillation and eases the oil from tissues) before the distillation process. Leaves are put in the upper part of the DU and sealed. Water is heated in the boiler unit of the DU. The hard leaves of Dhasingre take about two to three hours to macerate. Steam charged with wintergreen oil is passed from the vessel through the lid, where the steam is cooled in a condenser which contains parallel tubes or zigzag pipes for allowing the steam to flow while cold water flows around the tubes or pipes. Distillation process can last for five to seven hours, or the unit can be left overnight. Care should be taken towards maintaining temperature. Essential oil burns if temperatures exceed 100°C.

Wintergreen Oil Supply

The supply of essential oils is based on local resources such as raw materials, labour and expertise. Value addition takes place in both urban and rural areas. Oil extracted from hilly regions is transported to Kathmandu or cities in the Terai and sold to herbal

product companies or to traders/exporters. Herbal product companies make different healthcare products to sell in the domestic market. Traders sell the oil to exporters based in Kathmandu or Nepalgunj. Wintergreen oil is mainly exported to Europe from Nepal. It is estimated that more than 90 per cent of the production is exported, while only 10 per cent is consumed domestically. A simplified supply chain for Wintergreen oil in Nepal is given below:

Economic Analysis

Leaves and aerial twigs of Dhasingre yield up to 1 per cent Wintergreen oil, but the yield on average ranges anywhere between 0.3 to 0.9 per cent, with a mean productivity of

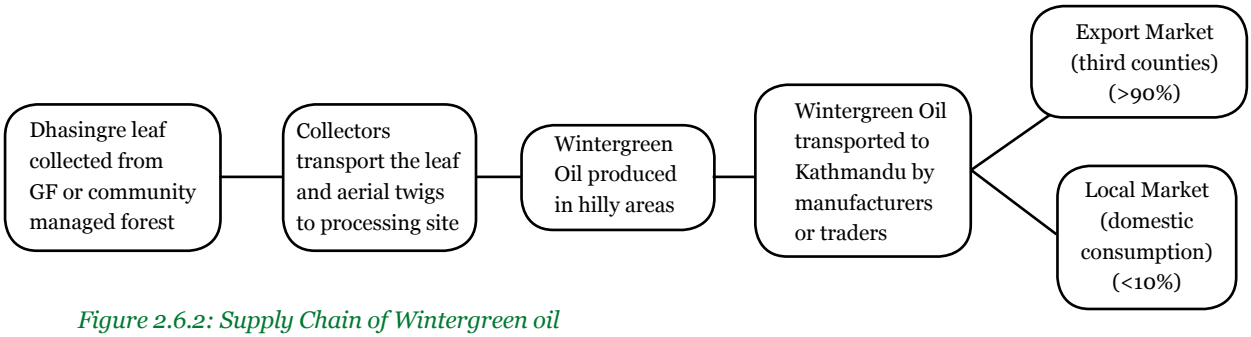


Figure 2.6.2: Supply Chain of Wintergreen oil

0.5 per cent at a commercial scale. Wintergreen oil is mostly exported, while domestic consumption is mainly for the production of pharmaceutical products.

Adding value to Dhasingre is possible in places where the distillation unit is within walking distance (generally two to three hours). It is not feasible to transport raw materials over long distances because of low prices for Dhasingre leaves and lack of road networks in hilly areas. Even in accessible areas, it is hard to cover the costs at the current price of Dhasingre. An adult person can generally collect 70kg per day. Rates of leaves and aerial twigs vary across the nation but on average, DU owners pay Rs.2.0 to 2.5 per kg. The amount seems relatively low but considering the unavailability of other income-generating activities and involvement of disadvantaged people and farmers with low land holdings, the amount provides substantial support to their households. Additionally, as Dhasingre is harvested from the wild, no other investment apart from labour is required like in the cultivation of conventional agricultural or cash crops. Collectors can utilise their leisure time to harvesting Dhasingre and the practice provides capital to females and children who can use the payments to purchase kitchen items and stationery.

Unit Production Cost

The unit production cost for one batch of Wintergreen oil is given in table 2.6.1. Prices of raw materials are based on actual prices in December 2010. All calculations are outcomes of long-term research and involvement of the writers in essential oil processing industry. Production costs may alter with variations in the cost of raw materials (wood fuel and leaves) and manpower. Depreciation and cost of DU is not included because this book is intended to provide the estimate for the establishment of an enterprise, and to give a simple cost benefit analysis.

Fixed Capital

Fixed capital for the establishment of a Wintergreen oil processing industry is highly variable because of the costs of distillation units. Locally-made mild steel distillation

Table 2.6.1: Estimated unit production cost for Wintergreen oil

Description	Rate (Rs)	Quantity	Amount
Cost of leaves per batch	2.5	600 kg	1,500
Royalty 1	600 kg	600	
Fuel (estimated)	35	8 bhari	280
Unit Operator	300	1	300
Helper 250	1	250	
Miscellaneous (water, cleaning of DU)	100		50
Sub Total			2,980
Per kg production cost (@0.5 per cent oil content, 3kg of oil extracted from a batch)			995
Market and Sale			
Risk and uncertainty cost (5 per cent of factory cost)			50
Transportation cost	Lumpsum		35
Total cost per kg			1,080
Price (selling) at Kathmandu			1,150
Profit margin per kg excluding the fixed costs (Rs)	70		

Source: Discussion with Wintergreen oil producers in Dolakha on December 2010.

units (made of Iron) are widely used, and the oil extracted through these units is slightly reddish-brown in colour (rust mixes with the oil to give the colour), different from the oil extracted from stainless steel units. Exporters in Kathmandu and importers abroad however prefer the former. Diesel and electric boilers are feasible in areas where both transportation and electricity facilities are available. Cost of these modern units are higher than conventional direct heating systems, and there may be alterations in operation costs. These facilities are difficult to put into practice in rural areas. Therefore, the estimates in table 2.6.1 and 2.6.2 are based on the cost of conventional mild-steel wet type distillation units. It has been estimated that Rs.322,350 is required for the purchase of a mild-steel unit and the establishment of a factory.

Pre-operating Costs

Industry registration, market linkage costs, training operators, and other hidden costs are kept in pre-operating costs. All these costs are highly variable and it is very difficult to estimate the actual costs. For instance, Rs.20,000 has been kept aside as training costs for an operator and Rs.15,000 to bear other costs, which comes Rs.35,000 as pre-operating costs.

Working Capital

Total productivity is estimated through resource inventory, and estimated production per year determines required working capital. Rural entrepreneurs do not always have enough working capital to run the unit throughout year. Therefore, total productivity is fragmented to 100kg production cycles and immediate sale. By multiplying Rs.1,080 (production cost per kg) with 100kg (production), Rs.108,000 is required as initial working capital.

The total investment for the establishment of a wintergreen oil processing industry and production of the first 100kg of oil is Rs.465,350. The distillation unit can extract two batches in a day, and 100kg of oil can be extracted in about 16-17 days if distilled twice a day.

A comprehensive business plan has to be developed to commence any business venture as it acts as guideline to the production activities. The arrangement of timelines,

Table 2.6.2: Estimated fixed capital cost for establishing MS distillation unit of 2,500L capacity

SN	Description	Number	Rate	Amount (Rs)
1	**Land and Improvement**			
	1.1 Water supply (3/4" Polythene Pipe)	1 roll	3,500	3,500
	1.2 Land Development		5,000	5,000
2	**Building**			
	2.1 Factory, store and office; single storey, double partitioned, wood fenced, 500 sq. ft base			50,000
	2.2 GT sheet roofing (10 ft, 40 sheets) including nails	40	1,200	48,000
3	**Equipment**			
	3.1 MS distillation unit: 2,000L capacity	1	175,000	175,000
	3.2 1,000L water tank	1	12,000	12,000
	3.3 Bucket	2	150	300
	3.4 Jug	2	25	50
	3.5 HDPE containers	4	500	2,000
	3.6 Weighing balance	1 set	2,000	2,000
	3.7 Wooden mallet	2	100	200
	3.8 DU transport and Instillation			20,000
4	**Furniture**			
	4.1 Chairs	5	300	1,500
	4.2 Bench	2	400	800
	4.3 Cupboard	1	2,000	2,000
	Total Fixed cost			**322,350**

responsibility assignments, methods of extraction, sustainable harvest quantities, amount of oil to be produced, financial assumptions, and profit are clearly identified and defined in the business plan. A business plan is also essential for registering the industry.

Major Issues on Entrepreneurship and Trade

Essential oil producers have almost same issues on entrepreneurship and trade and readers are therefore requested to refer to page no 62.

Along with these issues, the royalty for Dhasingre leaf has been increased from 25 paisa to Rs.1 recently. With this increment, it is hard for Dhasingre entrepreneurs to thrive. The costs presented above are actual costs as of December 2010 in different processing sites in Dolakha district. It is evident that even with a margin of Rs.70 per kg, entrepreneurs cannot bear depreciation and pay back bank loans. Therefore, royalty rate should be lowered back to 25 paisa per kg; it will be almost impossible to produce Wintergreen oil otherwise.

Conservation Status and Royalty

The global and national status of *Gaultheria fragrantissima* is not known. It has been prioritised by the Government of Nepal for economic development (GoN/MOFSC/DPR 2006). Leaves and aerial twigs are collected from natural forests (both national and community managed) for trade with the permission of District Forest Offices after paying a royalty of Rs.1 per kg.

PADAMCHAL

Rheum australe
D. Don

There are about seven species of *Rheum*, all commonly known as Padamchal or Chulthi. However, three species of *Rheum*, viz. *R. australe* D. Don, *R. acuminatum* Hook. f. & Thoms. ex Hook., and *R. nobile* Hook. f. & Thoms. are used traditionally in Nepal. *Rheum* belongs to Polygonaceae family and the plant is found in sub-alpine and alpine regions of the Himalayas. All three species have a wide range of medicinal uses. *Rheum australe* is mostly traded as Padamchal or Chulthi Amilo.

Habit

R. australe (**Common names**: Padamchal, Akase Chuk, Chulthe Amilo, Mire Chuk, Amalbed, Karaj Chulthi; **English name**: Himalayan Rhubarb; **Synonym**: *Rheum emodi* Wall. ex Meisn.) is an erect robust perennial herb with a thick rootstock and reaching a height up to 1.5m-2m. The stem is slightly aromatic, while its outer bark is wrinkled, stout, hollow and branched above. The stem has bitter, a bit chilly, and acidic taste. Leaves have long petioles and are large and orbicular or broadly ovate, while the leaf base is cordate with small upper leaves. New leaves appear during March-April. Flowers are small and reddish-purple in colour, borne in dense terminal spikes of about 20-30cm. Flowering occurs during June-July and fruiting in July- September (Polunin and Stainton 1984, Ghimire *et al.* 2008b). Its fruit is a violet-coloured nut (Shrestha and Shrestha, 2004).

Habitat and Distribution

R. australe is found in moist scrubland, open rocky slopes, and on the forest margins of alpine meadows. It is a hardy plant and can withstand temperatures up to -15°C (Huxley, 1992). It is endemic to the Himalayas and is distributed from Northern Pakistan, Kashmir, Himachal Pradesh to West, Central and Eastern Nepal, Sikkim, Bhutan and up to Southern Tibet. It is found within an altitudinal range of 3000m to 4200m.

R. australe is found beneath the forest of *Tsuga dumosa, Abies spectabilis, Acer* spp., *Betula utilis, Rhododendron campanulatum*, and *Rhododendron campylocarpum*. It is a major herb component of Birch-Rhododendron forests, and is associated with ground vegetation like *Rhododendron anthopogon, Primula* spp., *Aconitum* spp., *Cassiope fastigiata, Berberis* spp., *Rosa macrophylla, Arisaema* sp., *Bistorta* spp., *Meconopsis* spp., and *Potentilla* spp.

R. australe has been recorded from Thade (3050m), Hilay Dhap-Mane (3400m), Cholangpati (3600m), Langtang gaon (3200-3500m), and Gosaikunda (4200m) from

R. australe; left- entire plant, right- flower close up

Langtang National Park and Buffer Zone Area (HMGN/MOFSC/DPR 1997). *R. australe* is rare in Langtang National Park (Ghimire *et al.* 2008b).

Uses

The roots and rhizomes of *R. australe* are tonic, purgative, and astringent, and are used for stomach aches, dyspepsia, diarrhoea, anorexia, constipation, urticaria, and septic wounds. Powdered root is externally applied to indolent ulcers, and on the forehead for relief from headache. Similarly, the rhizome yields a bright yellow dye. Gathering of rhizomes for trade and leaf stalks for local consumption endangers plant population of *R. australe* (Manandhar 2002, Baral and Kurmi 2006).

The stems and roots of *R. australe* are traded in hilly districts of Nepal and are mostly exported to India.

Petioles of all three species of *Rheum* are pickled. The rootstock of all three species is reported to have medicinal properties and is very popular in homeopathic medicine. A watery extract from the root of *R. nobile* is taken orally in cases of stomach pains, constipation, dysentery, swelling of throat, and tonsillitis. Roots of *R. nobile* and *R. acuminatum* are therapeutically the same as that of *R. australe* (Manandhar 2002, Baral and Kurmi 2006, Ghimire *et al.* 2008b).

Chemical Composition and Properties

The roots of *R. australe* contain anthraquinones like chrysophanol, emodin, physcion (emodin-3-monomethyl ether), their respective 8-O- glucosides and 8-O-gentiobiosides, rhein, rheinal, rhein-11-O-β-D-glucoside and revandchinones 1,2,3 and 4, physcion, aloe-emodin, the flavonoid rutin and torachrysone 8-O-β-D-glucoside (Babu *et al.* 2003, Singh *et al.* 2005). The plant is also known to exhibit laxative, diuretic, anti-inflammatory, antimicrobial and antifungal properties (Chauhan *et al.* 1992).

Flavonoids have been isolated from bracts. The translucent bracts accumulate a substantial quantity of flavonoids. Other minor compounds were characterised as quercetin, quercetin 7-O-glycoside, kaempferol glycoside, and feruloyl ester (adopted from Ghimire *et al.* 2008b).

Leaves of some members of *Rheum* contain significant quantities of oxalic acid and should not be eaten in any quantity. Oxalic acid can lock up certain minerals in the body, especially calcium, leading to nutritional deficiency. The content of oxalic acid will be reduced if the plant is cooked. People who are prone to rheumatism, arthritis, gout, kidney stones or hyperacidity should take special caution if including this plant in their diet since it can aggravate their condition (http://www.pfaf.org).

Life Cycle

R. austrle is a biennial to perennial plant. It is bisexual with both male and female parts present in the same flower. It hybridizes freely with other members of Rheum (Huxley 1992). Seeds are dispersed in the field from July to September. Seeds remain dormant during the winter and sprouts during March-April or as soon as the snow melts. Only vegetative growth occurs in the first year. Leaves are shed just before winter and the whole plant is covered by snow. Immediately after the snow melts, new leaves arise and flowering and fruiting occurs in the second year.

Cultivation

Cultivation of *R. australe* has begun in some places of Nepal but is not practised widely. It prefers a deep, fertile, moderately-heavy, humus-rich, moisture-retentive, and well-drained soil. However, it can grow well in heavy clay soils too. *Rheum palmatum* and *R. officinale* are widely cultivated in the People's Republic of China.

Propagation Through Seeds: Seeds are collected during September-October (*Bhadra-Ashwin*) and uniformly sown in prepared nursery beds during March-April (*Falgun-Chaitra*). Pre-treating the seeds in running water for 12 hours accelerates germination and simultaneously increases germination percentage. Regular watering is needed after sowing but water-logging should be prevented. Seedlings are ready to be transplanted after three to four leaves appear. Before transplantation, the pits are half-filled with compost manure and left as such for a few days. Seedlings are transplanted maintaining a distance of 1-1.5m between two plants.

Propagation Through Rootstocks: Propagation through rootstocks is carried out during May-June (*Baisakh-Jestha*). Rootstocks are divided with a sharp blade or knife, making sure that there is at least one growth bud on each division. Larger divisions can be planted directly to their permanent positions. It is better to grow smaller divisions in nursery beds or polybags and grow them in light shade till they are well-established. Rootstocks are embedded 10-15cm below ground level. Rootstocks collected from fields can be directly cultivated during May-June (*Jestha*) (Huxley 1992, Shrestha and Shrestha 2004).

Sustainable Management

Harvest Time: Rootstocks are collected from mature plants (more than three years old and up to ten years old) at the end of October and November (*Kartik-Mangsir*). Petioles are collected during June- July (*Ashadh*).

Harvest Technique and Intensity: Harvesting should involve selective collection of a small portion of the rootstock. The whole plant should not be completely uprooted. Collected plants should be thoroughly shaken to allow seed dispersal. Harvesting should be selective and only allowed from populations (i) with a high density, (ii) evenly distributed in space, and (iii) for which reproductive potential will not be affected by plant removal.

Padamchal is threatened in the wild due to unsustainable harvesting. Harvesting should be done rotationally with at least three blocks in a collection area. Along with over- and premature harvesting, open grazing should be controlled in the collection area because trampling will destroy seedlings and saplings. A separate area can be allocated for grazing.

Value Addition

The plant's petioles and rootstocks are collected for trade. Market price of rootstock was Rs. 80 per kg and petioles (chulthi, amalbed) cost Rs. 90 per kg, as per the price offered by traders at Kathmandu and Nepalgunj in March 2011.

Value addition to rootstocks is limited to cleansing, drying and grading into smaller and larger pieces. These graded pieces are kept in separate jute bags and stored properly for trading. Similarly, petioles are collected, dried in the shade, weaved like a rope, and stored in a cool dry place.

Padamchal Supply and Market Chain

Village/district level traders are major actors in the Padamchal supply chain. They are in regular contact with national traders and exporters and often provide information about prices and market trends. Collectors transport both rootstocks and petioles to these traders, who in turn transport these herbs outside the district by acquiring export permits from district forest offices. Padamchal, after reaching Terai districts, is then exported to India.

The collection of Padamchal is a seasonal business and herders are often involved in its collection. Trade of Padamchal does not have a profound effect on a household's economy in most areas. However, Padamchal is a major source of income for marginalised groups and people with low land holdings. Marginalised and poor communities either go as herders to highlands or visit to collect a wide range of medicinal plants. A simplified supply chain for Padamchal is given below.

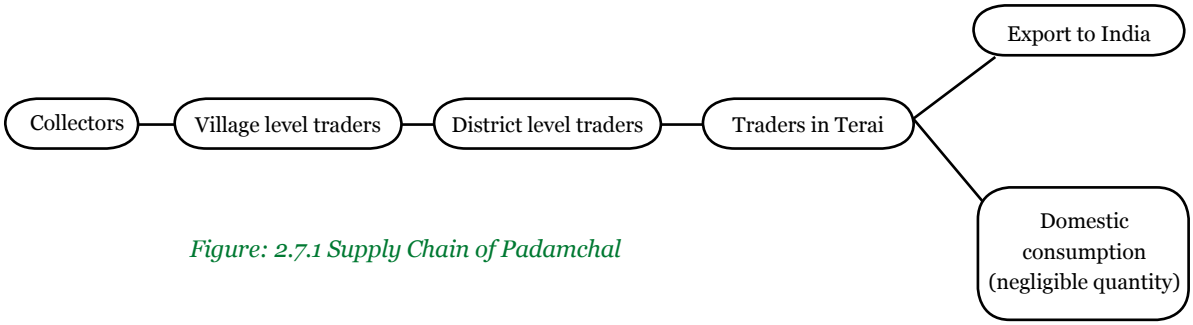


Figure: 2.7.1 Supply Chain of Padamchal

Economic Analysis

The cultivation of Padamchal has started in a few mountainous districts but cultivation on a commercial scale is yet to commence. Its economic efficiency and turnover is still a matter of concern. Its potency will decrease if cultivated on slightly-lower altitudes.

Dried Petiole

Cultivation of NTFPs or medicinal plants includes preparing a nursery and the land, purchase of seeds or seedlings, as well as compost manure, and labour costs. These costs are highly variable in terms of time and space (geographic proximity) and therefore taken as reference only. Please refer to Table 2.4.2 and 2.4.3 for estimated cultivation costs. It has been estimated that 200-300kg of dried petioles and 500-600kg of dried rootstocks can be produced from a hectare of Padamchal crop (Shrestha and Shrestha 2004).

