CONSERVATION OF INDIGENOUS MEDICINAL PLANTS AND THEIR TRADITIONAL KNOWLEDGE FOUND IN MOIST TEMPERATE HIMALAYAS PAKISTAN

BY

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Department of Biological Sciences
Quaid-i-Azam University
Islamabad
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In the name of Allah, the most beneficent, the merciful

"It is who sendeth down rain from the skies: with it reproduce vegetation of all kinds: from some we produce green (crops), out of which we produce grain, heaped up (at harvest): out of the date palm and its sheaths (or spathes) come clusters of dates hanging low and near: And (then there are) gardens of grapes, olives and pomegranates, each similar (in kinds) yet different (in variety): when they begin to bear fruit, feast your eyes with the fruits, and the ripeness thereof. Behold! In these things are signs for people who believe"(Al-Quran 99:6)

CERTIFICATE

This thesis by Mr. Muhammad Ibrar, is accepted in its present form by the Department of Biological Sciences, Quaid-i-Azam University, Islamabad-Pakistan as satisfying the thesis requirements for the degree of Doctor of Philosophy in Biological Sciences.

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EXTERNAL EXAMINER-2 _____

CHAIRPERSON
(Department of Biological Sciences) _____

Dated 27-5-2004

DEDICATION

I dedicate the success of this endeavor

to

my affectionate parents,

my wife

and

my sweet little daughter

Miss Hajra Ibrar.

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Muhammad Ibrar

Abstract

ABSTRACT

The moist temperate Himalayas, as one of the major ecological zone of Pakistan, deserves specific attention to the conservation of environment and the sustainable development of natural resources. During the last hundred years, the area has been subjected to major structural changes leading to a decrease of about fifty per cent of the potential forest area. The decrease in forest cover, combined with major changes in community structure has been responsible for the decline of indigenous medicinal plants resources and their traditional knowledge also. Ayubia National Park has been identified as one of the priority area to be focused for medicinal plant conservation.

The study was aimed to analyze traditional knowledge including local names, general distribution, flowering period, part used, medicinal and other uses, market values and taxonomic diversity of the medicinal plant of the area. Traditional knowledge about 117 indigenous medicinal plants (including 8 cultivated ones) have been collected from 140 informants. Women followed by children have been identified as the principle gatherers of medicinal plants. About 44 species were found to be market oriented. The field surveys were conducted by adopting predefined questionnaires through guided and transect walks. The market oriented indigenous species have been subjected through IUCN criterion for evaluation of their conservation status. According to this criterion, eleven species including two trees (*Juglans regia*, *Taxus wallichiana*), one shrub (*Berberis lycium*) and eight herbaceous species (*Asparagus adscendens*, *Atropa acuminata*, *Colchicum luteum*, *Dioscorea deltoidea*, *Podophyllum hexandrum*, *Rheum australe*, *Saussurea costus* and *Valeriana jatamansi*) have been found as endangered. Ex situ cultivation trials have been conducted on all of the endangered herbaceous species. Two exotic species (*Carum copticum* and *Nigella sativa*) have been trailed as crops substitute by involving local communities in the low land Himalayas through demonstration plots.

It has been concluded that in up land Himalayas where availability of cultivated land is quite less, the establishment of botanical gardens, home gardens or kitchen gardens may be the best ex situ conservation strategy, which can be adopted for sustainable utilization of medicinal plants. While clearly defined land tenure system and community participation in park management will be the best in situ conservation measure for adoptation. Medicinal plants as crop substitute can bring better results in low land Himalayas.

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Chapter - 1
Introduction

1. Introduction

Medicinal plants by definition are used in health care. Many of the world's population cannot afford medicines and rely on traditional systems of medicine, which are mainly plant based. It has been estimated by the world Health Organization that 80% of the world's population relies on traditional medicine to meet their daily health requirements (Akerele, 1993). Although there are many potent and specific drugs available today for the treatment of different diseases, there is a public swing to herbal medicines in a number of countries especially Pakistan. Plants are a logical source for new drug discovery and currently many thousands are being screened for biological activities in order to develop new drug entities. In recent years novel anticancer and antimalarial drugs have been developed from plant sources. The demand for medicinal plants is contributing to the loss of plant species and future demands should be met from cultivated sustainable species (Phillipson, 1997).

Medicinal plants probably constitute the largest single functional grouping of plants. According to an estimate 120 or so plant-based drugs prescribed for use worldwide come from just 95 species (Lewington, 1990) and an estimated 30,000 species worldwide fall in this group. Even this figure is only an estimate, because hardly any country has produced a comprehensive inventory of her medicinal plants. Medicinal plants cover all habits and habitats. They probably fall in over 5,000 genera and in more than 1000 families and subfamilies. They occur across a wide altitudinal range from the great Tibetan Plateau down to the seacoast and include aquatic plants and lower plant life forms like fungi and lichens. Out of the world's estimated 30,000 medicinal plants, information of propagation and seed storage would be available worldwide for less than 10 percent of the species. Agro-technology information may be available for perhaps only one percent (1%) of the world's medicinal plants. Thus a lot of work is yet to be done in this field (Shankar, 1998).

1.1. Mountainous Regions of Pakistan

Pakistan has one of the most prominent and significant mountain ranges of the world. Pamir knot is the most conspicuous spot on the physiographic map of Asia. It comprises

of 3,660 m high plateau on which several formidable linear mountain ranges occur over 5000 m covering from all significant directions i.e. Tien Shan, the Kunlun, the Karakorum, the Hindukush and Alai Ranges. The southern ranges, the Hindukush and Karakorum form the northern part of Pakistan. Further southward, the Himalayan chain forms an extensive mountain system. In Pakistan the Karakorum and Hindukush mountain ranges contain some of the highest peaks of the world i.e. K2 (8611 m), Nanga Parbat (8126 m), Rakaposhi (7788 m) and Tirich Mir (7690 m). Hindukush Mountains ranges extend from the northeast to southwest up to Koh-Safed. About two-thirds of Pakistan's surface area is mountainous i.e. 476,000 square kilometers out of the total area of 796,096 square kilometers of the country (Shah & Awan, 2002).

1.1.1. Himalayas in Pakistan

"Himalayas" is a Sanskrit word, which literally means "Abode of Snow" -from Hima, "snow", and alaya, "abode"-a term coined by the ancient pilgrims of India who traveled in these mountains. The Himalaya stretches to about 3,000 km in length and varies between 220-300km in width from Myanmar in the east to the borders of Afghanistan in west (between 72 91' E long and 27 36' N lat), it passes through Pakistan, China, India, Nepal, Bhutan and Bangladesh.

Geologically, or on the basis of their structure and history, the Himalayas are divided into four longitudinal levels (Wadia, 1975), which are

- The foothill belt or the **Outer Himalayas** are a series of low hills gradually rising from the plains called the Siwalik Hills attaining an altitude of about 1200m.
- The **Lesser Himalayas** lying north of the Outer Himalayas, where altitude varies from 1200-4000m and even up to 5000m.
- The central belt primarily corresponding to the **Greater Himalayas** or **Higher Himalayas**, or the ranges of the highest altitude.
- The **Tibetan Himalayas** or **Trans Himalayas** consisting of the Karakoram and the Hindukush, situated in the North of the Central Himalayas, is perpetually

covered with thick masses of snow and ice. This snow-covered region feeds the renowned glaciers and the rivers emanating from these glaciers.

Himalayas is endowed with richness and representatives in biodiversity. Northwestern Himalayan region is one of the 18 hotspots of the world. Concurrent with changes in topography altitude, precipitation, temperature, geological formations, soil conditions and resultant diversity of bio-climates, this region is rich in forestry, horticulture, agriculture and fauna. The Himalayas in Pakistan are not a single range or a chain but consist of a series of chains running roughly parallel to one another for long distances and converging at places, with numerous valleys and plateau or duns between them.