A collector can harvest about 3 kg of fresh rootstocks and 5 kg of petioles a day. 3 kg of fresh rootstock yields 1.5 kg of dried rootstock and 5 kg of fresh petioles yield 3 kg of dried petioles. Therefore a collector can earn about Rs.350-400 per day during the collection season.

Major Issues in Entrepreneurship and Trade

R. australe is traded in different names, viz. Padamchal, Padamchal danth, Amalbed, Chulthe, Karaj Chulthe, and Khokkim. Though the government has allocated different royalty rates for rootstocks and petioles, the issuance of export permits is still confusing due to these different trade names.

The price of petiole has reached as high as Rs.150 per kg in previous years but the demand for rootstocks and petioles has decreased drastically in the past few years. The market price of Padamchal is often dictated by demand from India; therefore, prices may rise dramatically in coming years, or might remain stable.

Conservation Status and Royalty

The plant's global status is not known. It is threatened in the Indian Himalayas (Nautiyal *et al.* 2003), and has a vulnerable status in Nepal (CAMP 2001). It is threatened mainly due to unsustainable harvesting of rootstock for trade. It has been prioritised by the government of Nepal for economic development (GoN/MOFSC/DPR 2006). Rootstocks and petioles are collected from national forests for trade with the permission of District Forest Offices by paying Rs.10 as royalty for rootstocks and Rs.5 for petioles. *Rheum nobile* is a striking plant of alpine regions and is rare and vulnerable in Nepal. Its occurrence is sparse throughout the country except in the highlands of Tamor valley in Eastern Nepal where natural strands of this beautiful plant can be seen.

Rheum nobile

BHANG

Cannabis sativa subsp. *indica* (Lam.) Small & Cronquist*

Cannabis sativa (**Common names**: Bhang, Ganja; **English name**: Hemp; **Synonym**: *Cannabis indica* Lam.; **Family**: Cannabaceae) is a cosmopolitan herb with a strong smell. The fibre obtained from the stem is used for weaving cloth.

Habit

C. sativa is an erect standing annual herb with finely-hairy slender branches and grooved stems. Plants may reach up to 3m or even more. Leaves are aromatic, digitate in shape with narrow coarsely toothed leaflets of variable size ranging from 3-10cm. Upper leaves have one to five linear lanceolate long pointed leaflets, while lower leaves have five to eleven leaflets. All leaves are long-stalked, gland-dotted, pale, and very fine downy beneath. The plant is dioecious with short axillary clusters of yellowish-green male flowers and stalk-less axillary clusters of green female flowers on a separate plant. Flowers are tiny and about 4mm long; male flowers are five-lobed perianth. Female flowers have two protruding styles while the perianth encloses the ovary. Fruits are glandular and hairy with a size of 4mm. Flowering and fruiting occurs from May to December (Polunin and Stainton 1984, Manandhar 2002).

Habitat and Distribution

C. sativa is found in North East Afghanistan, North Pakistan, Kashmir, North India, Nepal, Sikkim, Bhutan and South Tibet. It is distributed throughout Nepal within an altitudinal range of 100m to 2700m and is common on the edge of the fields, open grounds and wastelands. It is often seen on the edges of agricultural lands. It was cultivated throughout the tropical to temperate regions of Nepal. It is mostly found in the forests of *Schima wallichii, Castanipsis indica, Castanipsis tribuloides, Pinus roxburghii, Terminalia alata, Rhododendron arboreum, Quercus lanata*, and Laurels. Its shrub associates are *Gaultheria fragrantissima, Zanthoxylum armatum, Rosa* spp., and *Berberis aristata*.

It was documented from Dhunche VDC, Laharepauwa VDC, Ichowk VDC, and Gaonkharka VDC of Langtang National Park and Buffer Zone area (Ghimire *et al.*2008b, Pyakurel 2008, Pyakurel 2010).

Cannabis sativa a) habit, b) flowering twig, and c) flowering twig close up

* *Cannabis sativa* subsp. *kafiristanica* (Vavilov) Small & Cronquist is another sub species of *Cannabis sativa* and is naturalised in Southern Asia. Press *et al.* (2000) points out the possibility of all *Cannabis* of Nepal to be *Cannabis sativa* subsp. *kafiristanica* but again urges that detailed chemical analysis is necessary for definite conclusions

Uses

C. sativa is grown for a variety of purposes, including as source-material for various products such as food, clothing, cosmetics, fuel, and for the production of intoxicating *'ganja'* and *'charas'*. These intoxicating drugs are obtained from the stems, flowers, and leaves of the plant. The drug material is used medicinally, recreationally, and spiritually but its use is illegal.

Traditional Uses: Seeds (Bhang) are roasted and pickled. Roasted seeds are chewed in some western districts of Nepal. 'Ganja' and 'Charas' are smoked like tobacco. Bhang is also eaten mixed with sweets. The juice of the leaves is given in cases of diarrhoea and dysentery in doses of about six teaspoons twice a day. The paste of the leaves is applied to cuts and wounds. Powdered seeds in doses of about four teaspoons are given as an anthelmintic (Manandhar 2002). Other parts are used in cases of gastritis, diarrhoea, lymph fluid disorder, pimples, itching, and skin diseases, as well as for fever in Dolpo. Twigs are kept in houses to repel insects (Ghimire *et al.* 2008b).

The stem of *C. sativa* yields fibre used to make cordage, sacks and rough clothes. Its fibre is especially important for highland communities because the plant is locally available and the coarse clothes made out of the fibre protects them from severe cold.

Commercial Uses: Handicraft items made from *C. sativa* have high demand in international market. 'Ganja' and 'Charas' extracted from resins are traded illegally within the country and abroad.

Chemical Composition

C. sativa have narcotic, sedative, hypnotic, diuretic, anodyne, antispasmodic, analgesic, and aphrodisiac properties (Warrier *et al.* 1994). The plant contains both resin and volatile oil. Chief constituents of the resin are cannabinol, 9-dehydrocannabinol, tetra-hydrocannabinol, cannabidiol, cannabicitran, cannabichromene, cannabicyclol, cannabigerol, cannabielsoin, trans-cinnamic acid and cannabidiolic acid (CSIR 1986, Rastogi and Mehrotra 1993b, c).

Life Cycle

C. sativa is an annual herb and is propagated by seeds but its root shows perennial characteristics. Above ground parts are dead after the growing season but the plant can grow from underground parts in the next season. Pollination is facilitated by wind and insects.

Cultivation

C. sativa prefers loamy soil with good drainage-facilitating nutrient-absorbing capabilities. It prefers soil between pH scale 6.0 to 7.0 and with fundamental nutritional elements (nitrogen, phosphorus and potassium), but it can grow in a wide range of soils. The optimal day temperature range is believed to be between 24 to 30°C. Temperatures above 31°C and below 15.5°C seem to decrease potency (Green 2001). Watering frequency and amount is determined by many factors, including temperature and light, the age, size and stage of growth of the plant. A conspicuous sign of water deficiency is downward wilting of the leaves and excess water can kill young plants. During vegetative stage, the plant needs more nitrogen while during flowering phosphorus is more essential than other two elements.

Seeds are generally sown directly in the field before the monsoons, i.e. during May and June. Cultivation sites must receive 12 hours or more of sunlight. Seeds are pre-treated by soaking in warm water for 24 hours. It may take up to eight days for the seeds to germinate. Roots and two embryonic leaves emerge from the seed after two to four days. It is important to keep a constant environment with high humidity levels and medium- to high light intensity during the seedling stage. Weeding is not necessary but is recommended during the first month of germination. Plants become mature after two to three months of sowing but this depends on surrounding temperatures. Plants grown in tropical regions attain maturity in a shorter time compared with plants in upper tropical or temperate regions.

Sustainable Management

C. sativa is grown as a weed on the edge of agricultural fields, inside abandoned fields and in forests with low canopy cover. Due to its wide availability and narcotic properties, there is not much concern towards its sustainability. There is a provision of imprisonment for farmers who cultivate Cannabis to extract the narcotic. The cultivated site, if found, is destroyed.

Harvesting Time: The plant becomes ready to harvest when the flower turns white to reddish brown. Ideal time for collection of fibre is from September to November, but seeds are harvested from late September to early December.

Harvest Method: Plants are cut with a knife inches above the ground and put in a *doko*. Plants harvested without uprooting the roots can regenerate the next year. Further, it has been observed that proper harvesting increases the vitality and improves the quality of the fibre.

The outer dead bark is removed and the inner bark is peeled off. The dry bark is generally soaked for a few days in water before peeling. The harvested bark is dried in room temperature for a few days during which more than half its weight is lost. The dried bark is bundled and stored in a dry place. Moisture in the environment and the bark itself may develop fungus; therefore, care should be taken during storage. The bark is sold to cloth manufacturers or collectors themselves weave the fibre.

Harvest Intensity: Collectors used to harvest the plant without applying any scientific measures. Its harvest (to extract fibre) is limited compared to its availability in the wild but sustainable harvesting mechanisms can be applied for sustainability and quality. Collected plants should be thoroughly shaken to allow seed dispersal. About 10 per cent of mature plants should be left to assist in sexual reproduction.

Value Addition

C. sativa is a multipurpose plant and has a wide range of uses. But respecting legal provisions, only fibre-manufacturing process is discussed here. Processing of bark for the manufacture of fibre is entirely similar to that Allo and readers are requested to refer to page no 37 for details. The price of thread or woven clothes, and production quantity is almost same as that of Allo and refer to page 39-40 for detail.

Supply and Market Chain

The supply chain of *C. sativa* is simple yet intriguing because both legal and illegal actors are involved. Fibre is legally traded whereas resinous products are traded illegally. The supply chain for fibre and its products are quite clearly understood but the chain is vague for the resinous substance. However, a highly simplified supply chain is presented below.

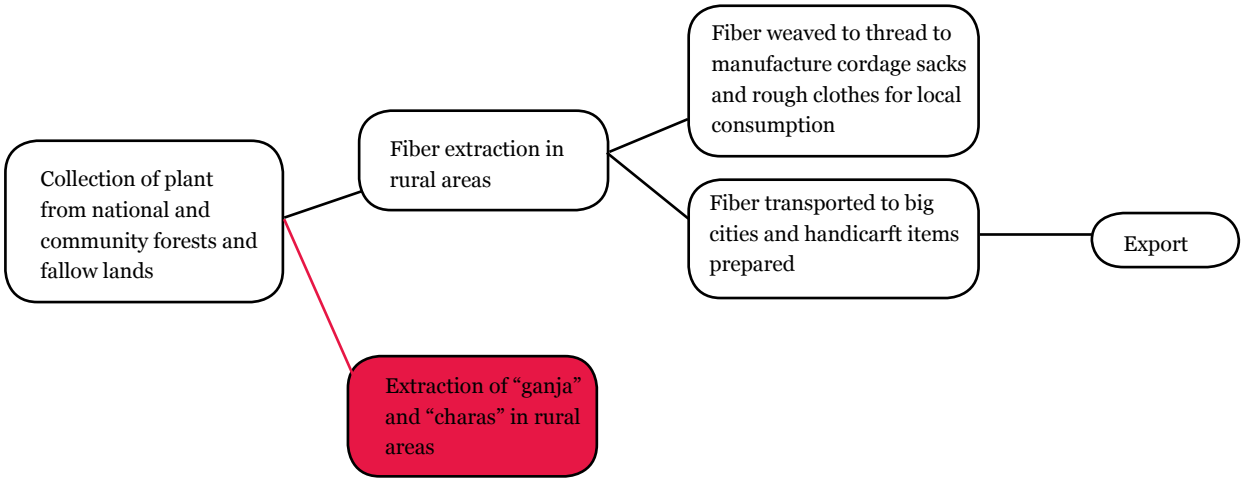


Figure 2.8.1: Supply and market chain of C. sativa. Red lines and boxes are illegal. The size of boxes does not represent the volume of trade.

Major Issues on Trade

The trade and export of handicraft items is adversely affected by the narcotic properties of the plant. Though processed fibre does not possess traces of narcotic properties, it is often treated like 'ganja' and 'charas'. Thus, the understanding of custom and government officials has to be improved.

Conservation Status and Legal Provisions

Global and National status not known but due to its wider distribution, it does not fall in any of the threat categories. Cultivation of *C. sativa* for extraction of 'ganja' and 'charas' is banned by government of Nepal but still practiced in most of the districts. Farmers grow *C. sativa* in forests or rugged and rural areas where the local populations are not likely to find the crop. They usually grow in a crop that is larger and obscures the plants, or camouflage, such as maize or sugarcane or bamboos.

LOKTA

Daphne bholua Buch.-Ham. ex D. Don
Daphne papyracea Wall. ex Steud.

Lokta (**English name**: Nepali Paper Plant, **Family**: Thymelaeaceae) is an evergreen or deciduous shrub found in temperate regions. Two species of Lokta (*Daphne bholua* and *D. papyracea*) are found in Nepal. The inner bark of both species of Daphne is extensively used for making Nepalese handmade paper and is an important source of income for people residing in rural hilly areas of Nepal. More than 200 handicraft items are made from Lokta paper and it is one of the major exported commodities of Nepal.

Habit

Daphne bholua (**Common names**: Seto Lokta, Seto Baruwa, Baruwa, Kagaj pate; **Synonym**: *D. cannabina* sensu Hook. f.) is an erect or spreading evergreen (*D. bholua* var *bholua*) or deciduous (*D. bholua* var *glacialis*) shrub, reaching heights up to 6m but mostly smaller than 3m. Leaves are alternate, very short stalked, elliptic to oblanceolate, entire, dull green, leathery, and hairless. Flowers are white, flushed pink or purplish externally, borne in terminal rounded stalkless clusters, and give out a sweet-scent. Fruits are ellipsoid in shape and turn black in colour when ripe. Flowering occurs from November to May, and fruiting from March to June (Polunin and Stainton 1984, Ghimire *et al.* 2008a).

Daphne papyracea (**Common names**: Lokta, Kalo Lokta, Kalo Baruwa, Kagajpate, Aule Lokti; **Synonym**: *D. cannabina* sensu Hook. f.) is an evergreen multi-branched erect shrub with smooth grey bark that often reaches 3m in height. Leaves are dark green in colour, entire, smooth, narrow-lanceolate to oblanceolate, and leathery. The plant has white or greenish white flowers borne in terminal clusters with persistent hairy bracts and give out a faint-scent. Fruits are small and fleshy, orange in colour at first and then deep red when fully ripe. Flowering occurs from October to April, and fruiting from April to June (Ghimire *et al.* 2008a).

Habit of Lokta: Top row (Daphne bholua); Left-entire plant, Middle-A flowering twig and Right-Flower close up. Bottom row (Daphne papyracea); Left- Entire plant, Middle-A flowering twig; and Right-Flower close up.

Habitat and Distribution

D. bholua is a shrub that tolerates shade and grows as an understorey shrub in moist places. The plant generally grows on moist north-east facing slopes and prefers humus-rich loamy to clay, well-drained soil. It can grow in acidic, neutral to slightly basic soils. Its growth is denser and gregarious in moist conifer and broad-leaved forests of the temperate Himalayas at middle elevations. *D. bholua* does not tolerate very dense canopy. Conversely, it grows easily in open forests or pastures (Ghimire *et al.* 2008b). The plant requires partial shade with about 30 per cent canopy cover (Branney 1994). It is distributed all over Nepal within an altitudinal range of 2000m to 4000m. It is distributed from Sikkim to north-east India to west China. Distribution range of *D. bholua* varies in Nepal from east to west. As mean annual precipitation is low and upper timberline is at a comparatively lower altitude in west Nepal, *D. bholua* rarely grows on altitudes more than 3000m there. In eastern Nepal, *D. bholua* extends up to 4000m (Jeanrenaud 1984). It has been recorded from Dhunche-Chandanbari (1970m), Dimsa-Cholangpati (2800m-3400m), and Helambu (2650m) within the Langtang National Park.

D. papyracea is a plant that likes shade and grows as an understorey shrub in moist places, but it also grows well in open places. Its growth is denser and gregarious in moist conifer and broad-leaved forests of the temperate Himalayas at middle elevation. *D. papyracea* is endemic to the Himalayas and is distributed from Kashmir to north-west India. It is distributed all over Nepal within an altitudinal range of 1500-2400m and is common in moist conifer forests and temperate Himalayas. A recently-conducted study revealed that the density of Daphne in Sindhupalchowk is 0.10 with relative density of 9.17 (Sharma, 2009). *D. papyracea* is found naturally in temperate zones of the LNPBZ SP area and is common in Kutumsang.

Both species of Lokta prefer north-east facing slopes with slopes ranging from 5 to 700 inclines. It is found in Rhododendron-Lyonia, Castanopsis-Quercus, or Laurel forests. Major associates of *D. bholua* are *Arundinaria maling, Betula utilis, Abies spectabilis, Quercus semecarpifolia, Taxus wallichiana*, and *Tsuga dumosa*. Similarly, *A. maling, Drepanostachyum falcatum*, and Laurels are major associates of *D. papyracea*.

Uses

Inner bark of Lokta is used to make paper. Nepal has a very long history of papermaking that goes back to at least the 12th century (Ghimire *et al.* 2008a). The paper has been praised for its attractive texture, durable character, anti-pest properties and eco-friendly nature. Handmade paper is insect-resistant and lasts for more than 500 years. For this reason, handmade paper had been used in ancient times to document religious myths and epics. It is widely used in government offices and courts. Although handmade paper has been widely used by the government of Nepal for many years, its domestic use is not growing significantly. Reliable data in relation to domestic consumption is difficult to obtain. Most low-quality paper rejected by export buyers end up in the domestic market.

Handmade paper is the fifth largest export product in the handicraft category and covers about 11 per cent of the total export in the category. Handmade paper products are exported to 60 countries, major importers being the US, UK, France, Japan and Switzerland. Handmade paper is used to manufacture postcards, gift items, lamp shades, notepads, files, visiting cards, photo albums, calendars, and diaries which are in turn sold through retail outlets in urban areas of Nepal or exported (Pyakurel 2009). Handmade paper products have registered a steady and healthy growth in terms of export over the last decade. According to market research, the total market size of handmade paper in European Union is estimated at ↓24.5 million. In fiscal

year 2003/2004, handmade paper items worth Rs.300 million was exported to third countries (Source: Nepal Handicraft Association). There are about 110,481 metric tonnes of raw lokta bark available in Nepal. Of this, it is estimated that only 800 to 1,000 metric tonnes is collected each year (HANDPASS, 2003).

Locally, the stem's bark is used as a source of coarse fibre for ropes and cordage. The bark's paste is applied to treat sprain and fracture after mixing with other herbs in Langtang (Dongol 2002). Bark decoction is used in cases of fever, while the root and bark juice is considered an anthelmintic and is used to treat intestinal worms. The juice is also used for intestinal disorders and as an anti-leech agent (Ghimire and Nepal 2007).

Chemical Composition

D. bholua contains toxic resins (CSIR 1986). Taraxerone has been isolated from the leaves; daphnoretin and β- sitosterol have been isolated from the bark, stem and roots (Rastogi and Mehrotra 1993).

Daphnin, Sterol and three glycosides (G-1, G-2 and amorphous G-3) have been isolated from the roots of *D. papyracea*. G-1 and G-3 are identified as flavonoid glucosides but not characterised (Rastogi and Mehrotra 1993a). Daphnetin, daphnetin-8-β-glucoside, taraxerol and its acetate taraxerone, daphnetin and β- sitosterol-D-glucoside have been isolated from aerial parts (Rastogi and Mehrotra 1993b).