1.1.2. Phytogeography of the Mountainous Regions of Pakistan

Four phytogeographical regions are recognized in Pakistan, which help to explain the richness of its flora. 70% species are uniregional and about 30% of the species are bi or pluri-regional. Among the uniregionals, the Irano-Turanian element is the most common (46%), followed by the Sino-Japanese (10%), Saharo-Sindian (9.5%) and Indian (4.5%) elements (Ali and Qaiser, 1986). Generally two phytogeographic regions are found in the mountains of Pakistan (Table 1).

Table 1: Phytogeography of the Mountainous Regions in Pakistan

Name of regions	Major areas in Pakistan
1. Irano-Turanian	
i) Western	Waziristan and North Balochistan
ii) Eastern	Upper portions of Gilgit (Hunza, Shimshal etc.) and Chitral or central Asiatic (partly) Wakhan and adjoining Area to the south-east
2. Sino-Japanese	Kashmir, NWFP (Koh Safed, parts of Hazara, Swat) Dir, Chitral (partly), Astor, Naltar, Bagrot Valleys

(Source: Ali & Qaiser, 1986)

Although it is difficult to define discrete habitat types and ecological zones with current state of knowledge about the ecosystems of Pakistan, some habitats with special significance of reference to biodiversity, have been identified as: 1) Indus plains region 2) Riverain 3) Swamps, seasonal Innovations, seepage and Jheels 4) Tropical thorn forests

5) Sand dune desert 6) Dry subtropical semi-evergreen scrub forest 7) Dry temperate semi-evergreen scrub forest 8) Sub-tropical pine forest 9) Tropical dry mixed Deciduous forest 10) Steppe forest in Balochistan hills in southern latitudes and lower slopes of some northern ranges 11) Steppie forest in higher ranges 12) Himalayan moist temperate forest 13) Himalayan dry coniferous forest 14) Cold desert and dry alpine zone and 15) Himalayan moist alpine zone (Afzal, *et al.,* 2001).

1.2. Moist Temperate Himalayas

These forests extend all along the entire length of the outer Himalayan ranges. They usually form a zone between 1450-3500 meters (4500-10,000 ft) depending upon the aspect, configuration, habitat and soil conditions. They merge with the sub tropical pine forests below and sub-alpine/alpine forests in their upper limits. This forest is typified by most of the Murree hill range (including the Gallies), the lower Neelum and Kaghan valleys extending westwards to parts of eastern Swat bordering on Indus Kohistan (Hussain & Ilahi, 1991).

1.2.1. Vegetation and Ecology

These forests are predominately coniferous with some broad-leaved species. The dominating species are few forming pure or mixed associations. The occurrence of species depends upon the aspect, altitude and local habitat conditions.

Abies pindrow Royle in northern aspects or moist slopes, *Pinus wallichiana* Jackson with *Taxus wallichiana* Zucc. as an understorey and occasional *Cedrus deodara* (Roxb. ex D. Don) G. Don on dryer hotter slopes. Broadleaved trees include *Ulmus wallichiana* Planchon, *Juglans regia* L., *Quercus floribunda* Lindl. ex A. Camus, *Acer caesium* Wall. ex Brandis, *A. stercuuliaceum* Wall. and *Prunus cornuta* (Wall. ex Royle) Steud., the shrub layer comprises *Viburnum grandiflorum* Wallich ex DC., *Berberis lycium* Royle, *B. ceratophylla* G. Don, *Rosa brunonii* Lindl., *Skimmia laureola* (DC.) Sieb. & Zucc. ex Walp. and *Lonicera webbiana* Wall. ex DC. Forbes include many species of *Impatiens* and *Euphorbia* as well as *Viola*, *Fragaria* and *Gentiana*. Creepeers include *Hedera nepalensis* K. Kock and *Clematis montana* Buch.-Ham. ex DC (Afzal, *et al.,* 2001).

1.2.2. Climate

The mean annual temperature is 54°F with a mean monthly maximum of 73°F. December and January are the coldest months while June is the hottest month. They generally develop under a total annual rainfall of about 63 or 75 cm (25 or 30″) to 150cm (60″), which is received mainly during the monsoon season. Snow is the primary form of precipitation during winter season. The recorded rainfall ranges from the highest i.e. 252cm(100.80″) in 1914 to the lowest 88cm (35.13″) in1920 with a mean of 148cm (59.3″). The major precipitation throughout the zone comes due to southwest monsoon pouring during July through September. Some appreciable amounts of rains may also come from westerly disturbance during the winter and spring months. Precipitation in winter is primarily in the form of snow. The snowfall varies from 1m(3′) to over 7 meters (22′) within the zone (Hussain & Ilahi, 1991). Maximum and minimum temperature and rainfall during the growing seasons (i.e., June to November) of the meteriological station Murree is presented in table 2.

Table 2: Meteriological Information of Growing Seasons of Murree Station (2001-2002)

Months	Temperature in °C (2167m)		Rainfall in mm
	Maximum	Minimum	
June 2001	23.4	15.3	342.0
July 2001	22.9	16.2	294.9
August 2001	22.9	16.4	133.5
September 2001	22.8	13.6	156.6
October 2001	22.0	10.7	17.2
November 2001	16.9	3.7	60.8
June 2002	26.0	14.5	314.9
July 2002	25.0	15.7	154.1
August 2002	—	—	—
September 2002	21.0	12.1	74.0
October 2002	20.1	9.4	19.8
November 2002	28.3	10.5	0.0

Source: Monthly Statistical Bulletin (Febraury, 2003), Federal Bureau of Statistics, Statistic Division, Government of Pakistan pp 1-3.

1.2.3. Soil and Topography

Most of the rock formations of the Himalayas are covered by the forests, which occur chiefly on the gneisses, schists and extended over quartzites, granites, limestone, conglomerates and shales.

The soil character, therefore, accordingly varies with the type of rock. The soils are predominately loamy and acidic with humus accumulation to a considerable depth. There is always a very thick layer of litter, which covers the entire forest floor under the conifers. Accumulation of litter occurs due to slow decomposition of needles (Hussain & Ilahi, 1991).

1.2.4. Geology

It forms a part of the northwestern syntaxis. It has been suggested that the rocks form a narrow band around a projection of peninsular rocks. The mountains are composed of granitoids in the north, slate and limestone in the central and southern parts. The northern boundary of the Himalayas is demarcated technically by the Main Mantle Thrust and geographically by the Kohistan mass. This part of the Himalayas constitutes the hill ranges of Kashmir, Hazara and across the Indus River includes hills occurring on the eastern stretches of Swat and Peshawar valleys (Tahirkheli, 1982).

1.2.5. Hydrology

The important rivers of the area are Siran river (rises from Bhogarmang valley and terminated in the Indus at Tarbella), Dor river (originates at the northern end of Dungagali and joins Siran river slightly before Tarbella), Haro river (rises at the southern end of Dungagali enters Rawalpindi near Ballan) and Kunhar river (rises from the lake Lulusar and joins the Jhelum river at Pattan). There are numerous tributaries of these rivers. Some of them are perennial in their flow while others have trickling water from the springs in the beds. Lakes of the area are confined to the upper mountainous region in the Kaghan valley. The three world fame lakes are Lulusar (3384 m elevation), Dudupat Sar (3636m elevation), and Saiful Malook Sar (3248m elevation). Sar means a lake (Hussain & Ilahi, 1991).