Life Cycle

The life span of both Lokta species has been reported to be more than 60 years (NSCFP 2001). Lokta propagates both sexually and asexually. Seed viability is very short and often limited to less than a week; therefore, the plant is difficult to propagate by seeds (Ghimire *et al.* 2008a). Wind and insects (bees, flies and lepidoptera) are major means of pollination. The plant shows extensive vegetative propagation by 'suckers'. These suckers can arise within the periphery of 5m from the tap root and more than eight suckers can arise from one adventitious root. Regeneration occurs in the proportion of 25 per cent by seeds and 75 per cent by root suckers (Jeanrenaud 1984). Coppices arise from the cut stem and are capable of germination, but such coppice shoots are less vigorous than plants that have originated from seeds or suckers (Jeanrenaud and Thompson 1986).

Lokta is a slow-growing plant and may take more than eight years to fully mature when propagated from seeds. The plants that regenerate from coppices could attain maturity in five to six years (Ghimire *et al.* 2008b). The plant's girth increases at the rate of 1.1cm per year on average. It has been reported that for each centimetre increase in diameter, bark yield could increase by more than 50 per cent (Dutt 1994). Similarly, the rate of annual height increments has been reported to be 25cm (NSCFP 2001). But increment is governed by various factors such as altitudes, soil types, aspects, forest cover and intensity of harvesting. Studies showed that light can have considerable influence on growth and regeneration of Lokta. Diameters of Lokta plants that grow out in the open have been reported to have increased by 30 to 50 per cent more than those growing in dense canopy (Dutt 1994).

Domestication and Cultivation

Lokta cultivation is still experimental in Nepal. Its cultivation and domestication is very difficult. It can be transplanted by seeds and stem cuttings in nurseries but the propagation technique has not been commercialised yet.

Propagation by Seeds: Seeds collected during the first two weeks of May show higher viability rates, but seeds can be collected by the third week of April to the end of May. Due to the short viability of seeds, nursery beds have to be prepared prior to the collection and seeds should be sown in beds or polybags immediately after collection. High level of experience is needed to identify mature seeds. Therefore, it is very difficult to propagate Lokta from seeds *ex situ*. After sowing, seeds must be covered by a thin layer of soil and also by mulch (hay or straw or other improvisations) to retain moisture and to protect seeds from birds. Nursery beds need regular water but water logging should be prevented. Hay or straw cover needs to be removed after seeds develop two to three leaves. A new roof about 2.5 feet high from the ground is needed. Seedlings can be transplanted to the field the following year, either directly from nursery beds or from polybags.

Propagation by Stem Cuttings: Lokta can be effectively propagated by stem cuttings. Stems can be cut from mature plants. Cut stem should have at least two or three nodes and be about 10cm in length. These cuttings can be planted in nursery beds or in poly bags with two-thirds of the inclined cut part emerging above ground. Roots will emerge in 18 months and the plant should be kept in a nursery for the next one to one and a half years. However, the survival rate of cuttings is relatively low—about 40 per cent (Shrestha and Shrestha, 2004). This technique is therefore not recommended for propagation.

Propagation by Layering Technique: Mature stems are bent to remain horizontal to the ground and covered with humus-rich soil during June-July. Watering is not necessary during the first half of layering because of the rains. Stems develop roots in the first year from each node. These young plants are left as such for a year and are transplanted to the fields the following year.

Sustainable Management

Lokta is a slow-growing plant and unsustainable harvesting practices throughout the country are adversely affecting its wild population. Bark is collected by cutting a plant that is only about 1.5m in height and the bark is removed right up to the root, leading the plant to die. This method is unsustainable because regeneration from coppices is prevented, even though collectors get higher quantities of bark from the roots. Similarly, all sizes of Lokta are harvested, rendering natural growth and affecting genetic diversity. Furthermore, the resource is harvested without assessing harvestable quantity.

Harvesting Time: The bark should be harvested either after fruiting, or before flowering. June to September is the appropriate season for harvesting. By doing so, natural growth is not hampered.

Harvest Technique: Proper harvesting of bark accelerates the sprouting of coppices and maintains a healthy population in the wild. Bark should be harvested from mature tillers in a cluster. Bark from very old plants are difficult to digest and that from young plant yields inferior-quality paper. Further, weight-loss from young plants is far more than that of mature plants. Plants more than 2m in height are considered harvestable (NSCFP, 2001). Harvestable plants must be at least 1 inch in diameter (20-30cm above ground level) to yield superior bark. But Jeanrenaud (1984) suggests that a harvestable plant's age should be not less than 10 years and the girth should be at least 3cm in diameter. Stems should be cut with a sharp knife, with the cut side facing north or shade to minimise moisture loss, and bark should be removed from the cut stem. If properly cut, coppices will appear and become harvestable in five to six years but harvesting can only be done in about eight years if propagated by seeds (Ghimire *et al.* 2008a).

The selection of Lokta according to the age plays a vital role in the sustainable management of the plant's wild population and quality of paper production. Ideally, bark should be harvested from a plant that is at least five to six years old—if regenerated by coppices—and eight to twenty years old if propagated by seeds. Plants that have lesser branches should be selected for harvesting.

Harvest Intensity: Collection areas, including forests, should be divided into at least eight blocks and a rotational harvest system should be applied, harvesting only from one block per year. Blocks should be demarcated according to the availability of the plant and collection area. More than often, CF or other CBOs carry out resource quantification and issue collection permits considering the quantity, population and regeneration potential. Harvest quantities vary in different places. A harvest of about 50-60 per cent of mature plants is considered sustainable. About 1 per cent of the mature plants should be left in the area to promote sexual vegetation and maintain genetic variation. The minimum acceptable limit for harvesting is considered to be not more than 200 individuals per hectare. Collection intensity and quantity should be altered if the harvest limit poses a threat to the long term survival of Lokta.

Table 2.9.1: Relationship between harvest intensity and recovery time for two species of Lokta

Harvest Intensity	Recovery Time in rotational harvest system	
	***Daphne bholua* (Seto Lokta)**	***Daphne papyracea* (Kalo Lokta)**
50 per cent harvest	4-8 years	4-24 years
60 per cent harvest	5-8 years	5-31 years
70 per cent harvest	7-9 years	Not recommended due
80 per cent harvest	9-10 years	to long recovery time

Source: Ghimire and Nepal, 2008

Study conducted in Kangchenjunga Conservation Area of Eastern Nepal shows the interrelationship between quantity that can be harvested and recovery time, which is illustrated in the following table. Observation showed that *D. bholua* has a better recovery time than *D. papyracea*. Also, the long recovery/maturity time shows why ex situ cultivation is not prolific for Lokta.

Due to a prolonged life cycle and extensive collection, integrated management of Lokta is necessary. Beside proper harvest methods, regeneration and plant establishment should be enhanced by maintaining proper habitat conditions and providing adequate protection to seedlings from various forms of damage. Other anthropogenic activities (grazing, trampling, fire etc) may greatly hinder natural regeneration. These activities therefore must be minimized (Ghimire *et al.* 2008b).

Value Addition

Collectors and two tiers of producers are involved in value addition of Lokta. Outer bark along with black spots is removed by collectors. Primary level producers/ manufacturers process the dried bark and make 20 inch by 30 inch white paper sheets of different weights ranging from 5gm to 40gm per sheet, according to the demand. Paper producers transport the paper to big cities like Kathmandu where they are finally processed into more than 200 different items.

The paper-making process is the same as that of Argeli but the only difference is that bleaching powder is not necessary as the colour of Lokta paper is relatively whiter compared to that of Argeli, and Noori is not kept during papermaking because Lokta bark itself secrets mucilaginous substance and spreads well in frame. Please refer to Value Addition of Argeli for paper making process (Page 28-30).

Product Range

Technologies available in rural areas clearly suggest that production of 20 inch by 30 inch plain sheets is the final product from these regions. Paper manufacturers in Kathmandu make more than 200 items from these plain sheets. These products are then sold in markets in Kathmandu and other major cities or exported abroad.

Handmade Paper Supply Chain

Handmade paper is a product in which all elements in the supply chain are based on local resources. Paper making uses local raw materials, local labour and local expertise (technology). The promotion of quality paper/product-making has great potential to alleviate rural poverty in the hilly regions of Nepal. A highly simplified supply chain for Lokta paper making in Nepal is given below:

Handmade paper making is a seasonal business in the hills. Typically, the industry begins in November and ends in June before the start of monsoons. Raw paper made in the hills is brought to Kathmandu and sold to paper product manufacturers, who in

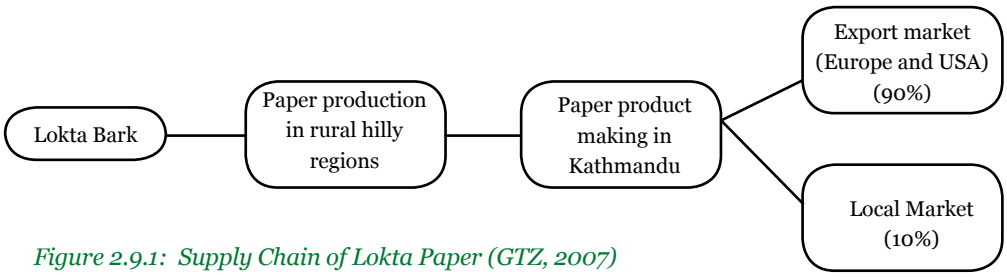


Figure 2.9.1: Supply Chain of Lokta Paper (GTZ, 2007)

turn make various stationery and handicraft items and export them mostly to Europe and the US. Ninety per cent of paper products made in Kathmandu are exported; the remaining 10 per cent are sold locally. Paper product making continues year round in Kathmandu.

Economic Analysis

Handmade paper industries are located in areas where resources are available and often determine the price of raw bark. The price of bark varies according to the place and time but on average, 1kg of dried Lokta bark costs Rs.50-55 (paid by factory at Kyul, Helambu, in 2010). The quantity of harvested bark varies according to the distance of the resource and availability in forests. In general, a collector collects 4-5kg of dried bark in a day, earning about Rs.200-250 per day. When compared with the average per capita income for Nepalese, Lokta bark collection can be a good source for alternative income generation.

Unit Production Cost

The unit production cost for one kori of 20 gm Lokta paper is given in table 2.9.2. Prices of raw materials are based on actual prices in September 2010. All the calculations are outcomes of long-term observations in handmade paper factories. Production costs may vary as the cost of raw materials (bark and caustic soda) and manpower are not fixed. Further, paper production in rural areas is costly because of higher transportation costs.

Table 2.9.2: Estimated unit production cost for Lokta paper production (20 gram paper)

Description	Rate (Rs)	Quantity	Amount
Bark cost per batch	55	10kg	550
Royalty	3	10kg	30
Fuel (estimated)	35	2 bhari	70
Caustic Soda (Rs)	75	1kg	75
Labour	1.5	1 tau	300
Cost per Kori (200 sheets of 20 grams each)			1,025
Risk and uncertainty cost (5 per cent of subtotal)			51
Market and sale			
Transportation cost	15	4	60
Total cost			1,136
Price (selling) at Kathmandu			1,500-1,600
Profit margin per kori excluding the fixed costs (Rs)			365-465

Source: Pyakurel, 2007

Fixed Capital

Fixed capital requirement for the establishment of a Lokta factory at cottage level is estimated to be around Rs.63,200. This price is sufficient to make 400 frames. For details, please refer to the fixed costs of Argeli (refer to page no 32-33).

Pre-operating Cost

Industry registration, market linkages and other hidden costs are kept in pre-operating costs. All these cost heads are highly variable. Therefore, it is very difficult to estimate the actual pre-operating cost, and 10 per cent of fixed assets have been kept as pre-operating costs, which comes to around Rs.6,500.

Initial Working Capital

Since it is difficult for rural entrepreneurs to regularly visit Kathmandu, a quarterly-based sale is recommended. A rough estimation of 60 days work (in three months) and per day production of 2 kori (of 20 gram sheets) requires Rs.136,320 as initial working capital.

Therefore, it is estimated that Rs.206,020 is required to commence a handmade paper industry including working capital for the first three months. In one cycle, 120 kori of paper can be produced and about Rs.49,800 can be earned by an entrepreneur (excluding depreciation and fixed costs).

Major Issues in Entrepreneurship and Trade

The major obstacle for entrepreneurs is the unavailability of skilled manpower and bark collectors. Factories are often situated in rural areas where migration is a big issue. It is very hard to find working groups (or youths) in villages and further, due to globalization, people are less interested in the collection of NTFPs.

Handmade paper is exported to more than 50 countries and covers almost 11 per cent of total exports. But availability of raw material is a major concern because of unsustainable harvesting. Paper manufacturers tend to mix Argeli or other fibrous plants with Lokta without informing exporters, which can hamper the credibility of Nepalese handmade paper.

Conservation Status and Royalty

The natural status (national and global) of Lokta is not known. However, due to unsustainable harvesting practice, its status is threatened throughout Nepal. Bark is collected from natural forests for trade with permission of District Forest Offices, paying the government a royalty of Rs.5 per kg.

Drying hand-made paper

SATUWA

Paris polyphylla Sm

Paris polyphylla Sm. (**Common name**: Satuwa; **English name**: Love Apple; **Synonyms**: *Daisua polyphylla* (Sm.) Raf., *Paris daisua* Buch.-Ham. ex D. Don; Family: **Trilliaceae**) is an erect perennial herb distributed in temperate regions throughout Nepal. The name "Paris" comes from "Par," meaning equal, and it refers to the symmetry the flower exhibits. Paris is a very variable species with a large number of subspecies. The rhizomes and roots of *P. polyphylla* have medicinal and commercial value. The market of Satuwa rhizomes has boomed in the last couple of years.

Habit

Paris polyphylla is a plant that is about 40-70cm high with an herbaceous stem. Leaves are 5-16cm long and 1.5-4cm wide, dark green in colour, stalked, 4-9 in number, and arranged in a whorl at the top of the stem. The leaf's shape can be elliptic, oblong or lanceolate; its surface is glabrous and has an acuminate tip. Rhizomes are somewhat bitter, stout and creeping. Flowers are yellowish-green in colour with short stalks and borne solitary on terminal heads. Perianths have 8-12 segments in two different whorls—the outer whorl is lanceolate, long, pointed, and has green leaf-like segments, while the inner whorl has thread-like yellow or purple segments. Individual flowers live for quite long, sometimes up to three months. Fruits are globular. Flowering occurs from April to May and fruiting from July to September (Polunin and Stainton 1984, Manandhar 2002, Ghimire *et al.* 2008b).

Habitat and Distribution

There is some confusion about the origins of *P. polyphylla*. The plant could have Sino-Japanese or East Asiatic elements. It is found in North-West India, Nepal, Bhutan, Southern Tibet, Myanmar and mainland China. Though found throughout Nepal, it is more common in Central and Eastern Nepal within an altitudinal range of 1800-3300m. It prefers moist and swampy habitat and grows in dense forests, bamboo forests, thickets, grassy or rocky slopes, and in humus-rich moist soil (Polunin and Stainton 1984, Manandhar 2002). The best places to find *P. polyphylla* within the altitudinal range mentioned are north-facing hills and near streams and swampy areas.

It is often found in broadleaved and dense woodlands where *Rhododendron arboreum, Quercus lanata, Q. semecarpifolia, Aesculus indica*, and *Tsuga dumosa* are major tree species. It has been recorded from Syaprubesi-Khangjung (2000m), between Ghatte Khola and Deorali (2400m), Ramche VDC, Birdim VDC, and Helambu VDC inside Langtang National Park and Buffer Zone Area. It is fairly common in LNP area.

Uses

Rhizomes are used as a cure for stomach aches, or as an antispasmodic, digestive, vermifuge, anthelmintic, expectorant, and tonic (CSIR 1966, CSIR 1986, HMGN/MOFSC/DMP 1970, IUCN 2004, Baral and Kurmi 2006). The root's paste is applied as an antidote to poisonous insect and snake bites, while also to alleviate narcotic effects.

Paris polyphylla, different stages

Chewing a root piece is believed to heal internal wounds below the throat (Rajbhandari 2001). The root paste is also applied to cuts and wounds. Root pieces are fed to cattle which are suffering from diarrhoea or dysentery. The juice of the root or the powder is taken as anthelmintic and in cases of fever (Pohle 1990, Manandhar 2002, Shrestha et al. 1995). Root extract is mixed with the rhizome of Panch aaule (*Dactylorhiza hatagirea*) and applied on fresh cuts and wounds (Ghimire *et al.* 2008a). The plant's rhizomes are also used as an alternative to the drug Diosgenin (ANSAB 2003).

Chemical Composition

Rhizomes contain glucosides (α-paridin and α-paristyphnin), glycosides, saponins, dioscin, diosgenin, paryphyllin, and steroids (CSIR 1966, CSIR 1986). Polyphylln A-H and paristerone were isolated from tubers (Rastogi and Mehrotra 1993c).

Life Cycle

Satuwa is a monoecious plant with male and female parts present in the same flower, but the plant is not self-fertile. It is an herbaceous species whose life cycle is completed in two or more years. It is a slow-germinating plant and takes about seven months to germinate from the seed. Germination process starts as soon as seeds are sown. The plant sprouts after winter (February), while flowering occurs during April-May and fruiting occurs during June-August.

Satuwa also propagates by underground rhizomes. The aerial part of the plant dries out but underground rhizomes remain dormant during the snowy winter. As soon as the snow melts or winter is over, the rhizome gives rise to a new plant.

Cultivation

The commercial cultivation of Satuwa is yet to commence in Nepal. However, it has been practised in other parts of the world. It grows well in soils with pH ranges from 5.6-7.5, i.e. slightly acidic to neutral soils. The plant prefers light (sandy) and medium (loamy) soils. It can grow well in full shade (deep woodlands) as well. The plant requires moist humus-rich soil and therefore regular watering is essential (Grey 1938, Philips and Rix 1989, Huxley 1992, Thomas 1990). It can be cultivated in Baitadi, Darchula, Bajhang, Jajarkot, Rolpa, Rukum, Manang, Kaski, Parbat, Makawanpur, Gorkha, Dhading, Rasuwa, Dolakha, Solukhumbu, Tehrathum, Sankhuwasabha, Panchthar and Taplejung districts. Besides the afore-mentioned districts, it can be cultivated in all districts with temperate moist climate.

Propagation by Seeds: Seed are collected from healthy plants during July-August (*Shrawan-Bhadra*). The outer fleshy coating is removed, properly cleansed and dried well before storing. Seeds are sown in a prepared nursery during September (*Ashwin*). Seeds are sown apart so that seedlings can grow freely. It takes about six to seven months to produce a primary root. Being a shade-loving plant, nursery beds should be shaded with appropriate roof structures. Regular watering is necessary. Plants are transferred to the prepared fields during May-June (*Baisakh-Jestha*).

Propagation by Rhizomes: Satuwa propagates efficiently with underground rhizomes and this process is more prolific than propagation from seeds. Tubers are cut into small pieces ensuring that growing bulbs are present in each piece. These rhizomes are grown in polybags during the rains. Leaves appear in about three to four months. The rhizomes are kept in the nursery for the first year and transplanted to prepared fields during May-June the next year.

Sustainable Management

The market price of Satuwa has increased dramatically over the past few years due to high demand from Tibet. High demands trigger an over-harvesting of the plant from the wild. Its cultivation has not started on a commercial scale and a proper mechanism to regulate wild harvesting should be in place.

Harvesting Time and Method: Underground rhizomes are collected during September- October (*Ashwin-Kartik*) after fruits are fully ripe. Underground parts are carefully dug out by axes (*Kuto*) or by hand. Some rhizomes are left in the field to facilitate natural regeneration and to maintain a healthy population in the wild.

Harvest Intensity: Satuwa is a slow-growing plant; care should therefore be taken while harvesting. Resource inventory is mandatory for Satuwa because its population is declining at a fast pace. Only a quarter of the current stock should be allowed to be harvested from a particular area, regardless of any contrary rules or policies. Alternatively, collection areas (government forests or any other forest) should be divided into at least four blocks and harvestable plants can be harvested from one block in a year.

Value Addition

Soil and attached particles are cleaned in running water. Rhizomes are dried in the sun until they are free of moisture. They are then graded into small and large pieces and stored in different jute bags in a well-aerated place, or transported mostly to district headquarters for sale. Satuwa is often exported to India and Tibet at this stage.