1.3. Indigenous Medicinal Plants of Pakistan

In Pakistan reliance on herbal medicine is partly owing to the high cost of conventional allopathic medicine and inaccessibility of modern health care facilities, but also because traditional medicine is often deemed a more appropriate method of treatment especially in rural areas. Medicinal plants have a rich resource base, which is spread over a wide range of ecological zones in Pakistan. Pakistan has around 6000 species of wild plants (Stewart, 1972). About 2000 medicinal plants are known in Pakistan, but only a small proportion of these has so far been commercially exploited. According to the National Institute of Health (NIH), approximately 400 plants species are used extensively in traditional medicines. The Tibbi Pharmacopeia of Pakistan (a pharmacopoeia of traditional drugs compiled by the Tibbi board) has listed around 900 single drugs and about 500 compound preparations made of medicinal plants. There are about 27 large herbal manufacturing companies in Pakistan, which produce Unani medicine on a commercial scale. The number of herbal medicine manufacturers in the non-organized sector runs into the hundreds. The annual turn over of some large herbal manufacturers is comparable to multinational companies in Pakistan. Traditional healers (around 50,000 in numbers, including homeopaths) serve about 60% of the population, especially those living in the rural areas. The four ecological regions where medicinal plants are exploited commercially are described below:

- **Medicinal Plants of Alpine and High Altitude Areas**

  Most plants of these areas are slow-growing perennials, which require several years of vegetative growth for reproduction by seed. Most of these are classified as threatened or vulnerable. Endangered plant species of this area include *Podophyllum hexandrum* Royle "Bankakri", *Saussurea costus* (Falc.) Lipsch. "Kuth", *Picrorhiza kurrooa* Royle ex Benth. "Nilkanthi", *Aconitum heterophyllum* Wall. ex Royle "Atis" and *Corydalis* spp.

- **Medicinal Plants of Temperate Montane Forest**

  Common medicinal plants of these areas are *Atropa acuminata* Royle ex Lindl. "Angoor-e-shafa", *Angelica glauca* Edgew "Chora", *Paeonia emodi* Wall. ex Royle

"Mamekh", *Geranium wallichianum* D. Don ex Sweet "Rattan jot", *Glycyrrhiza glabra* L. "Mulathi", and *Ephedra* spp.

- **Medicinal Plants of Sub-Tropical Foothill Forests**

  Species found here include *Terminalia* spp., *Mallotus philippensis* (Lam.) Muell.-Arg. "Kamila", *Emblica officinalis* Gaertn. "Amla", *Butea monosperma* (Lam.) Kuntze "Palas"etc.

- **Medicinal plants of Arid and Semi-Arid Areas**

  Some important species of medicinal plants of commercial importance like *Artemisia* spp., *Ephedra gerardiana* Wall. ex Stapf. "Asmani", *E. procera* Fisch. & Meyer "Naru", *Bunium persicum* (Boiss.) Fedtsch. "Siah Zeera", etc. are found in cold arid habitats. In warm arid areas, species like *Commiphora wightii* (Arnot) Bhandari "Guggal". (LEAD, 2000)

Pakistan with its limited natural forests, estimated to be less than 4%, is experiencing a rapid decline at a rate of 4-6% per year. The loss and degradation of natural forests clearly implies a decline in species number and genetic diversity of populations (Afzal *et al.*, 2001). Of the total 622 endangered plants listed so far in the red Data books, 137 occur in the Himalayan region. Of the 137 species, 71 species are from the eastern Himalayas, 56 species from the western Himalayas, and ten species are common to both these regions (Ahuja, 1998).

The local communities of different areas of Pakistan have the centuries old knowledge about traditional uses of most of the plants of their area. This indigenous knowledge of plants is transferring to them from generations to generations by their ancestors. Some of the important plants are commercially exploited for the extraction of various types of active ingredients. The different systems of Eastern medicines i.e., Unani, Ayurvedic and homoeopathy etc. are entirely based on the medicinal properties of these plants. Indigenous knowledge of these plants is in danger of being lost and will not be known to the next generations, if it is not documented. Thus there is a dire need to conserve this precious knowledge about medicinal plants.