Market

Rhizomes of *P. polyphylla* are traded raw to India and Tibet. The market price of rhizomes has escalated in the past few years due to overwhelming demand from Tibet. Prices for the last four years are given in the following table:

Table 2.10.1 Price pattern of Satuwa for last four years

Year	2006	2008	2009	2010
Price of Rhizomes (per kg)	Rs.150	Rs.330	Rs.700	Rs.2,200

Satuwa Market and Supply Chain

The market for Satuwa is dictated by Tibetan and Indian traders but in recent years, Tibetan traders have shown more interest in raw Satuwa rhizomes. A higher proportion of collected rhizomes are now traded to Tibet. Collectors or village traders transport Satuwa to district headquarters, where traders often visit themselves. The rhizomes are then transported to Tibet and India. A simplified market chain for Satuwa is given below:

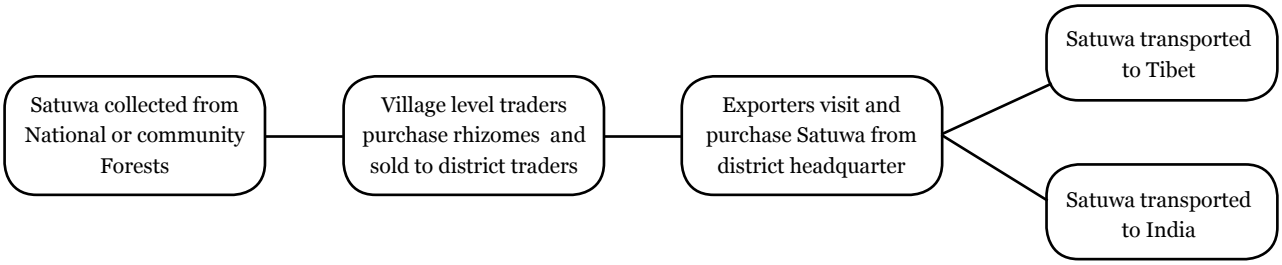


Figure 2.10.1: simplified market and supply chain of Satuwa

Major Issues

Over and premature collection for trade is a major issue. Due to a rise in prices, collectors have been harvesting the plant indiscriminately, affecting its sustainability in the long run. The increase in prices is due to Tibetan demand and it is not certain that this rise is sustainable. Collectors have been receiving fair prices in recent years but can get more if other value addition techniques can be applied, such as fair labelling of the product.

Conservation Status and Royalty

Unsustainable harvesting of rhizomes for trade endangers its population in the wild. The global conservation status of Satuwa is not known. IUCN and CAMP list Satuwa as vulnerable in Nepal (Shrestha and Joshi 1996, CAMP 2001). Tubers are collected from natural forests with the permission of District Forest Offices by paying a royalty of Rs.15 per kg.

SEABUCKTHORN

Hippophae salicifolia D. Don;

Hippophae tibetana Schlecht.

Seabuckthorn (*Hippophae* L.) is a small genus of shrubs and small trees belonging to family Elaeagnaceae. It is a west Himalayan Species (Stainton 1972). *Hippophae salicifolia* D. Don and *Hippophae tibetana* Schlecht. are widely distributed in sub-Himalayan regions of Nepal. Seabuckthorn is a multipurpose plant species having wide range of ecological, medicinal, ethno-botanical and commercial uses.

Habit

Hippophae salicifolia D. Don (**Common names**: Dale Chuk, Chichi; **English name**: Seabuckthorn; **Synonym**: *Hippophae conferta* Wallich) is a deciduous willow like thorny tree reaching up to 10m high. The barks are reddish brown in colour with deep longitudinal furrows. Leaves are short stalked, oblong to lanceolate, pubescent above and densely white-downy beneath, 3-7cm by 6-8mm, with star shaped hairs beneath. Male flowers are yellowish and appear as dense stalkless clusters. Female flowers are solitary appearing on leafless stems. Fruits are ovoid, yellowish red or orange in color, succulent, ranged along the stem and highly acidic. Flowering occurs from April to May and fruiting from October to March (Polunin and Stainton 1984, Manandhar 2002).

Hippophae tibetana Schlecht. (**Common names**: Bhuin Chuk, Taru, Tora, Chichisin; **English name**: Seabuckthorn; **Synonym**: *Hippophae rhamnoides* L. sub sp. *tibetana* (Schlecht.) Servett) is deciduous much dense shrublet (dwarf shrub), often reaching a height of 60cm. It has long terminal spines formed from the tips of old branches, and with small narrow elliptic leaves covered with rust colored scales. Leaves 1.5-2cm by 2-4mm. Flowers are stalkless, yellowish minute and unisexual. Inflorescence appears on leafless stems. Ripe fruits are orange red in color. Flowering occurs from April to June and Fruiting from August to September (Polunin and Stainton 1984).

Habitat and Distribution

H. salicifolia is found in gorges colonizing alluvial gravel, wet landslips and riversides in temperate and sub-alpine areas. It is distributed from Himanchal Pradesh to S.E. Tibet at altitudes ranging from 2000-3700 m asl. The plant species occurs on the fragile lands with weak soil composition and unfertile river fords. Newly emerging plants are grown abundantly along the fords where the associates are lacking. The

Hippophae salicifolia (Top row): a) colony; b) individual plant; and c) fruiting branch. Hippophae tibetana (bottom row): a) colony; b) fruiting branch; and c) fruiting branch close up

barren lands invade as the pioneer species of the secondary succession. *H. salicifolia* grows and flourishes within a short interval. It associates mainly with *Alnus nepalensis, Debregeasia salicifolia, Desmodium elegans, Pinus wallichiana, Populus* sp., *Princepia utilis, Randia* sp., *Rosa sericea* etc in the lower elevation whereas it mixes with *Abies spectabilis, Cedrus deodara, P. wallichiana, Taxus wallichiana, Tsuga dumosa* and even to *Betula utilis* on the higher elevations (Polunin & Stainton 1984, Rongsen 1992, Pyakurel 2001). *H. salicifolia* was recorded from Ramechhap, Dolakha, Sindhupalchowk Rasuwa, Kaski, Baglung, Myagdi, Gorkha, Manang, Mustang, Jajarkot, Kalikot, Dolpa, Jumla, Mugu, Humla, Bajura, Baitadi, Bajhang and Darchula districts.

Hippophae tibetana is distributed from Himanchal Pradesh to S.E. Tibet, Nepal, Sikkim (India), Bhutan and Southern China. It is distributed throughout the grasslands and on the river banks from sub-alpine to alpine regions of Nepal within the altitudinal range of 3300m to 4500m, but was recorded at altitude of 4800m on way to Larke Pass at Gorkha. It is found in the inner dry valleys of the Himalayas. *H. tibetana* is hardy species occurring frequently in Alpine tundra. These areas are covered by snow on winter and early spring so these are deciduous. Main associates of these species are *Anemone* sp., *Astragalus candolleanus, Berberis* sp., *Bistorta milletii, Caragana* sp., *Geranium* sp., *Iris* sp., *Juniperus indica, Lonicera spinosa, Myricaria rosea, Primula* sp., *Rhododendron anthopogon*, *Rosa* sp., *Salix* sp., *Sophora* sp (Polunin & Stainton 1984, Rongsen 1992, Pyakurel 2001, Pyakurel and Gurung 2006). *H. tibetana* was recorded from Taplejung, Sankhuasabha, Solukhumbu, Rasuwa, Gorkha, Manang, Mustang, Humla and Dolpa districts.

In Langtang area, *H. salicifolia* was recorded in Chandanbari, Dhunche- Sing Gompa (2400m), Sherpa Gaon-Langtang Range (2600m), Kyangjin- Langtang (3500m) and between Ghatte Khola and Deorali (2400m). Similarly, *H. tibetana* was recorded in Langtang valley (3960m), above Kyangjin (4000m) from the Langtang National Park and Buffer Zone Area (HMGN/MOFSC/DPR 1997).

Uses

Seabuckthorn is a multipurpose plant and often regarded as elixir to the Himalayas. It is also known as 'liquid gold plant' in Russia, China and Mongolia. Seabuckthorn is important plant of Himalayan region and has ecological, ethno-botanical and economical uses.

Ecological Importance: Seabuckthorn has a mighty and well-developed root system. A five year old plant can have 3 m deep taproot with horizontal feeder roots extending up to 6-10 m. Over 80% of the horizontal roots are in the top 0.2-0.8 m soil; helping to prevent erosion. Horizontal roots also have root turions (underground buds) which sprout and give rise to another plant. In this way a strong network of roots and plant population exists. It is this well developed root system that bolsters the plant to withstand drought climatic condition (Ghaffar 1994). Wider distribution and adaptation, extensive and well-developed root system, rapid regeneration, compact canopy and coverage are important attributes with which it protects soil from wind and water erosion. The plant species occurs on the fragile lands with weak soil composition and unfertile river fords where the associates are lacking. A symbiotic association of *Frankia*, an actinomycete, has been reported from root nodules of Seabuckthorn. This symbiotic association enables the plant to fix as much as 180kgof environmental Nitrogen/ha/annum (Rongsen 1992; Singh *et al.* 2001).

Local Use: Ripe berries are sour in taste and are eaten raw or processed to make homemade vinegar (Nepali: *Chuk*). Fruits of *H. tibetana* are used as a fixative for dyed clothes. The fruit juice is likewise suitable as a polish of metal objects (Pohle 1990). It is also used as fuel wood and timber in the cold desert areas Nepal Himalayas. Stems of *H. salicifolia* are used for making plough.

Medicinal Use: Hippophae oil is used in different life saving medicines. The drug preparations of *Hippophae* are used for healing wounds, treating burns, frost bite, eczema, ulcer, radiation burns of the skins, mucositis of mouth, rectum and vagina, etc (Singh 1999). The seed oil is highly expensive and reported to have anti-wrinkle and anti-cancer properties. The seed oil is also considered to be anti-inflammatory and anti-microbial and is used to treat mucositis, radiation damage, burns, ulcers etc (Xu 1999).

Fruit juice is used in cold and cough, fever, gastritis, blood and digestive system disorders. Fruit juice is used as appetite stimulant, blood purifier, diuretic, anthelmintic and tonic (Pohle 1990, Ghimire *et al*. 2008b). Fruits are also used in menstrual disorders (Pyakurel and Gurung 2006).

Commercial Use: Besides being medicinal, Seabuckthorn has important non-medicinal applications too. Seabuckthorn fruit juice and oil are already being used on the European countries, China and Mongolia for the production of more than 200 products including the edible juice, jam, jellies, confectionaries, shampoo cosmetic products, pharmaceutical products, etc. Production of Seabuckthorn juice has started since 1990s in trekking routes of Manang and Mustang district. Fruit juice collected from Seabuckthorn is mostly centralized in Kathmandu and juice are made and sold mostly in supermarkets. Some cottage industries of Karnali and Seti zones are producing Seabuckthorn juice on local level.

Chemical Composition

Major chemical compositions of Seabuckthorn seed are carbohydrate, lipid (fat) and proteins. Seed contains 10.85% (*H. salicifolia*) and 19.51% (*H. tibetana*) of oil. The oils have 11-18% saturated acids, 82-88% unsaturated fatty acids, Linoleic & Linolenic acids, Vitamin E, β-Carotene, etc.

Fruit contains soluble sugar (7.1%), organic acids (4.4%), Vitamins (Vitamin C, Vitamin E, Carotene), free amino acids, proteins (globulin, albumin, carotene), flavonoids, 27 elements and several bioactive substances and minerals (Rongsen 1992). Amongst all, Vitamin C content is very high in fruit, almost 5-100 times higher than any other fruits or vegetables.

Life Cycle

Seabuckthorn is a dioecious plant species with no distinct remarkable variation in the appearance of sexuality. Pollination is anemophilous. Sex of the plant is not clear till the flowering stage (Rongsen, 1990). Seabuckthorn propagates by seeds but can regenerate well by vegetative means. Vegetative propagation is facilitated by 'root turions' present in the horizontal roots. These root turions are capable to give rise to individual plant. Water is important for the growth of Seabuckthorn and is always found in the vicinity of water bodies. Seabuckthorn can thrive well in the regions which receive at least 400mm precipitation on a year but *H. tibetana* is reported to grow well in regions which receive 300mm precipitation per annum.

Cultivation

Cultivation of Seabuckthorn is not practiced in Nepal as it is abundant in the natural stage. It has been estimated that *H. salicifolia* is found in 2364 sq km area and *H. tibetana* is found in 830 sq. km area in Nepal (Ghimire *et al*. 2008a). However, few initiatives were taken towards the propagation of Seabuckthorn. Seabuckthorn is a pioneer species and grows on eroded soil but the propagation rate is higher in the moist soil. *H. salicifolia* and Apple are intercropped in some places with good results. *H. salicifolia* fixes the atmospheric nitrogen and is used by Apple, and Apple provides protection for Seabuckthorn. Plant can be propagated both from seeds and stem cuttings. But the rate of regeneration is faster in seed propagation than through stem cuttings.

Propagation by Seeds: Seeds are collected from mature, healthy trees during September-November (Bhadra-Kartik) for *H. salicifolia* and October-November (Ashwin-Kartik) for *H. tibetana*. The seeds are thoroughly washed with water and suspended pulps are removed. Then the seeds are sun dried for 1-2 days and stored in well aerated space. Artificial regeneration of Seabuckthorn is limited and little success has been achieved so far. The seeds collected should be transplanted in the similar location after germination. One kilogram of *H. salicifolia* contains 90,000 to 110,000 seeds, whereas same quantity of *H. tibetana* contains 50,000 to 70,000 seeds. The viability of the seeds is often less than two years. The germination rate from seeds in natural condition ranged between 60 to 75% (Pyakurel 2001, Pyakurel & Gupta 2004, SNV/WUPAP 2009).

Pretreatment of seeds for *H. tibetana*- Cold stratification of seeds for three months or, seeds dipped in the ice before sowing.

Pretreatment of seeds for *H. salicifolia*- The seeds are soaked in water for three days. The water should be changed regularly, once in a day. Alternatively, the seeds can be dipped in lukewarm water to accelerate the germination.

Pretreated seeds of both species are immersed in wet sand/loamy sand for about a week. Radicle and plumule emerges from the seed and are finally transplanted in the prepared nursery beds or in plastic poly bags. Alternatively, pretreated seeds can be directly sown in the nursery beds or in plastic polybags.

Propagation by Cuttings: Seabuckthorn can be propagated through stem or root cuttings. The stems or roots of mature plant (at least three years old) are cut into small parts (10-20cm) during February (second week of Magh to second week of Falgun). Most of the cuttings are selected from mature female plants, and few from the male plants. The cut lower parts are treated with growth promoting hormone and are immersed two-third of its length in prepared nursery beds on in the plastic poly bags. The cutting are regularly watered but care should be taken to prevent water lodging (Ghimire *et al.* 2008a, SNV/WUPAP 2009).

Yield: 450kg of *H. tibetana* fruits per hectare was recovered from natural forest in Lete and Kunjo VDCs of Mustang district. However, it has been estimated that under proper management, a hectare plantation can yield 750-1500kg fruits.

Sustainable Management

Seabuckthorn grows in the rural areas and it is hard to operate the management activities in those remote locations. Its wood is least preferred as fuel wood and people rarely use the wood for other household purposes. Forest fire is the major threat regarding the sustainability of Seabuckthorn. Commercial level collection has not been institutionalized but it was observed that the fruit was excessively collected in few places (for example-in Khambachen region of Kangchenjunga Conservation Area in 2008).

Harvesting Time: Fruits of *H. salicifolia* are collected during September-November (Bhadra-Karitk), and fruits of *H. tibetana* are collected during October-November (Ashwin-Kartik). However, the maturity time depends upon the altitude and geography of the location.

Harvest Method: Thorns of the stem causes difficulty in harvesting the Seabuckthorn fruits. Proper harvesting is further aggravated by extremely delicate nature of fruit pulp. Therefore, collectors used to collect the fruits early in the morning. Frost hardens the fruit pulp and there are less chances of juice loss when harvested early in the morning (*H. tibetana*). Cleanness of collector's hand is a matter of concern for the recovery of hygienic juice.

Fruits of *H. salicifolia* are collected by spreading the plastic or cloth below the plant and shaking the plant early in the morning (during winter). Long forceps are also used to collect the fruits of fruiting twigs. Fruits of *H. salicifolia* are harvested by bending the branches and plucking the fruits.

Due to the difficulty in harvesting the fruits, collectors often used to cut the whole branches (especially for *H. salicifolia*), which is the big concern for the sustainability of the species.

Harvest intensity: It will take about four to five years for Seabuckthorn to become mature and the plants yields fruits for the next 12-15 years. Fruits should be collected only from the mature plants. Quantification of harvestable stock should be assessed before issuing the collection permit. It has been estimated that 80% harvest of fruits from collection area is considered sustainable.

Value Addition

Cleansing and Storing: Soil, plant parts (leaf, thorn, stem, bark, flowers etc) and other particles are the common adulterations of the fruit, which should be cleaned off properly. Once properly cleaned, they can be stored for few days under controlled temperature (4-6°C). But the storing temperature should be even low if the fruits have to store for longer time. However, it should be noted that it is better to process the fruits as early as possible after collection. The piling of fruits is not possible due to the extremely delicate nature of fruits, therefore it is difficult to store the fruits in quantity.

Extraction of Juice: Peeling machine is commercially used to extract the fruit juice. It is the efficient way to extract juice from fruits. Traditionally, the juice was extracted by squeezing the juice by keeping it in the fine cloth. Alternatively, the juice can be extracted by squeezing the fruits in between the two wooden slabs. However, chances of juice loss are higher in this method.

The juice thus extracted is filtered with the help of fine cloth or steel net. The juice is then pasteurized by heating up to 80-90°C for five minutes. The pasteurized juice is preserved by adding Potassium Metabisulphite (KMS). Generally 1.5 gram of KMS is mixed with 1 kilogram of juice and kept in the plastic pet jars (peeling machine, pet jars and all other equipment should be cleaned with 1.5% KMS solution and 1.5% citric acid solution). The semi processed juice is now stored in cool, dry and dark areas. Contact with sunlight must be avoided. The semi processed can be stored for six months. Most of the collection centers situated in the rural areas transport the semi processed juice to Kathmandu.

Production of Processed Juice:

Water and sugar in appropriate quantity are mixed with the semi processed juice to prepare the processed Seabuckthorn juice. The acidity of Seabuckthorn varies according to the species and also depends on the habitat therefore the quantity of sugar and water should depend on the acidity of the semi processed juice. Table given below gives the appropriate mixture of sugar, water and semi processed juice.

The mixture of water and sugar should be boiled for 5-7 minutes. Semi processed juice is mixed after the mixture is cooled and additional 1 gram of KMS is added as preservative. The whole mixing process must be carried out in stainless steel container because acidity of juice

1.6 part sugar+1.4 part water+1 part semi processed juice; or
1.8 part sugar+1.2 part water+1 part semi processed juice

might deteriorate the quality of processed juice. The prepared juice is packed in well cleaned bottle and labeled accordingly and finally preserved in dark and cool place. The juice can be consumed within 12 months from the date of manufacture under well preserved condition.

Economic Analysis

Table 2.11.1 Fixed assets cost

SN	Particulars	Quantity	Rate	Total
1	Drum	1	2000	2000
2	Pet Jars	15	300	4500
3	Alcoholic thermometer	4	200	800
4	Big spoons	2	400	800
5	Refracto-meter	1	13000	13000
6	Pipes roll	½	3000	1500
7	Peeling machine	1	20000	20000
8	Weighing balance		2000	2000
9	Stainless steel utensils (40l capacity)	2	2500	5000
10	Miscellaneous (aprons, cloth etc)			2000
	Total fixed assets cost			**51600**

Cost of Production for Semi Processed Juice

The production cost for the semi processed juice is calculated as per the 100 liter production.

Table 2.11.2 Cost of production of semi processed juice

	Particulars	Quantity	Rate	Total
1	**Raw materials cost**			
	1.1 Crude fruit juice	100 liter	120	12000
	1.2 Firewood	2 bhari	300	600
	1.3 Potassium Meta bisulphate (at the rate of 1,5 gm per liter)	150 gram	250	37.5
2	**Labor cost**			
	2.1 For processing 100 liter per day	7 persons	300	2100
3	**Packaging cost**			
	Pet jars	5 nos	300	1500
4	**Administrative cost**			
	4.1 House Rent/ Space rent (Per month Rs 2000)	2 days	70	140
	4.2 Administrator cost (Per month Rs 9000)	2 days	300	600
	4.3 Office Helper (Per month Rs 6000)	2 days	200	400
	4.4 Electricity	L/s		50
	4.5 Water	L/s		30
	4.6 Miscellaneous			30
	4.7 Stationery	L/s		50
	4.8 Depreciation (Rs 51600)	Per day		141
Total cost				**17658.5**
	Per liter production cost			176.59
	Profit margin (20% of production cost)			35.32
	Transportation	Per liter		30
Per liter cost of semi processed juice				**241.9**

Prices given above are indicative and might vary according to the locality of production site, rate of unskilled manpower, transportation cost. Therefore local level producers needs to understand all those aspects before commencing the ventures, and plan accordingly.

Unit Production Cost of Processed Juice

The production cost for the processed juice is calculated as per the 100 liter production.

Table 2.11.3 Cost of production for processed juice

	Particulars	Quantity	Rate	Total
1	**Raw Materials' cost**			
	1.1 Semi processed juice	250 liter	242.9	60725
	1.2 Sugar	450 kg	65	29250
	1.3 KMS (at the rate of 1gm per liter	250 gm	240	60
	1.4 Firewood	10 bhari	300	3000
	1.5 Water			100
2	**Labor's cost**			
	2.1 Wage per day	20	300	6000
3	**Packaging Cost**			
	3.1 Juice Bottles	1000	10	10000
	3.2 Label Stickers	1000	5	5000
	3.3 Cartoon Box	100	10	1000
	3.4 Cartoon Tape	Ls		1000
4	**Administrative Cost**			
	4.1 Accountant (9000 per month)	10 days	300	3000
	4.2 Helper (6000 per month)	10 days	200	2000
	4.3 House rent	15 days		1000
	4.4 Electricity bill			400
	4.5 Telephone			200
	4.6 Stationary			500
	4.7 Miscellaneous			500
	4.8 Local transportation	1000 bottles	2.5	2500
	4.9 Promotional cost	1000 bottles	2	2000
5	**Depreciation**	**10**	**141**	**1410**
Sub total				**129645**
	Per liter factory cost (1 liter semi processed juice will make 4 liters of prepared juice)			129.645
	20% profit to the company			25.929
	Total price per bottle (of 1 liter)			155.574
	Selling price			180

Major Issues on Entrepreneurship and Trade

The consumer's price of Seabuckthorn juice is quite high as compared to the other soft drinks available in Nepal and therefore limited to few departmental stores and business malls. There is no established market chain for the Seabuckthorn semi processed juice and in the present scenario, no one (or very few) natural product manufacturers are involved in the production of Seabuckthorn Juice. This has created a monopoly market therefore semi processed juice producers who are located in the remotest areas of Nepal found extreme difficulty in finding the market.

Despite the multipurpose use, it is almost impossible to extract the Seabuckthorn seed oil with our current technology. There should be consorted effort to introduce such technologies which will optimize the use of natural resources.

Conservation Status and Royalty

Conservation status is not known. The fruits can be collected from national forests by paying Rs 5 per kg as royalty to the concerned district forest office.

SUGANDHAWAL/ SAMAYO

Valeriana jatamansii Jones

Valeriana jatamansii Jones (**Common names**: Sugandhawal, Samayo; **English names**: Indian valerian, True valerian; **Synonyms**: *V. wallichii* DC., *Nardostachys jatamansi* (Jones) DC.; **Family**: Valerianaceae) is a perennial herb found in the temperate belt of Nepal. Valerian oil, which is very expensive, is extracted from the rhizomes and roots of *Valeriana jatamansii* and has a wide range of medicinal and industrial uses. There are four species of *Valeriana* in Nepal out of which two have medicinal value: *V. jatamansii* Jones and *V. hardwickii* Wall., also known as false Valerian.

Habit

Valeriana jatamansii is a perennial rhizomatous aromatic herb that reaches up to 50cm in height. Leaves arise from the base of the stem (rosette) and are radical, long-stalked, ovate, heart-shaped, acute, toothed or wavy margined and measure 2.5-8cm across. The flowering stem also bears some small, almost-sessile, and entire or pinnate-lobed leaves. A cluster of small white or pink-tingled flowers arise on the erect stem. Flower clusters are 2.5-5cm across and fruits are crowned with persistent calyx. Flowers are bisexual with both male and female parts on the same plant. Rhizomes are 2-7cm long, yellowish-brown, woody, unbranched and aromatic, lying horizontal to the ground. Numerous long and slender fibrous roots arise from the rhizomes (Polunin and Stainton 1984, Manandhar 2002, Baral and Kurmi 2006, Ghimire *et al.* 2008a).

Habitat and Distribution

V. jatamansii is indigenous to the Chinese Himalayas. Geographically, it is distributed from Afghanistan, Kashmir, North-west India, Nepal, Sikkim, North-east India, Bhutan and Myanmar to SW China. It is found within an altitudinal range of 1500m to 3600m on north-facing moist forest bases and in open areas (Polunin and Stainton 1984). However, it is abundantly found between the altitudes of 1500 and 1700m in north-facing moist forests and shrubberies (Ghimire *et al.* 2008a). It is homogenously distributed throughout the Mahabharat range (from eastern to western Nepal) in the forests of Pangar (*Aesculus indica*), Okhar (*Juglans regia*), Jhule salla (*Picea smithiana*), Mayal (*Pyrus pashia*), Banjh (*Quercus lanata*), Lali guras (*Rhododendron arboreum*), and Lauth salla (*Taxus wallichiana*) (Ghimire *et al.* 2008a). It is found mostly in moist areas but rhizomes are bigger when the plant grows in semi-shaded areas.

It has been recorded from Langtang, Khamjing, Thulo Shyapru, Birdim, Cholangpati and Ghopte areas of Langtang National Park and Buffer Zone area.

Valeriana jatamansii, different stages

Uses

V. jatamansii has a wide range of medicinal and commercial uses. Roots and rhizomes are used in different medication systems (Ayurvedic, Tibetan, and Yunani). A paste of the plant is applied to boils. Roots are carminative, stimulant, and used for hysteria, insomnia, nausea, pimples, rheumatism and cholera. Juice of the roots is applied for headaches, sore throat, indigestion, and wounds, and is dropped in the eye for eye troubles (Manandhar 2002). Roots are used to relieve tension, anxiety, over-excitability and hysteria. It aids in the relief of cramps and intestinal colic and also menstrual pains. In Langtang, rhizomes are boiled in water and applied as massage on paining joints (Dangol 2002). Its roots and rhizomes are used as incense in houses and monasteries.

V. jatamansii has been used in Western countries for a variety of complaints such as nervous tension, restlessness, insomnia, migraine, dysmenorrheal, intestinal colic, rheumatism and as a pain reliever. In Europe, the oil has been used for cholera, epilepsy and for skin diseases. In China, it is used for backaches, cold, menstrual problems, bruises, and sores (Gurung 2009).

Valerian oil is extracted from the roots and rhizomes of V. jatamansii. Yield per centage of Valerian oil ranges from 0.09 per cent to 1.0 per cent on dry weight basis. The amount of Valerian oil varies on the age of the plant, habitat, and drying and storage methods. The oil has a wide range of therapeutic properties (anodyne, antidandruff, diuretic, antispasmodic, depressant of the central nervous system etc). It is also used in pharmaceutical preparations and as a fragrance and flavouring agent (Ghimire et al. 2008a &b, Gurung 2009).

Chemical Composition

New groups of iridoid (valtrates or valepotriats) have been isolated from the roots and rhizomes which are used as tranquillizers and sedatives (Tang *et al.* 2002). Roots and rhizomes contain flavonoids, alkaloids (chatinine and valerine), aliphatic acids, different steroids, phenols, saponins, naphtholic acid and tannins (Bos *et al.* 1997, Wasowski *et al.* 2002).

α-Pinene (14.5), limonene (0.8), 1,8-cineole (0.3), ρ-cymene (1.2), borneol acetate (7.2), borneol (4.5), nerolidol (1.0) and maaliol (11.6%) were isolated from valerian oil (Rastogi and Mehrotra 1993c). Other constituents are arcurcumene, α-, β- and γ-patchoulenes, calarene, β-bergamotene, α fenchene, β-sitosterol, valeranone, iso-valeric and β methyl-valeric acids. However, composition varies considerably depending on the origin of the plant material. Patchouli alcohol was the main component in the oils of Nepalese valerian. The other components identified in commercially-available rhizomes were γ- patchoulene, α- humulene, α- bulnesene, bornyl isovalerate, and two unidentified components with a retention index or 1431 and 1645 respectively. The patchouli alcohol, and β-and γ- patchoulenes, are considered to be characteristic for the oil of V. jatamansii as these compounds are not isolated from other *Valeriana* species (Bos *et al.* 1997, Gurung 2009).

Life Cycle

Sugandhawal is a slow-growing and long-living herb. It propagates both sexually by seeds and asexually. New coppices arise from the underground stem and the plant reproduces vegetatively. Young plants arising from rhizomes are called ramets. Plenty of new ramets arise from a mature plant and remain entangled. Above-ground parts of Sugandhawal die during winter but rhizomes remain dormant. Ramets arise from the rhizome after winter and develop as a new plant. Flowering occurs from February to June and fruiting from October to November (Ghimire *et al.* 2008a).

Cultivation

Sugandhawal can be propagated from seeds and rhizomes (with roots). It can be successfully cultivated within an altitudinal range of 1000m to 3000m on moist north-facing slopes and on the edges of cultivated land. It will grow better in places with warm summers and cold winters. It prefers loamy soil but can grow in a wide range of soil types. It grows well in soil with a pH scale of 4-6.4, 3.36-5.3 per cent of organic matter, 0.26-0.46 per cent of nitrogen, 2.24-2.46 kg per hectare of phosphorus and 600-811 kg per hectare of potash (CMAPSL 2004).

Propagation by Seeds: Seeds are collected in October-November from mature and healthy plants. These seeds are air-dried for a few days and kept in a dry cloth or cotton sac and stored in a cool dry place. Before sowing, seeds are pre-treated by immersing in running water for 12 hours to accelerate germination. One part of seed is mixed with five to six parts of nursery soil and sown in a prepared nursery in March-April. Seeds are very small; therefore, 10-15 grams of seeds can be sown in one ropani (5480 sq. ft; 493.2 sq. m). Seeds will germinate after seven to ten days of sowing. Four to five leaved seedlings are either transferred to polybags or left as such. But seedlings need to be removed from a crowded area to minimize competition.

Seeds can be directly implanted in polybags. For this, polybags are filled with nursery soil and two seeds implanted in each polybag. Seedlings are transplanted to the field after the plant grows to a height of 20 cm (Ghimire *et al.* 2008a).

Propagation by Rhizomes: Mature rhizomes are cut into small pieces ensuring the presence of a root in each piece and are planted in nursery beds or in polybags in April-May. Rhizomes can be directly planted in the field. The distance between two plants should be at least 30-40cm and between two rows 50-60cm. Regular watering and weeding is needed. Intercropping can be done with potato, buckwheat, and wheat (Ghimire *et al.* 2008a).

Rhizomes can be harvested two years after plantation. It has been estimated that 2,500kg of rhizomes can be harvested from one hectare under proper care.

Sustainable Management

Harvest Time and Method: Rhizomes should be collected only after the plant attains maturity i.e. from September to November. A very good indication of maturity is when the leaf's colour turns pale-yellow. Care should be taken while harvesting, which should follow a selective collection of matured rhizomes, leaving some part in the ground to facilitate vegetative propagation and replanting of younger ones. Plants should be thoroughly shaken to allow seed dispersal. Harvesting can be done with the help of a metallic axes (*kuto*) without damaging younger plants and other associated species.

Harvest Intensity: The collection area should be divided into four plots and harvesting should be done on a rotational basis. Only mature plants should be harvested, even if rotational system is followed. It is recommended to leave 25-40 per cent of rhizomes behind to promote vegetative reproduction. In case of cultivated Sugandhawal, farmers often remove all rhizomes and re-transplant after composting the soil.

Post Harvesting and Storage: Valerian oil is extracted from dried rhizomes of *V. jatamansii*. Content and quality of Valereian oil decreases if the rhizomes are not stored properly; therefore, care should be taken during storage. Rhizomes are thoroughly washed in water and suspended particles removed. Washing is generally done by

rinsing the rhizomes in spring water. Rhizomes are dried in the shade until they are free of moisture, and then kept in jute bags and stored in a cool dry place for later use.

Value Addition and Processing

Valerian oil is extracted from the rhizomes and roots of Sugandhawal. Rhizomes are mostly transported to processing units by district traders, or distillation unit operators (or managers) visit district headquarters or market centres and transport the products to processing units. Its processing involves a simple distillation unit. The processing technique is same as that of Timur and readers are requested to refer page no 58 for details. It takes 12-13 hours to extract one batch of Valerian oil.

Sugandhawal and Valerian Oil Market and Supply Shain

The demand for Sugandhawal rhizomes and Valerian oil is very high in India and Pakistan. It has been estimated that about 100 tonnes of Sugandhawal rhizomes is harvested annually from Nepal. But Olsen's 2005 study indicates that 67 to 345 tonnes of Sugandhawal rhizomes is annually exported from Nepal. The price is not uniform in the country and ranges between Rs.80 per kg in Bajura and Bajhang, Rs.110 per kg in Jumla, Rs.150 per kg in Kathmandu and Rs 190 in Nepalgunj (March 2011). Valerian oil is one of the most expensive essential oils among Nepalese product and price per kg ranges between Rs.38,000 and Rs.40,000.

The supply of Valerian oil is based on local resources such as supply of rhizomes, wood fuel, labour and expertise. Value addition takes place mostly in rural areas. Final processing of Valerian oil for different products is yet to be institutionalised. Income is shared among rural collectors, urban traders and exporters.

Most collected rhizomes are transported to district headquarters or nearby market centres by collectors/farmers themselves or village traders. District traders purchase and sell to essential oil entrepreneurs within the district, or outside the district to nearby Terai cities or Kathmandu. Oil extracted in hilly regions and the Terai is transported to Kathmandu or Nepalgunj and sold to traders/exporters. Traders sell the oil to exporters who are mostly stationed in Kathmandu or Nepalgunj. A simplified supply chain of Sugandhawal and Valerian oil in Nepal is given below:

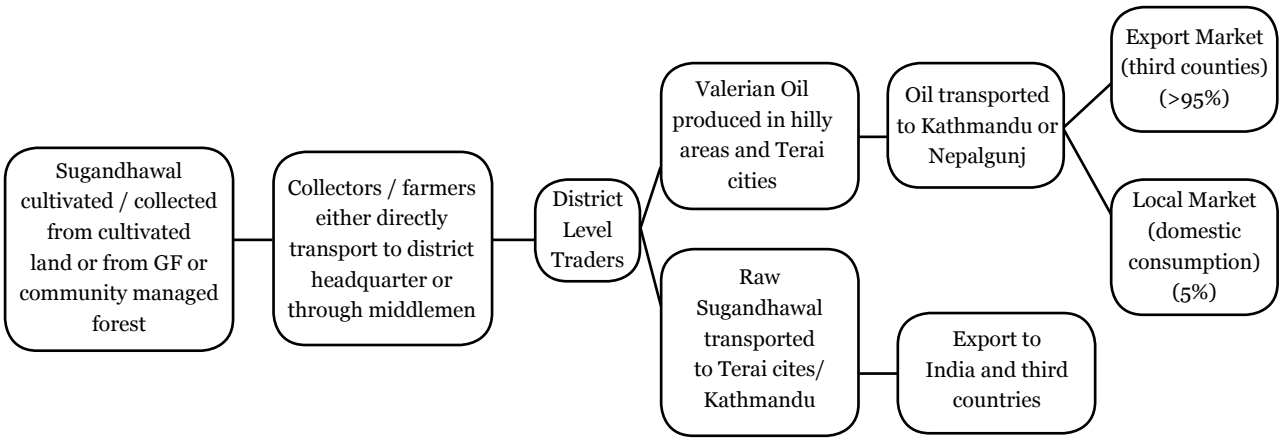


Figure 2.12.1: Supply and Market Chain of Sugandhawal and Valerian oil

Table 2.12.1 Cost Benefit Table for Production of one kilogram of Valerian Oil

Description	Rate (Rs)	Quantity	Amount
Rhizomes cost per batch*	100	300kg	30,000
Royalty (Royalty is waived for cultivated NTFPs)	15	300kg	4,500
Fuel (estimated)	35	12 bhari	420
Unit Operator	300	1	300
Helper	250	2	500
Miscellaneous (water, cleaning of DU)	100		100
Sub Total			**35,820**
Per kg production cost (@0.35 per cent oil content, 1.05 kg of oil extracted from a batch)			34,115
Market and Sale			
Risk and uncertainty cost (5 per cent of factory costs)			1,700
Transportation (often stationed in rural areas)	Lumpsum		70
Direct cost (per kg)			35,885
Price (selling) at Kathmandu*			38,000-40,000
Profit margin per kg excluding fixed costs and depreciation (Rs)			2,115-4,115

Economic Analysis

If dried and stored properly, Sugandhawal rhizomes can yield up to 1 per cent Valerian oil, but on average 0.2-0.5 per cent oil has been extracted at commercial levels. A collector can harvest 10kg of fresh rhizomes from the wild. Almost 40 per cent of the weight is lost while drying. Collection of Sugandhawal from the wild is a major income generation activity for people residing in the hills of Mid- and Far-western Nepal. It is a source of livelihood for disadvantaged groups and farmers with low land holdings.

Unit Production Cost

The unit production cost for one batch of Valerian Oil is given in table 2.12.1. Production costs may vary with the cost of raw materials (wood fuel and fruit) and manpower. Prices of raw materials quoted below are based on actual prices in September 2010. A stainless steel distillation unit of 1,000L is required to process 300kg of dried rhizomes. Details of cost are given in table 2.12.1

*Prices given are indicative only and entrepreneurs are suggested to re confirm the price before commencing any venture.

Fixed Capital

The fixed capital requirement to install a 1,000L stainless steel DU is almost the same throughout the country except for transportation costs. Similarly, costs for land improvement and factory construction are same as that of Timur. Total fixed capital comes to around Rs 397,350. Please refer to table 2.5.2 and page 61 for details on fixed capital.

Pre-operating Costs

Industry registration, market linkage costs, operator training and other hidden costs are allocated under pre-operating costs. All these costs are variable; it is very difficult therefore to estimate actual pre-operating costs. For instance Rs.20,000 has been assigned as training costs for the operator and Rs.15,000 for other costs, which come to Rs.35,000 as pre-operating costs.

Initial Working Capital

Production quantity determines working capital. Rural entrepreneurs do not always have enough working capital to run the unit throughout the year. Furthermore, the extraction of Sugandhawal is very expensive because rhizomes are priced higher. Production and sales should therefore be planned in such a way that each production cycle produces about 20 batches of Valerian oil (1.05 kg oil in each batch, refer to table 2.12.1) and the oil is sold at a time that enables entrepreneurs to prepare for the next cycle. Thus by multiplying Rs.35,885 (production cost per kg) with 21 kg (production in 20 batches), Rs.753,585 is required as initial working capital. Total investment for the establishment of a Valeran oil processing industry including production of the first 20 batches is Rs.1,185,935.

A comprehensive business plan has to be developed to provide guidelines for production. The arrangement of time line, responsibility assignments, methods of extraction, sustainable harvest quantities, amount of oil to be produced, financial assumptions, and profit are clearly identified and defined in the business plan, which is also obligatory for registering the industry.

Major Issues in Entrepreneurship and Trade

The processing of Sugandhawal requires more than Rs.1.1 million and its management might be a concern for rural entrepreneurs. There should be a mechanism in place which will provide loans, such as cooperatives.