Over the years, unsustainable utilization of these medicinal plant resources by locals and their overexploitation on commercial basis by industrialists has threatened their occurrence and abundance. The medicinal plants are now either susceptible to endangerment or vulnerability. In some areas, the Forest Department auctions the collections of limited quantities of herbs to the highest bidder, with the result that medicinal plants are collected indiscriminately leaving little room for their regeneration. Such activities have resulted in the depletion of medicinal plant in those areas where they were once used to be abundant. The example of *Dioscorea*, *Digitalis* and *Colchicum* may be cited in this connection. In fact there is no clearly definable medicinal plant sector formulating policies that regulate trade practices, the promotion of innovative conservation measures and the sustainable utilization of medicinal plants.

The importance of *in situ* conservation has scarcely been recognized by conservationists even today and it is not even appreciated by forest managers. Threat assessment of the wild populations of medicinal plants, is another area to look at for urgent and coordinated action. Large-scale cultivation of medicinal plants is today absolutely necessary in order to meet the growing demands for raw material.

1.4. Protected Areas

Pakistan has attempted to protect its resources for future generations as well as for more immediate functional benefits. Firstly, Pakistan is a signatory of virtually all the important international agreements such as the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), the Convention on Wetlands of International Importance (RAMSAR), the World Heritage Convention, and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn). In addition, Pakistan is a member of the World Conservation Union (IUCN) and the International Waterfowl and Wetland Research Bureau (IWRB).

Secondly, the federal and provincial authorities have made significant attempts to protect biodiversity and the natural capital. Conservation of biodiversity requires number of approaches one of which is the establishment of protected areas, natural reserves and national parks. In recent years, great effort has been expanded by the countries of

Himalayan region to establish protected areas for the protection of biodiversity. A network of national parks, wildlife sanctuaries and game reserves has been established which cover about ten million hectares (National Park: 2,842,087 ha; Wildlife Sanctuaries: 4,359,667 ha; Game reserves: 3, 535,284 ha). Within the Pakistan Himalayas, 55(8) protected areas have been established: 9(2) National Parks, 8(2) Wildlife Sanctuaries, 1 Nature Reserve and 39(4) Game Reserves (Nos. in bracket refer to Moist Temperate Himalayas, Table 3) (Jamali, 1998).

Table 3: Protected Areas of Moist Temperate Himalayas

Name of Protected Area	IUCN category	Area (ha)	Notification data	Coordinates
Machiara National Park	II	13.537	1982	34/31-34/34N-73/32-73/39E
Ayubia National Park	II	1.684	1984	34/01-34/03N-73/22-73/27E
Salkhala Wildlife Sanctuary	IV	810	1982	Not recorded
Manshi Wildlife Sanctuary	IV	2.321	1977	34/41N-73/25E
Ghamot Game Reserve	Unassigned	27.283	-	Not recorded
Moji Game Reserve	do	3.861	-	do
Qazi Nag Game Reserve	do	4.832	-	do
Kingar Gali Game Reserve	do	20.300	1992	34/25-34/34N-72/11-71/25E

Source: (The IUCN Directory of South Asian Protected Areas, 1990) & *(The Nation, May 8th, 2003)

In Pakistan, a national park is an area of outstanding scenic merit and natural where the landscape, flora and fauna are protected and preserved in a natural state. Public access for recreation, education and research is provided for. Access roads and other facilities should be planned so they do not conflict with the main objectives of national parks. Hunting wild animals is prohibited, as is firing a gun or otherwise interfering with animals or plants. Clearing land for cultivation, mining or allowing polluted water to flow in National Parks is also prohibited. Under the regulations, these acts may be allowed for scientific purposes or to improve the park. There are 16 National Parks in Pakistan and

AJK, covering a total area of 2,842,087 ha. The average size of protected areas is 177630 ha (Table 4).

The main objective of a National Park can be defined as the Scientific Reserve/Strict Nature Reserve: to protect nature and maintain natural processes in an undisturbed state in order to have ecologically representative examples of the natural environment available for scientific study, environmental monitoring, education, and for the maintenance of genetic resources in a dynamic and evolutionary state.