Conservation Status and Royalty

The global status of Sugandhawal is not known. It is considered to be vulnerable in Nepal (CAMP 2001). Commercial collection of rhizomes for trade poses great threat to its sustainability in the wild. It has been incorporated in the protection list of the government of Nepal and has been prioritised for conservation and economic development (GoN/MOFSC/DPR 2006). The Department of Forest, as per Forest Act 1993 and Forest Regulation Act 1995, banned the export of raw Sugandhawal. However, large amounts of unprocessed air-dried rhizomes are illegally exported to India (Olsen 2005). Valerian oil can be exported after proper certifications and permissions from Department of Forests. Dried rhizomes of Sugandhawal have a royalty of Rs.15 per kg.

REFERENCES

Acharya D. 2006. Nepali Hate Kagajko Antarik Bazaar: Ek Charcha. *Smarika (Chhaithu Barshik Sadharan Sabha 2062 BS*. Nepal Hate Kagaj Sangh, Kathmandu, Nepal. (*In Nepali*)

Akiyama S., Yonekura K. and Ohba H. 1998. New Records and Treatment of Nepalese Flowering Plants. *Newsletter of Himalayan Botany*. **23**:18-25

ANSAB. 1997. *Forest Products Market/Enterprise Options Study. Final Report*. Asia Network for Small Scale Agricultural Bioresources (ANSAB), Kathmandu, Nepal.

ANSAB. 2003. *Commercially Important Non Timber Forest Products (NTFPs) of Nepal*. ANSAB (In Nepali)

Arnold J. E. M. & Pérez M.R. 2001. Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics*. **39**: 437-447.

Babu S. K., Srinivas P. V., Praveen B., Kishore S. K., Murty S. U. and Rao M. J. 2003. Antimicrobial constituents from the rhizomes of *Rheum emodi*. *Phytochemistry*. **62** (2): 203-207.

Banerji M. L. 1965. Contribution to the Flora of East Nepal. *Rec. Bot. Surv. India*. **19** (2): 1-90.

Banjade M. R. and Paudel N. S., 2008. Economic Potential of Non-timber Forest Products in Nepal: Myth or Reality? *Journal of Forest and Livelihood*. **7** (1): 36-48.

Barakoti T.P. 2000. Germination of chiraito (*Swertia chirata*) seeds tested through various methods under different conditions in the eastern hills of Nepal. In: *The Himalayan Plants, Can They Save Us?* (Watanabe T., Takano A., Bista M.S. & Saiju H.K., eds.). Society for the Conservation and Development of Himalayan Medicinal Resources (SCDHMR), Tokyo, Japan. 271-278.

Barakoti T.P. 2004. *Attempts Made for Domestication Conservation and Sustainable Development of Chiretta (Swertia chirayita)*. Nepal Agricultural Research Council, Agricultural Research Station, Pakhribas, Dhankuta, Nepal.

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

Basnet D.B. 1999. *Edgeworthia gardneri* Meissn. – a source of raw material of eco-friendly traditional hand-made paper of eastern Himalaya. *Ethnobotany*. **11**: 115-118.

Bhatt A., Rawal R.S. & Dhar U. 2006. Ecological features of a critically rare medicinal plant, *Swertia chirayita*, in Himalaya. *Plant Species Biology*. **21**: 49–52.

Bhattarai K.R. & Basnet B. 2000. Study of seed germination of Swertia chirayita: a step towards its domestication. In: *The Himalayan Plants, Can They Save Us?* (Watanabe T., Takano A., Bista M.S. & Saiju H.K., eds.). Society for the Conservation and Development of Himalayan Medicinal Resources (SCDHMR), Tokyo, Japan. 198-200.

Bhattarai S., Chaudhary R. P. and Taylor R. S. L. 2006. Ethnomedicinal plants used by the people of Manang district, Central Nepal. *Journal of Ethnobiology and Ethnomedicine*. **2**: 41.

Bird R., ed. 1991. *Focus on Plants. Volume 5*. Thompson and Morgan.

Bos R., Woerdenbag H.J., Hendriks H., Smit H.F, Wikström H.V. and Scheffer J.J.C. 1997. Composition of the essential oil from roots and rhizomes of Valeriana wallichii DC. *Flavour and Fragrance Journal*. **12**: 123-131.

BPP (Biodiversity Profiles Project), 1995h. *Biodiversity Profile of the High Mountain/High Himal Physiographic Zones*. Biodiversity Profile Project, Publication No. 14, DNPWC, Kathmandu, Nepal.

Branney P. 1994. *Community Forestry Guidelines Series. Guidelines for Managing Community Forests in the Koshi Hills* (2nd Edition). Nepal-UK Community Forestry Project.

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

Campbell B.M. & Luckert M.K. 2002. Towards understanding the role of forests in rural livelihoods. In: *Uncovering the Hidden Harvest: Valuation Methods for Woodland and Forest Resources* (Campbell B.M. & Luckert M.K., eds.). Earthscan, London. 1-16.

CECI. 2006. *Synthesis of Seminar Presentation and Discussions*. First National Trade Show and Seminar on Herbs, Herbal Products and Spices, 12-14 November 2005. Published by CECI March 2006.

Chapagain D. and Dhakal J. 2002. *Nepal ma CITES Karyanwayan*. Department of National Park and Wildlife Conservation, Kathmandu, Nepal. (*In Nepali*)

Chassot P. 2003. A new species of *Swertia* L. (Gentianaceae) from Nepal. *Botanical Journal of the Linnean Society*. **141**: 389-394.

Chaudhary R.P. 1998. *Biodiversity in Nepal -Status and Conservation*. Tecpress Books, Bangkok.

Chauhan N. S., Kaith B. S. and Mann S. K. 1992. Anti-inflammatory activity of *Rheum australe* roots. *International Journal of Pharmacognosy*. **30** (2): 93-96.

Chopra K. 1993. The value of non-timber forest products: an estimation for tropical deciduous forests in India. *Economic Botany*. **47**: 251-257.

CMAPSL. 2004. *Jadibuti Nursery, Kheti tatha Samrakshan. Digo Jibikoparjanko lagi Aausadhijanya tatha Telyukta Jadibutiko Samrakshan*. CECI, Kathmandu, Nepal. (*In Nepali*)

CSIR. 1986. *The useful plants of India*. Publications & Information Directorate, Council of Scientific and Industrial Research (CSIR), New Delhi, India.

Cunningham A.B. 2001. *Applied Ethnobotany: People, Wild Plant Use and Conservation*. Earthscan, London, UK.

Dangol B. R. 2002. *Forest Community Diversity and Associated Medicinal Plants in the Langtang National Park, Rasuwa, Central Nepal*. A M. Sc thesis submitted to Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, Nepal.

Dobremez J. F. 1976. *Le Nepal, Ecologie et Biogeographie (The Ecology and Biogeography of Nepal)*. Editions du Centre National de la Recherche Scientifique, Paris, France.

Duke J. A. and Ayensu E. S. 1985. *Medicinal plants of China*. Houghton Mifflin China. 90 - 91.

Dutt P. 1994. *Lokta (Daphne) Species: the Supply Situation in the Basantpur Area*. Nepal-UK Community Forestry Project, Kathmandu, Nepal.

Edwards D. M. 1996. *Non-Timber Forest Products for Nepal: Aspect of the Trade in Medicinal and Aromatic Plants*. FORESC Monograph 1/96, Forest Research and Survey Center, Ministry of Forests and Soil Conservation, Kathmandu.

FAO. 1995. Valuing Forest: Context, Issues and Guidelines, by Gregersen H.M., Arnold J.E.M., Lindgren A.L & Contreras– Hernosilla. *FAO Forestry Paper No 127, Rome*.

FAO. 1999. Towards a Harmonized Definition of Non Wood Forest Products. *Unasylva*. **50** (198): 63-64.

Farooqi A. A. and Sreeramu B. S. 2001. *Cultivation of Medicinal and Aromatic Crops*. Universities Press.

Ghaffar, A. 1994. Seabuckthorn, a Multipurpose Plant. *In: Proceedings of the International Seminar on Farming Systems Research in the Context of Food Security*, University of Arid Agriculture, Rawalpindi, Pakistan. 115-120.

Ghimire S.K., Lama Y.C., Tripathi G.R., Schmitt S. and Thomas Y.A. 2001. *Conservation of Plant Resources, Community Development and Training in Applied Ethnobotany at Shey-Phoksundo National Park and its Buffer Zone, Dolpa*. Report Series No 41. WWF Nepal, Kathmandu, Nepal.

Ghimire S.K., McKey D. & Aumeeruddy-Thomas Y. 2005. Conservation of Himalayan medicinal plants: Harvesting patterns and ecology of two threatened species, *Nardostachys grandiflora* DC. and *Neopicrorhiza scrophulariiflora* (Pennell) Hong. *Biological Conservation*, **124** (4): 463-475.

Ghimire S.K., Pyakurel D., Nepal B.K., Sapkota I.B., Parajuli R.R. & Oli B.R. 2008a. *A Manual of NTFPs of Nepal Himalaya (Gair Kastha Ban Paidawar Digdarshan)*. WWF Nepal, Kathmandu, Nepal. (*In Nepali*)

Ghimire S.K., Sapkota I.B., Oli B.R. and Parajuli-Rai R. 2008b. *Non Timber Forest Products of Nepal Himalaya: Database of Some Important Species Found in the Mountain Protected Areas and Surrounding Regions*. WWF Nepal, Kathmandu, Nepal.

Ghimire, S.K. & Nepal, B.K. 2007. *Developing a Community-Based Monitoring System and Sustainable Harvesting Guidelines for Non-Timber Forest Products (NTFP) in Kangchenjunga Conservation Area (KCA), East Nepal*. An unpublished report submitted to WWF Nepal.

Godoy R., Lubowski R. & Markandya A. 1993. A method for the economic valuation of non-timber tropical forest products. *Economic Botany* **47** (3):220-233.

GoN/MOFSC. 2006. *Sacred Himalayan Landscape- Nepal Strategic Plan* (2006-2016). Broad Strategy Document.

GoN/MOFSC/DoF. 2010. *Country Report- Nepal: State of Forestry in Nepal, A Synopsis Report*. Department of Forests.

GoN/MOFSC/DPR. 2006. *Prioritized Medicinal Plants for Economic Development in Nepal*. Department of Plant Resources, Ministry of Forest and Soil Conservation, Government of Nepal, Kathmandu. (*in Nepali*).

GoN/NPC. 2007. *Three year Interim Plan* (2007/08-2009/10). Government of Nepal/National Planning Commission.

Green G. 2001. *The Cannabis Grow Bible* (4th Edition). 47.

Grey C. H. 1938. *Hardy Bulbs*. Williams & Norgate.

Grimes A., Loomis S., Jahnige P., Burnham M., Onthank K., Alarcon R., Cunenca W.P., Martinez C.C., Nell D., Balick M., Bennett B. and Mendelsohn R. 1994. Valuing the Rainforest: the Economic Value of Non-timber Forest Products in Equador. *Ambio* **23** (7): 405- 410.

GTZ. 2007. *Handmade Paper in Nepal: Upgrading with Value Chain Approach*. Deutsche Gesellschaft fvr Technische Zusammenarbeit (GTZ) GmbH, German Technical Cooperation/ Private Sector Promotion-Rural Finance Nepal.

Gurung K. 2009. *Essential Oils in Nepal: A Practical Guide to Essential Oils and Aromatherapy*. Himalayan Bio Trade Pvt. Ltd., Kathmandu, Nepal.

Gurung K. and Pyakurel D. 2010. *Survey and Enumeration of Orchids in Jajarkot district*. A report submitted to District Forest Office, Jajarkot.

Gurung K. 2007. *Resource Assessment of Potential Non Timber Forest Products (NTFPs) for Commercialization in Langtang National Park and Buffer Zone (LNPBZ), WWF Nepal*. Final Report Submitted to Langtang National Park and Buffer Zone Support Project (LNPBZ SP).

Hagen T. 1998. *Nepal - The Kingdom in the Himalaya* (4th Edition). Himal Books, Lalitpur, Nepal.

Hammett A.L., 1993. Non-Timber Forest Products: Profits and Panacea. *In* Edwards D.M. and Bowen M.R. (eds) *Focus on Jaributi*. Forest Research and Survey Centre, Ministry of Forest and Soil Conservation, Kathmandu, Nepal. 2-3.

HANDPASS. 2003. *Lokta Production and Handmade Paper Making in Nepal-Problems and Way Forward'?* Kathmandu (Unpublished).

Hara H. 1966. *The Flora of Eastern Himalaya*. University of Tokyo, Japan.

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

HMGN/UNDP/FAO. 1977. *Langtang National Park Management Plan* (1977-82). HMGN/UNDP/FAO Project NEP/72/002, Kathmandu.

HMGN/ADB/FINNIDA. 1988. *Master Plan for Forestry Sector Nepal.* HMGN/ADB/FINNIDA, Ministry of Forest and Soil Conservation, HMGN, Kathmandu, Nepal (Main Report).

HMGN/IUCN. 1988. *The National Conservation Strategy for Nepal – Building on Success*. HMGN and IUCN-Nepal, Kathmandu, Nepal.

HMGN/MFSC. 2002. *Nepal Biodiversity Strategy*. HMGN/Ministry of Forest and Soil Conservation.

HMGN/MFSC/DMP, 1982. *Wild Edible Plants of Nepal.* Department of Medicinal Plants, Nepal, Bulletin No. 9. HMGN/MoFSC/DMP Kathmandu, Nepal.

HMGN/MOFSC/DMP. 1970. *Medicinal Plants of Nepal.* Bulletin of the Department of Medicinal Plants No.3. First edition. HMGN, Ministry of Forests and Soil Conservation, Department of Forestry and Plant Research. Thapathali, Kathmandu, Nepal.

HMGN/MOFSC/DPR .2004. *Non-Timber Forest Product Development Policy*. HMGN/Ministry of Forest and Soil Conservation/ Department of Plant Resources. Kathmandu, Nepal.

HMGN/MOFSC/DPR. 1997. *Flora of Langtang and Cross Section Vegetation Survey (Central Zone).* Bulletin of the Department of Medicinal Plants Nepal No. 6 (2nd Edition). HMGN/MoFSC/DPR Kathmandu, Nepal.

HMGN/MOFSC/FDP. 1993. Forest Act 1993. HMGN/Ministry of Forest and Soil Conservation/ Forestry Development Project. Kathmandu, Nepal.

HMGN/MOFSC/FDP. 1995. *Forest Regulations 1995.* HMGN/Ministry of Forest and Soil Conservation/Forestry Development Project. Kathmandu, Nepal.

HMGN/MoPE. 1998. *Environmental Strategies and Policies for Industry, Forestry and Water Resource Sectors, vol. 1 and 2*. HMGN, Ministry of Population and Environment, Kathmandu, Nepal.

HMGN/NPC. 1993. *The Nepal Environmental Policy and Action Plan (NEPAP)*. HMGN/National Planning Commission. Kathmandu, Nepal

http://www.pfaf.org

http://www.pfaf.org/user/default.aspx

Huxley A. 1992. *The New RHS Dictionary of Gardening*. MacMillan Press.

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

Jeanrenaud J.P. and Thompson I. 1986. *Daphne* (lokta), bark biomass production management implications for paper making in Nepal. *Commonwealth Forestry Review.* **65** (2): 117-130.

Jeanrenaud J.P. 1984 *Daphne (Lokta), Some Silvicultural Considerations*. A paper presented at the Department of Forest, Government of Nepal and UNICEF Lokta (Daphne) Forestry Policy and Planning Workshop-Seminar, 21 December 1984, 1-19.

Joshi P. and Dhawan V. 2005. *Swertia chirayita*- an overview. *Current Science.* **89** (4): 635-640.

Kalia N. K., Singh B. and Sood R. P. 1999. A new amide from *Zanthoxylum armatum*. *J Nat Prod.* **62**: 311–312.

Keil M., Hartle B., Guillaume A. & Psiorz M. 2000. Production of amarogentian in root cultures of *Swertia chirata*. *Planta Medica.* **66**: 452-457.

Khoshoo T. N. and Tandon S. R. 1963. Cytological, morphological and pollination studies on some Himalayan species of *Swertia*. *Caryologia*. 16: 445-477.

Kirtikar K. R. and Basu B. D. 1984. *Indian Medicinal Plants, Volume III*. Bishen Singh Mahendra Pal Singh, Dehradun.

Koba H., Akiyama S., Endo Y. and Ohba H. 1994. *Name List of Flowering Plants and Gymnosperms of Nepal, 1*. The University Museum, University of Tokyo, Japan.

Kunwar R.M. 2006. *Non-Timber Forest Products of Nepal: A Sustainable Management Approach*. Center for Biological Conservation Nepal and International Tropical Timber Organization, Japan.

Lange D. and Schippmann U. 1997. *Trade Survey of Medicinal Plants in Germany: A Contribution to International Plant Species Conservation*. Bundesamt für Naturschutz, Bonn

Manandhar N.P. 2002. *Plants and People of Nepal*. Timber Press, Portland, Oregon.

Medicinal Plant Specialist Group. 2007. *International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP)*. Version 1.0. Bundesamt für Naturschutz (BfN), MPSG/ SSC/IUCN, WWF Germany, and TRAFFIC, Bonn, Gland, Frankfurt, and Cambridge (BfN-Skripten 195).

Mehta M. B., Kharya M. D., Srivastava R. and Verma K. C. 1981. Antimicrobial and anthelmintic activities of the essential oil of *Zanthoxylum alatum* Roxb. *Ind Perfum*. **25** (2): 19–21.

Melnyk M. & Bell N. 1996. The direct-use values of tropical moist forest foods: the Huottuja (*Piaroa*) Amerindians of Venezuela. *Ambio*. **25**: 486-472.

NARMSAP/TISC, 2002. *Forest and Vegetation Types of Nepal*. Ministry of Forests and Soil Conservation/Natural Resource Management Sector Assistance Programme/ Tree Improvement and Silviculture Component.

Nautiyal B. P., Prakash V., Maithani U. C., Chauhan R. S., Purohit H. and Nautiyal M. C. 2003. Germinability, productivity and economic viability of Rheum emodi Wall. *ex* Meissn. Cultivated at lower altitude. *Current Science*. **84** (2): 143-148.

Nepstad D.C. and Schwartzman S. 1992. Non timber product extraction from tropical forests, evaluation of a conservation and development strategy. *Advances in Economic Botany*. **9**: 7-12.

NSCFP. 2001. *Participatory Inventory Guidelines for Non-Timber Forest Products*. Swiss Agency for Development and Cooperation (SDC), Nepal Swiss Community Forestry Project (NSCFP), Kathmandu, Nepal.

Olsen C.S. and Larsen H.O. 2003. Alpine medicinal plant trade and Himalayan mountain livelihood strategies. *The Geographical Journal*. **169**:243-254.

Olsen C.S. 2005. Quantification of the trade in medicinal and aromatic plants in and from Nepal. *Acta Horticulture*. **678**: 29-35.

Pant S.R. 2004. *Genetic Diversity in Swertia Species (Gentianaceae) of Nepal*. A M.Sc. Thesis submitted to Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, Nepal.

Peters. C.M., Gentry. A.H. and Mendelsohn. R.O. 1989. Valuation of an Amazonian rainforest. *Nature*. **339**: 655-656.

Phillips R. and Rix M. 1989. *Bulbs*. Pan Books.

Pohle P. 1990. *Useful Plants of Manang District*. Nepal Research Centre Publications No 16. Franz Steiner Verlag Wiesbaden GMBH, Stuttgart.

Polunin, O. and Stainton A. 1984. *Flowers of the Himalaya*. Oxford University Press.

Prajapati T.K., Rasaili N.K. & Neupane S.H. u.d. *Participatory NTFP Resources Assessment and Management*.

Prakrit. 2007. Sugandhit Tael Niryatma Dekhiyika Samasyaharu. *Prakrit* **3** (1): 9-15 (*in Nepali*)

Prasad B.N. 1999. Effect of GA3 on seed germination and seedling growth of *Swertia chirata* and its medicinal uses in Nepal. *Vasundhara* **4**: 93-96.

Prasai D. 2007. *Ethno medicinal Knowledge of Tamang Communities of Rasuwa District, Nepal*. A M.Sc Thesis submitted to Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, Nepal.

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

Pyakurel D. and Gupta V.N. 2004. Effect of temperature and gibberellic acid on seed germination and seedling growth of Seabuckthorn. *Scientific World*. **2** (2): 21-27

Pyakurel D. 2001. *Germination and Seedling Growth of Seabuckthorn (Hippophae L.) Seeds as Affected by Temperature and Gibberellic Acid*. A M.Sc Thesis submitted to Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, Nepal.

Pyakurel D. 2007. *Enterprise Development and Market Linkage Based on Non Timber Forest Products (NTFPs) of Kangchenjunga Conservation Area (KCA)*. A report submitted to Kangchenjunga Conservation Area Project / World Wildlife Fund (KCAP/WWF), Taplejung.

Pyakurel D. 2008. *Resource Assessment of Chiraito (Swertia chirayita) in Langtang National Park Buffer Zone Area*. A report submitted to LNPBZ-SP/WWF, Rasuwa.

Pyakurel D. 2010. *Resource Assessment and Value Chain Analysis of Lokta, Argeli and Dhasingre in selected Buffer Zone Community Forests of Nuwakot and Sindhupalchowk district of LNPBZ*. A report submitted to Langtang National Park Buffer Zone Area Support Programme / World Wildlife Fund (LNPBZ-SP/WWF), Rasuwa.

Pyakurel D. and Gurung K. 2006. *Identification and Inventory of Non Timber Forest Products (NTFPs) of Manaslu Conservation Area*. A report submitted to National Trust for Nature Conservation / Manaslu Conservation Area Project (NTNC / MCAP), Gorkha.

Raina R., Johri A.K. and Srivastava L.J. 1994. Seed germination studies in *Swertia chirata* L. *Seed Res*. **22**: 62–63.

Rajbhandari K.R. 2001. *Ethnobotany of Nepal*. Ethnobotanical Society of Nepal (ESON), Kathmandu, Nepal.

Rastogi R.P. and Mehrotra B.N. 1993a. *Compendium of Indian Medicinal Plants, Volume* 1, 1960-1969. Central Drug Research Institute, Lucknow and Publications and Information Directorate, New Delhi, India.

Rastogi R.P. and Mehrotra B.N. 1993b. *Compendium of Indian Medicinal Plants, Volume* 2, 1970-1979. Central Drug Research Institute, Lucknow and Publications and Information Directorate, New Delhi, India.

Rastogi R.P. and Mehrotra B.N. 1993c. *Compendium of Indian Medicinal Plants, Volume* 3, 1980-1984. Central Drug Research Institute, Lucknow and Publications and Information Directorate, New Delhi, India.

Rongsen L. 1990. *Seabuckthorn Resources and its Underexploited Potential in the Himalayan Region*. ICIMOD MFS series no.12, Kathmandu, Nepal.

Rongsen L. 1992. *Seabuckthorn; A Multipurpose Plant Species for Fragile Mountains*. ICIMOD occasional paper no. 20, Kathmandu, Nepal.

Schippmann U., Leaman D. and Cunningham A.B. 2006. Cultivation and wild collection of medicinal and aromatic plants under sustainability aspects. *In*: Bogers R.J., Craker L.E., and Lange D. (eds). *Medicinal and Aromatic Plants*. Springer, Dordrecht. Wageningen UR Frontis Series no. 17. (http://library.wur.nl/frontis/medicinal_aromatic_plants/05_schipmann.pdf)

Sharma B.K. 2009. *Status of potential Non-timber Forest products (NTFPs) for wise use and conservation in the eastern part of Langtang National Park's Buffer Zone, WWF Nepal*. A Report Submitted to Langtang National Park and Buffer Zone Support Project (LNPBZ SP).

Shrestha K. K., Sah J. P. and Ghimire S. K. 1995. *Ecology, Exploitation Trend and Conservation*

of Potential High Altitude Medicinal Plants in Gyasumdo Valley, Manang. A report submitted to Annapurna Conservation Area Project (ACAP), King Mahendra Trust for Nature Conservation, Kathmandu, Nepal.

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

Shrestha T.B. 1984-85. Indigenous Gymnosperms. *In* Majupuria T.C. (ed) *Nepal Nature's Paradise*. Craftsman Press, Bangkok. 252-260.

Shrestha U. and Shrestha S. 2004. *Major Non Timber Forest Products of Nepal*. Bhundipuran Prakasan, Kathmandu, Nepal. (*In Nepali*)

Singh N. P., Gupta A. P., Sinha A. K. and Ahuja P. S. 2005. High-performance thin layer chromatography method for quantitative determination of four major anthraquinone derivatives in *Rheum emodi*. *Journal of Chromatography* **A**. 1077: 202-206.

Singh S. K. 1999. *Hippophae*: A Medicinal Plant from Eroded Areas. *Amruth*. Fritz.

Singh V., Nayyar H. and Uppal R. 2001. Germination behavior of different biotypes of Seabuckthorn (*Hippophae rhamnoides, H. salicifolia and H. tibetana*) growing in dry temperate Himalayas. *International Workshop on Seabuckthorn*. India International Centre, New Delhi.

SNV/WUPAP 2009. *Seabockthorn Kheti, Byabasthapan ra Prasodhan Bidhi*: Shrot Pustika. SNV/WUPAP. (*In Nepali*)

Stainton J.D.A. 1972. *Forests of Nepal*. John Murray, London.

Subedi B. 2006. *Linking Plant-Based Enterprises and Local Communities to Biodiversity Conservation in Nepal Himalaya*. Adroit Publishers, New Delhi, India.

Tang Y., Liu X. & Yu B. 2002. Iridoids from the rhizomes and roots of *Valeriana jatamansi*. *Journal of Natural Products*. **65** (12):1949-1952.

Thapa P. 2003. *Financial Analysis of Allo Based Micro Enterprise and Its Impact on Livelihood of Rural Community of Parbat District*. A research report submitted for the partial fulfillment of the requirement of the Degree of Bachelor of Science in Forestry, IOF Pokhara.

Thomas. G. S. 1990. *Perennial Garden Plants*. J. M. Dent & Sons, London.

Tiwary M., Naik S.N., Tewary D. K., Mittal P.K. and Yadav S. 2007. Chemical composition and larvicidal activities of the essential oil of *Zanthoxylum armatum* DC (Rutaceae) against three mosquito vectors. *J Vect Borne Dis*. **44**: 198-204

Walter S. 1998.The Utilization of Non Timber Forest Products in the Rainforests of Madagaskar: A Case Study. *Plant Research and Development*. **47/48**: 121-144.

Warrier P. K., Nambiar V. P. K. and Ramankutty C. (eds). 1994-1996. *Indian Medicinal Plants* Vol 1-5. Orient Longman Limited, Hyderabad, India.

Wasowski C., Marder M., Viola H., Medina J.H. and Paladini A.C. 2002. Isolation and identification of 6-methylapigenin, a competitive ligand for brain GABAA receptors, from *Valeriana wallichii*. *Planta Medica*. **68**: 934-936.

WCMC. 1994. *Priorities for Conserving Global Species Richness and Endemism*. *In*: Caldecott J.O., Jenkins M.D., Johnson T. and Groombridge B. (eds). World Conservation Press, Cambridge, UK.

WHO. 2002. *WHO Traditional Medicine Strategy 2002-2005*. World Health Organization, Geneva.

Wickens G.E. 1991. Management issues for development of non-timber forest products. *Unasylva*, **42** (165): 3-8.

Xu M. 1999. The medical research and exploitation of Seabuckthorn. *Hippophae* **7**: 32-34.

SN		Nepali/ Local Name	Scientific Name	Family	Distribution	Parts Used
1	Aank	आँक	*Calotropis gigantea*	Asclepiadaceae	100-1000	Root, root bark, leaf, latex
2	Ainselu	ऐंसैलु	*Rubus ellipticus*	Rosaceae	1200-2500	Fruit, root
3	Akarkara	अकरकरा	*Anacyclus pyrethrum*	Compositae	1800-2500	Root
4	Allo	अल्लो	*Girardinia diversifolia*	Urticaceae	1700-3000	Leaf, stem, bark
5	Amala	अमला	*Phyllanthus emblica*	Euphorbiaceae	150-1400	Fruit
6	Amriso	अम्रिसो	*Thysanolaena maxima*	Gramineae	500-2000	Stem, flower
7	Ander	अडेर	*Riccinus communis*	Euphorbiaceae	150-2400	Seed
8	Argeli	अर्गेली	*Edgeworthia gardneri*	Thymelaeaceae	1500-3000	Bark
9	Asuro	असुरो	*Justicia adhatoda*	Acanthaceae	500-1600	
10	Attis	अतिस	*Aconitum heterophyllum*	Ranunculaceae	2400-4100	Root, Rhizome
11	Attis	अतिस	*Delphinium himalayai*	Ranunculaceae	3000-4500	Root
12	Babari	बावरी	*Ocimum basilicum*	Labiateae	300-1500	Leaf and young aerial parts
13	Bael	बेल	*Aegle marmelos*	Rutaceae	100-1100	Fruits
14	Baet	बेत	*Calamus latifolius*	Palmae	100-1000	Stem
15	Bajradanti	बज्रदन्ती	*Potentilla fulgens*	Rosaceae	1700-4800	Root
16	Ban jira	वन जिरा	*Heracleum nepalense*	Umbelliferae	1800-3700	Flower, fruit
17	Ban Lasun/Jimbu jhar	बन लसुन/जिम्बु झार	*Allium wallichii*	Amaryllidaceae	2400-4700	Root, leaf
18	Ban Silam/Chhinak	वन सिलाम/चिनाक	*Elsholtzia flava*	Labiateae	1600-3000	Seeds
19	Daar	दार	*Boehmeria rugulosa*	Urticaceae	300-1700	Bark
20	Ban tarul/Gittha	वन तरुल/गीठ्ठा	*Dioscorea bulbifera*	Dioscoreaceae	150-2100	Underground parts
21	Baramase chutro	बारमासे चुत्रो	*Berberis wallichiana*	Berberidaceae	2000-3300	Fruit, bark, leaf
22	Barro	हर्रो	*Terminalia bellirica*	Combretaceae	300-1100	Fruit
23	Batulopate/Gudargano	बाटुलोपाते/गुदर्गानो	*Cissampelos pareira*	Menispermaceae	150-2200	Root
24	Bayer	बयर	*Ziziphus mauritiana*	Rhamnaceae	200-1200	Fruit
25	Bhaki amilo	भकी अमिलो	*Rhus javanica*	Anacardiaceae	1300-2400	Fruit
26	Bhale chiraito	भाले चिराइतो	*Swertia angustifolia*	Gentiniaceae	600-2600	Whole plant
27	Bhale sunpati	भाले सुनपाती	*Rhododendron lepidotum*	Ericaceae	2100-4600	Leaf, flower
28	Bhang/Ganja	भाँङ्ग/गाँजा	*Cannabis sativa*	Cannabaceae	200-2700	All except root
29	Bhimal	भिमाल	*Grewia optiva*	Tiliaceae	150-1800	Bark
30	Bhojpatra	भोजपत्र	*Betula utilis*	Betulaceae	2700-4300	Bark
31	Bhorla	भोर्ला	*Bauhinia vahlii*	Leguminosae	200-1300	Tender pods, leaves, seeds

SN		Nepali/ Local Name	Scientific Name	Family	Distribution	Parts Used
32	Bhringiraj	भृङ्गराज	*Eclipta prostrata*	Compositae	200-1200	Whole plant
33	Bhuinchuk	भुईंचुक	*Hippophae tibetana*	Elaeagnaceae	3300-4500	Fruit
34	Bhutkesh	भुतकेश	*Selinum wallichianum*	Umbelliferae	2700-4800	Whole plant
35	Bilaune	बिलौनी	*Maesa chisia*	Myrsinaceae	1200-2600	Root bark
36	Bisfej	विषफेज	*Polypodium vulgare*	Polypodiaceae	1200-3200	Rhizome
37	Bish	बिष	*Aconitum novoluridum*	Ranunculaceae	4200-5000	Root, Rhozome
38	Bish	विष	*Aconitum spicatum*	Ranunculaceae	3300-4300	Root, flower, leaf
39	Bishma	विषमा	*Aconitum bisma*	Ranunculaceae	3000-4800	Root, Rhozome
40	Bojho	बोझो	*Acorus calamus*	Araceae	200-2300	Root
41	Budo/Thulo Aushadhi	बुढो/ठुलो औषधि	*Astilbe rivularis*	Saxifragaceae	1800-2100	Rhizome
42	Chabo	चाबो	*Piper chaba*	Piperaceae	100-1500	Dried spike
43	Chhatiwan	छतिवन	*Alstonia scholaris*	Apocynaceae	60-500	Bark
44	Chiraito	चिराइतो	*Swertia alata*	Gentiniaceae	2000-3600	Whole plant
45	Chiraito	चिराइतो	*Swertia petiolata*	Gentiniaceae	3300-4500	Whole plant
46	Chiraito	चिराइतो	*Swertia racemosa*	Gentiniaceae	3000-5000	Whole plant
47	Chiraito, Kalen	चिराइतो, कालेन	*Swertia ciliata*	Gentiniaceae	2800-4000	Whole plant
48	Chiraito, Tite	चिराइतो, तिते	*Swertia chirayita*	Gentiniaceae	1500-3000	Whole plant
49	Chiuri	चिउरी	*Diploknema butyracea*	Sapotaceae	300-1500	Fruits
50	Chutro	चुत्रो	*Berberis aristata*	Berberidaceae	1800-3500	Fruit, bark, leaf
51	Chutro	चुत्रो	*Berberis asiatica*	Berberidaceae	1200-2500	Fruit, bark, leaf
52	Dalechuk	डालेचुक	*Hippophae salicifolia*	Elaeagnaceae	2000-3700	Fruit
53	Devdar	देवदार	*Cedrus deodara*	Pinaceae	1900-2700	Leaf, seed
54	Dhasingre/Patpate/ Macchino	धसिंग्रे/पटपटे/मछिनो	*Gaultheria fragrantissima*	Ericaceae	1200-2700	Leaf
55	Dhatelo	धटेलो	*Prinsepia utilis*	Rosaceae	1500-2900	Seed
56	Dhaturo/ Kalo dhaturo	धतुरो/कालो धतुरो	*Datura metel*	Solanaceae	1000-2500	Seeds
57	Dhayaro	धँयारो	*Woodfordia fruticosa*	Lythraceae	200-1800	Leaf, flower
58	Dhup jadi	धूपजडी	*Jurinea dolomiaea*	Compositae	3200-4300	Root
59	Dron puspi	द्रोण पुष्पी	*Leucas cephalotes*	Labiatae	150-2400	Whole plant
60	Eklebir	एक्लेविर	*Lobelia pyramidalis*	Campanulaceae	1100-2300	Leaf, flower
61	Furke pat	फुर्के पात	*Wikstroemia canescens*	Thymelaeaceae	1800-3200	Bark
62	Fusre dhupi	फुस्रे धूपी	*Juniperus recurva*	Cupressaceae	2500-4600	Wood, leaf, fruit

SN		Nepali/ Local Name	Scientific Name	Family	Distribution	Parts Used
63	Gamdol	गामडोल	*Brachycorythis obcordata*	Orchidaceae	1000-2000	Rhizome
64	Gandhaino/Gadalno	गन्धाइनो/गदाल्नो	*Pleurospermum dentatum*	Umbelliferae	3200-4500	Root
65	Ghangaru	घङ्गारु	*Pyracantha crenulata*	Rosaceae	1000-2500	Fruits
66	Ghode machha	घोडा मर्चा	*Thymus linearis*	Labiateae	1500-4300	Whole plant
67	Ghodtapre/Brahmi	घोड्तापे्र/ब्राम्ही	*Centella asiatica*	Umbelliferae	500-2100	Whole plant
68	Ghuikumari	घ्यु कुमारी	*Aloe vera*	Liliaceae	1200-1400	Leaf
69	Guchi chyau	गुच्ची च्याउ	*Morchella conica*	Morchellaceae	2000-3500	Whole plant
70	Gujar gano	गुजर गानो	*Stephania glandulifera*	Menispermaceae	1100-2500	Root
71	Gurjo	गुर्जो	*Tinospora sinensis*	Menispermaceae	100-500	Stem
72	Hadchur	हडचुर	*Viscum album*	Loranthaceae	600-2300	Fruit, root
73	Harro	बर्रो	*Terminalia chebula*	Combretaceae	150-1100	Fruit
74	Indrajau	इन्द्रजौ	*Holarrhena pubescens*	Apocynaceae	100-1500	Bark, seed
75	Indreni/Lahare aamp	इन्द्रेणी, लहरे आँप	*Trichosanthes tricuspidata*	Cucurbitaceae	1200-2300	Seed
76	Jaitun	जैतुन	*Olea cuspidata*	Oleaceae	100-2600	Seeds
77	Jamanemanro	जमानेमान्द्रो	*Mahonia napaulensis*	Berberidaceae	2000-2900	Fruit
78	Jamun	जामुन	*Syzygium cumini*	Myrtaceae	300-1200	Fruits, Bark
79	Jatamansi	जटामसी	*Nardostachys grandiflora*	Valerianaceae	3600-5000	Rhizome
80	Jhyau (Lichen)	झ्याउ	*Parmelia sp*	Parmeliaceae	1000-3000	Whole plant
81	Jimbu	जिम्बु	*Allium hypsistum*	Amaryllidaceae	4000-5000	Leaf
82	Kadi patta	कडी पत्ता	*Murraya koenigii*	Rutaceae	100-1400	Leaves
83	Kafal	काफल	*Myrica esculenta*	Myricaceae	1200-2300	Fruit, bark
84	Kage Lasun	कागेलसुन	*Allium carolinianum*	Amaryllidaceae	3300-5100	Root, leaf
85	Kakad singhi	काकडसिंगी	*Pistacia chinensis subsp.integerrima*	Anacardiaceae	1500-2100	Leaf gall
86	Kakoli	काकोली	*Fritillaria cirrhosa*	Liliaceae	3000-4600	Root, Rhizome
87	Kaladana/Hatti paila	कालादाना/हात्ती पाइला	*Eulophia dabia*	Orchidaceae	2000-3100	Rhizome
88	Kalo bikhma	कालो विषमा	*Aconitum laciniatum*	Ranunculaceae	3800-4600	Root, Rhozome
89	Kalo chiraito	कालो चिराइतो	*Swertia nervosa*	Gentiniaceae	700-3000	Whole plant
90	Kalo dhupi	कालो धुपी	*Juniperus indica*	Cupressaceae	3000-4600	Wood, leaf, fruit
91	Kande dhupi	काँडे धुपी	*Juniperus squamata*	Cupressaceae	3000-4500	Wood, leaf, fruit
92	Kapase ful	कपासेफूल	*Saussurea gossypiphora*	Compositae	3500-5700	Root, flower
93	Katush	कटुस	*Castanopsis indica*	Fagaceae	1200-2900	Fruit

SN		Nepali/ Local Name	Scientific Name	Family	Distribution	Parts Used
94	Kaulo	काउलो	*Persea odoratissima*	Lauraceae	1500-2100	Bark
95	Ketuki	क्यातुकी	*Agave cantula*	Agavaceae	500-3700	Leaf
96	Kharane	खराने	*Symplocos ramosissima*	Symplocaceae	1400-3000	Seed oil
97	Khas khas	खस खस	*Vetiveria zizanioides*	Gramineae	300-1000	Rhizome
98	Khayar/ Cutch	खयर	*Acacia catechu*	Leguminosae	200-1400	Stem extract
99	Khiraula	खिरौला	*Lilium nepalense*	Liliaceae	2200-3400	Rhizome
100	Khote salla	खोटे सल्ला	*Pinus roxburghii*	Pinaceae	900-2100	Resin, leaf
101	Koiralo	कोईरालो	*Bauhinia variegata*	Leguminosae	150-2000	Flower
102	Kumkum/Kiya	कुमकुम/किया	*Didymocarpus villosus*	Gesneriaceae	900-2500	Fruit, stem
103	Kurilo/Satavari	कुरिलो/सतावरी	*Asparagus racemosus*	Liliaceae	150-2100	Root, tendril
104	Kusum	कुसुम	*Schleichera oleosa*	Sapindaceae	100-300	Fruit, Seed, Bark
105	Kutki, Katuki	कुट्की, कटुकी	*Neopicrorhiza scrophulariiflora*	Scrophulariaceae	3600-4800	Root, Rhozome
106	Laghu patra	लघुपत्र	*Podophyllum hexandrum*	Berberidaceae	2400-4500	Root, Rhozome
107	Lali guras	लाली गुराँस	*Rhododendron arboreum*	Ericaceae	1500-3600	Leaf, flower
108	Lapsi	लप्सी	*Choerospondias axillaris*	Anacardiaceae	1200-1500	Fruit
109	Lauth salla	लौठ सल्ला	*Taxus wallichiana*	Taxaceae	2400-3400	Leaf
110	Lokta	लोक्ता	*Daphne bholua*	Thymelaeaceae	2000-3100	Bark
111	Lokta	लोक्ता	*Daphne papyracea*	Thymelaeaceae	1500-2300	Bark
112	Madhu bish	मधु विष	*Aconitum gammiei*	Ranunculaceae	3300-4300	Root, Rhozome
113	Maharangi	महारँगी	*Arnebia benthamii*	Boraginaceae	2800-3800	Root
114	Maharangi	महारँगी	*Maharanga bicolor*	Boraginaceae	2100-3000	Root
115	Maharangi	महारँगी	*Maharanga emodi*	Boraginaceae	2200-4500	Root
116	Maikopila	माईकोपिला	*Saussurea tridactyla*	Compositae	4500-5800	Seed
117	Majitho	मजिठो	*Rubia manjith*	Rubiaceae	1200-2100	Stem, root
118	Malingo	मालिङ्गो	*Yushania maling*	Gramineae	2500-3000	Stem
119	Mallo	मलो	*Viburnum mullaha*	Sambucaceae	1800-2700	Fruit
120	Mangan, Jinseng	मन्गान, जिन्सेङ	*Panax pseudo-ginseng*	Araliaceae	2100-4200	Whole plant
121	Mauro mulo	मौरो मुलो	*Delphinium brunonianum*	Ranunculaceae	4300-5500	Whole plant
122	Mayal	मयल	*Pyrus pashia*	Rosaceae	750-2700	Leaf, fruit
123	Museli	मुसली	*Curculigo orchioides*	Hypoxidaceae	400-1700	Rootstock
124	Musure katush	मुसुरे कटुस	*Castanopsis tribuloides*	Fagaceae	1200-1800	Fruit

SN	Nepali/ Local Name	Scientific Name	Family	Distribution	Parts Used
125 Nagbeli	नागबेली	*Lycopodium clavatum*	Lycopodiaceae	1200-3500	Pollen
126 Nakkali sugandhawal	नक्कली सुगन्धवाल	*Valeriana hardwickii*	Valerianaceae	1200-4000	Root, Rhozome
127 Neem	नीम	*Azadirachta indica*	Meliaceae	up to 900	Leaf, bark, seed, fruit
128 Nigalo	निगालो	*Drepanostachyum falcatum*	Gramineae	1500-2700	Stem, tendril
129 Nilo bish/Nirbisi	निलो विष/निर्विसी	*Delphinium denudatum*	Ranunculaceae	1500-2700	Root
130 Nirbisi	निर्विसी	*Parnassia nubicola*	Parnassiaceae	2900-4200	Root, Rhozome
131 Nundhiki	नुनढिकी	Osyris wightiana	Santalaceae	1100-2600	Leaf
132 Nyuro/Kalo nyuro	न्युरो/कालो न्युरो	*Diplazium sp*	Dryopteridaceae	1100-3000	Tender fronds
133 Okhar	ओखर	*Juglans regia*	Juglandaceae	1200-3000	Fruit, bark
134 Paani Amala	पानी अमला	*Nephrolepis cordifolia*	Dryopteridaceae	500-2400	Root tubers
135 Padam puskar	पदम पुष्कर	*Iris decora*	Iridaceae	1800-4000	Leaf, seed, flower
136 Padamchal	पदमचाल	*Rheum acuminatum*	Polygonaceae	3200-4000	Rhizome, stem
137 Padamchal	पदमचाल	*Rheum nobile*	Polygonaceae	3900-5000	Rhizome, stem
138 Padamchal, Chulthi amilo	पदमचाल, चुल्ठी अमिलो	*Rheum australe*	Polygonaceae	3000-4200	Rhizome, stem
139 Pakhanved/Pashanved	पाखनवेद/पाषणभेद	*Bergenia ciliata*	Saxifragaceae	1600-3600	Rhizome, Rootstock
140 Panchaaule	पाँचऔंले	*Dactylorhiza hatagirea*	Orchidaceae	2800-4000	Root
141 Pangar/Pangra	पाँगर/पाङ्ग्रा	*Aesculus indica*	Hippocastanaceae	1900-2400	Seed, wood
142 Patina	पतिना, पुदिना	*Mentha spicata*	Labiateae	1800-2700	Leaves
143 Pipla	पिप्ला	*Piper longum*	Piperaceae	200-800	Root, Dried Spike, Fruits
144 Punarnava	पुनर्नवा	*Boerhavia diffusa*	Nyctaginaceae	300-1200	Leaves, shoots, roots
145 Rajbrikshya	राजबृक्ष	*Cassia fistula*	Leguminosae	150-1400	Fruit, Seed
146 Ram Tulsi	राम तुल्सी	*Origanum vulgare*	Labiateae	1000-4000	Leaf, Flower, Seeds
147 Ramsikia	रामसिकिया	*Polygonatum cirrhifolium*	Convallariaceae	1500-3700	Leaves, shoots
148 Rato guras	रातो गुराँस	*Rhododendron barbatum*	Ericaceae	2700-3600	Flower
149 Rittha	रिठ्ठा	*Sapindus mukorossi*	Sapindaceae	1000-1400	Fruit, seed, bark
150 Rudraksha	रुद्राक्ष	*Elaeocarpus sphaericus*	Elaeocarpaceae	700-1700	Fruit
151 Sajyon	सज्योन	*Jatropha curcas*	Euphorbiaceae	100-2000	Seed
152 Sal	साल	*Shorea robusta*	Dipterocarpaceae	60-1500	Resin, seed, Leaf
153 Sarmaguru	शर्मागुरु	*Swertia multicaulis*	Gentiniaceae	4000-4900	Whole plant
154 Sarpagandha	सर्पगन्धा	*Rauvolfia serpentina*	Apocynaceae	100-900	Root
155 Satuwa	सतुवा	*Paris polyphylla*	Liliaceae/Trilliaceae	2000-3000	Rhizome

SN		Nepali/ Local Name	Scientific Name	Family	Distribution	Parts Used
156	Seti ghas	सोती घाँस	*Cymbopogon jwarancusa*	Gramineae	1600-3000	Whole plant
157	Seto bish	सेतो बिष	*Aconitum deinorrhizum*	Ranunculaceae	3000-3600	Root, Rhizome
158	Seto bish	सेतो बिष	*Aconitum ferox*	Ranunculaceae	2100-3800	Leaf, flower, rhizome
159	Sikakai	सिकाकाई	*Acacia rugata*	Leguminosae	400-800	Fruits, Leaves
160	Silam	सिलाम	*Perilla frutescens*	Labiateae	600-2400	Seed oil
161	Siltimur	सिल्टिमुर	*Lindera neesiana*	Lauraceae	1800-2700	Root, bark, fruit
162	Simal	सिमल	*Bombax ceiba*	Bombacaceae	up to 1200	Flower, Bark, Root
163	Sindure, Rohini	सिन्दुरे, रोहिणी	*Mallotus philippensis*	Euphorbiaceae	150-1800	Bark, leaf, fruit
164	Siplikan	सिप्लिकान	*Crateva unilocularis*	Capparaceae	100-1800	Bark, tender shoot
165	Sisnu	सिस्नु	*Urtica dioica*	Urticaceae	1000-2500	Leaf
166	Sita phal/Saripha	सीता फल/सरिफा	*Annona squamosa*	Annonaceae	500-900	Fruit
167	Somlata	सोमलता	*Ephedra gerardiana*	Ephedraceae	2300-5200	Leaf, tendril shoot, fruit
168	Sugandhakokila	सुगन्धकोकीला	*Cinnamomum glaucescens*	Lauraceae	2000-2500	Fruit
169	Sugandhawal, Samayo	सुगन्धवाल	*Valeriana jatamansii*	Valerianaceae	1500-3600	Root, Rhizome
170	Sunakhari	सुनाखरी	*Dendrobium aphyllum*	Orchidaceae	1100-1500	Stem
171	Sunakhari	सुनाखरी	*Dendrobium bicameratum*	Orchidaceae	1100-2500	Stem
172	Sunakhari	सुनाखरी	*Dendrobium denudans*	Orchidaceae	800-1500	Stem
173	Sunakhari	सुनाखरी	*Dendrobium eriiflorum*	Orchidaceae	800-1500	Stem
174	Sunpati	सुनपाती	*Rhododendron anthopogon*	Ericaceae	3300-5100	Leaf
175	Talispatra	तालिसपत्र	*Abies spectabilis*	Pinaceae	2400-4400	Leaf
176	Tanki	टाँकी	*Bauhinia purpurea*	Leguminosae	300-1600	Bark, flower buds, young fruits
177	Tatalo	टटेलो	*Oroxylum indicum*	Bignoniaceae	600-1300	Bark
178	Tejpat	तेजपात	*Cinnamomum tamala*	Lauraceae	450-2100	Bark
179	Timur	टिमुर	*Zanthoxylum armatum*	Rutaceae	1100-2500	Fruit
180	Tite	तिते	*Campylandra aurantiaca*	Liliaceae	2300-2700	Rhizome
181	Titepati	तितेपाती	*Artemisia dubia*	Compositae	1200-3400	Stem, Root, Leaf
182	Titepati	तितेपाती	*Artemisia indica*	Compositae	300-2400	Stem, Root, Leaf
183	Titepati	तितेपाती	*Artemisia vulgaris*	Compositae	300-2500	Stem, Root, Leaf
184	Tuki phul	टुकी फुल	*Taraxacum officinale*	Compositae	1500-3500	Root
185	Tunni	टुनी	*Toona ciliata*	Meliaceae	200-2500	Leaf, bark, flower
186	Vyakur	भ्याकुर	*Dioscorea deltoidea*	Dioscoreaceae	450-3100	Root, fruit
187	Yarshagumba	यार्चागुन्बु	*Cordyceps sinensis*	Hypocreaceae	4200-5000	Whole plant

GLOSSARY OF SOME MEDICAL TERMS USED IN THIS BOOK

Ache	Feel physical pain
Altitide Sickness	Effects of oxygen deficiency in the blood and tissues at high altitudes
Analgesic	A medicine used to relieve pain or capable of relieving pain
Anodyne	*See Analgesic*
Anorexia	A prolonged eating disorder due to loss of appetite
Anthelmintic	A medication capable of destroying or expelling parasitic intestinal worms
Antidiarrhoetic	Medication that prevents diarrhoea
Antidote	A drug that stops or controls the effects of a poison
Antimicrobial	An agent/medicine that destroys microorganisms which might carry disease
Antipyretic	Any medicine that lowers body temperature to prevent or alleviate fever
Antiseptic	A substance that destroys disease-causing micro-organisms without harming body tissue
Antispasmodic	A drug used to relieve or prevent spasms, especially of smooth muscles
Anxiety	A relatively permanent state of worry and nervousness occurring in a variety of mental disorders, usually accompanied by compulsive behavior or attacks of panic
Aperients	A purging medicine that stimulates evacuation of the bowels
Aphrodisiac	A drug or other agent that stimulates sexual desire
Asthma	Respiratory disorder characterised by wheezing (breathing with difficulty); often of allergic origin
Astringent	A drug that causes contraction of body tissues and canals, tending to draw together or constrict soft organic tissue
Boil	A painful sore filled with fluid
Bowel	The part of the alimentary canal between the stomach and the anus
Bronchitis	Inflammation of the membranes lining the bronchial tubes; a type of respiratory disease
Bruises	An injury that doesn't break the skin but results in some discoloration
Burn	An injury caused by exposure to heat, chemicals or radiation
Carminative	Medication that prevents the formation of gas in the alimentary tract or eases its passing
Cholera	An acute intestinal infection caused by ingestion of contaminated water or food
Constipation	Irregular and infrequent or difficult evacuation of the bowels; can be a symptom of intestinal obstruction or diverticulitis
Decoction	(pharmacology) the extraction of water-soluble drug substances by boiling
Depressant	A drug that reduces excitability and calms a person
Diabetes	A polygenic disease characterized by abnormally high glucose levels in the blood
Diarrhoea	Frequent and watery bowel movements
Diuretic	Any substance that tends to increase the flow or urine
Dizziness	A reeling sensation or a feeling that one is about to fall
Dysentery	An infection of the intestines marked by severe diarrhoea
Dyspepsia	A disorder of the digestive function characterised by discomfort or heartburn or nausea
Eczema	Generic term for inflammatory conditions of the skin
Epilepsy	A disorder of the central nervous system characterized by loss of consciousness and convulsions
Expectorant	A medicine that promotes expectoration
Febrifuge	A medicine that lowers body temperature to prevent or relieve fever
Fever	A rise in the temperature of the body; frequently a symptom of infection
Frostbite	Destruction of tissue by freezing
Galactagogue	Any agent or substance that induces milk secretion
Gastritis	Inflammation of the lining of the stomach; symptoms include nausea, loss of appetite and discomfort after eating
Gout	A painful inflammation of the big toe and foot caused by defects in uric acid metabolism, resulting in deposits of the acid and its salts in the blood and joints

Headache	Pain in the head caused by dilation of cerebral arteries or muscle contractions or a reaction to drugs
Hypnotic	A drug that induces sleep
Hysteria	A condition of excessive or uncontrollable fear
Indigestion	A disorder of digestive function characterized by discomfort, heartburn or nausea
Inflammation	A response of body tissues to injury or irritation; characterised by pain, swelling, redness and heat
Insomnia	An inability to sleep; chronic sleeplessness
Insecticide	A chemical or preparations that are used to kill insects
Itching	An irritating cutaneous sensation that produces a desire to scratch
Jaundice	Yellowing of the skin and the whites of the eyes caused by an accumulation of bile pigment (bilirubin) in the blood; can be a symptom of gallstones or liver infection or anemia
Leukoderma	A congenital (inborn, not hereditary) skin condition characterised by spots or bands of unpigmented skinMassage Kneading and rubbing parts of the body to increase blood circulation and promote relaxation
Menstrual disorders	A disorder related to menstruation or the menses
Migraine	A severe recurring vascular headache; occurs more frequently in women than men
Mucosistis	A painful inflammation and ulceration of the mucous membrane
Nausea	The state that precedes vomiting
Narcotic	A drug that produces numbness; often taken for pleasure or to reduce pain; extensive use can lead to addiction
Neuralgia	Acute spasmodic pain along the course of one or more nerves
Pimples	A small inflamed elevation of the skin; a pustule or papule; common symptom in acne
Purgative	Stimulates evacuation of the intestines
Refrigerant	A drug that causes cooling or freezing effect
Rheumatism	Any painful disorder of the joints or muscles or connective tissues
Scabies	A contagious skin infection caused by the itch mite (*Sarcoptes scaboi*); characterised by persistent itching and skin irritation
Sedative	A drug that reduces excitability and calms a personSore An open skin infection
Sprain	A painful injury to a joint caused by a sudden wrenching of its ligaments
Stiffness	The property of moving with pain or difficulty
Stimulant	A drug that temporarily quickens some vital process
Stomach ache	Pain localised in the stomach or abdominal region
Sudorific	A medicine that causes or increases sweating
Toothache	An ache localized in or around a tooth
Tonic	A medicine that strengthens and gives energy
Tonsillitis	Inflammation of the tonsils
Tuberculosis	Infection by the *Tubercle bacillus* manifesting itself in lesions of various parts of the body (especially the lungs and bones); also known by its acronym TB
Ulcer	An inflammatory and often suppurating lesion on the skin or an internal mucous surface resulting in necrosis of tissue
Urticaria	An itchy skin eruption characterised by weals (raised marks on the skin) with pale interiors and well-defined red margins; usually the result of an allergic response to insect bites or food or drugs
Vermicide	Drug that kills intestinal worms

GLOSSARY OF BOTANICAL TERMS USED IN THIS BOOK

Acuminate	A leaf shape narrowing to a slender point
Acute	Less than right angle (>90 degrees); often used to describe the tip of a leaf
Alternate	First leaf or branches on one side and then on the other in two ranks along an axis; not paired
Anemophilous	Pollinated by the wind
Axillary	The upper angle between an axis and an offshoot such as a branch or leafstalk
Biennial	A plant whose life cycle normally takes two seasons from germination to death to complete; flowering biennials usually bloom and bear fruit in the second season
Bract	A modified leaf or leaf-like part just below and protecting an inflorescence
Bristles	A stiff hair or filament
Capsule	A dry dehiscent seed vessel or the seed-containing structure
Coppices	A dense growth of bushes
Deciduous	Plants and trees that shed foliage at the end of the growing season; broadleaved trees are mostly deciduous
Dentate	Coarsely saw-like toothed margin, especially of a leaf
Digitate	Leaves resembling a finger
Dioecious	Having male and female reproductive organs in separate plants (Unisexual)
Elliptic	A leaf shaped like an ellipse (rounded like an egg)
Entomophilous	Pollinated by insects
Evergreen	A plant or tree having foliage that persists and remains green throughout the year
Ex situ	State of not being in the original or natural habitat
Glabrous	Having no hair or similar growth; smooth
Globose	Having the shape of a sphere or a ball
Habitat	The type of environment in which an organism or plant or group normally lives or occurs
Herb	A plant lacking a permanent woody stem; mostly annual
Hermaphrodite	Having both male and female reproductive organs in the same plant or animal
Inflorescence	The flowering part of a plant or arrangement of flowers on a stalk
In situ	Being in the original position; not having been moved
Lanceolate	A leaf shaped like a lance head; narrow; pointed at each end
Monoecious	Having male and female reproductive organs in the same plant (bisexual)
Mulch	A protective covering of half-rotten vegetable matter spread to reduce evaporation and soil erosion
Oblanceolate	A leaf shape that has a broad rounded apex and a tapering base
Offshoots	Root offshoots; small branches arising from the root of a mature plant
Palmate	Having leaflets or lobes radiating from a common point
Panicle	Compound raceme or branched cluster of flowers
Peduncle	Stalk bearing an inflorescence or solitary flower
Perennial	A plant lasting for three seasons or more
Perianth	Collective term for the outer parts of a flower consisting of the calyx and corolla and enclosing the stamen and carpel; floral envelope
Pubescent	Covered with fine soft hairs or down
Root turions	A small bulb arising from the stem which often gives rise to a new plant
Sessile	Attached directly by the base; not having an intervening stalk
Shrub	Low woody perennial plant usually having several major branches
Spikes	An indeterminate inflorescence bearing sessile flowers on an unbranched axis
Stalk	A slender or elongated structure that supports a plant part (leaf) with main organ (stem, branches)
Suckers	Small plants that arises from underground stem and are capable to grow as an individual plant
Thicket	A dense growth of bushes
Tiller	Grow shoots in the form of stools or tillers
Understorey	A technical term used to describe plants that can grow and tolerate low light conditions; often grows as second storey to bigger trees.

Loading Rhododendron anthopogon leaves and aerial twigs for Anthopogon oil production

WWF in Numbers

1961

WWF was founded in 1961

+ 100

WWF is in over 100 countries, on 5 continents

+ 5m

WWF has over 5 million supporters

+ 5,000

WWF has over 5,000 staff worldwide

Why we are here.
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

www.wwfnepal.org

WWF Nepal, P. O. Box: 7660, Baluwatar, Kathmandu, Nepal
T: +977 1 4434820, F: +977 1 4438458, E: info@wwfnepal.org, wwfnepal.org