Table 4: National Parks of Pakistan

National Park	Region	Size ha	Date
1. Ayubia	North West Frontier Province	3312	1984
2. Central Karakoram	Northern Areas	973,845	1995
3. Chinji	Punjab	6,070	1987
4. Chitral Gol	North West Frontier Province	7,750	1984
5. Deosai Plains	Northern Areas	363,600	1993
6. Handrap Shandhoor	Northern Areas	51,800	1993
7. Hazarganji-Chiltan	Balochistan	15,555	1980
8. Hingol	Balochistan	699,088	1997
9. Khunjerab	Northern Areas	227,143	1975
10. Kirthar	Sindh	308,733	1974
11. Lal Suhanra	Punjab	51,588	1972
12. Machiara	AJK	13,593	1996
13. Margalla Hills	Islamabad	17,386	1980
14. Sheikh Buddin	North West Frontier Province	15,540	1993
15. Lulusar Lake*	North West Frontier Province	12,026	2003
16.Saif-ul-Malook Lake*	North West Frontier Province	75,058	2003

Source: (The IUCN Directory of South Asian Protected Areas, 1990) & *(The Nation, May 8th, 2003)

1.5. Ayubia National Park (the focal area of study)

1.5.1. Location and Establishment

Ayubia National Park is located in Lesser Himalayas three hours drive north of Islamabad in the Galliat Hills (North West Frontier Province). It was declared a national park in 1984 with the aims of preserving its beautiful landscapes, forests and biodiversity for

scientific research, education and recreation. The average altitude is 2300 m (maximum 3000 m at Mushkpuri Top). The initial area of the park was 1684 ha, expanded through a northern extension in 1998 to make a total of 3312 ha. The park supports one of the best remaining examples of moist Himalayan temperate forest in Pakistan and is surrounded by seven major villages and three small towns (Nathiagali, Ayubia and Khanspur) (Aumeeruddy *et al.*, 1998).

1.5.2. Geography and Demography of the villages

The villages of Malach and Pasala are located on the western side of the park and inhabitants from these villages go to the small towns of Nathiagali and Dungagali for shopping; villages in Khanaspur area are located in the southern part of the park and people in that area go to the market in Khanaspur. Lahur Kas is a remote village located on the eastern edge of the park accessible only by small paths in addition to a poor tract accessible by four-wheel drive vehicles and which links it to the small town of Berote. Habitations in Malach and Pasala are scattered and distributed among a number of sub-villages, Kalaban, Kanisan, Bata, Jaswara and Ser (Malachh), Toheedabad and Kundla (Pasala), whereas habitations in sub-villages of Khanaspur e.g. Darwaza, Mominabad, Riala and Ramkot, are grouped closer together. The distance of sub-villages to the National Park is variable (1-3 kms) and villages and sub-villages lie either on the main road or at a close walking distance (half an hour walk) from it, with the exception of Lakur Kas as previously mentioned (Aumeeruddy *et al.*, 1998). A general description of the demography of the villages has been given in table 4.

1.5.3. Ethnicity, Tribes, Cultures, Customs and Socio-economy

The main bazaars, Nathiagali, Khanaspur and Ayubia form a concentrated nucleus of market places, shops, hotels and summerhouses. The best-represented ethnic groups in the region in terms of numbers are Korals and Abassis. Villages are formed of a mixture of these two ethnic groups and other minor groups such as Gujars, Syed and Rajput. Local tourists visit the region primarily from May to October. Most people from Khanaspur (Mominabad, Riala, Ramkot and Darwaza) migrate to Rawalpindi, Murree and Abbottabad during the winter season (November to April) for business reasons. Most

people from other villages remain in place during the winter. The literacy rate is very low, especially among women. Higher secondary school is not available to girls and only two schools are available to boys. Electricity is available in almost all villages as well as community water pipes. Apart from villages in Khanspur that rely mostly on Light Petroleum Gas (LPG) and kerosene for cooking and heating, all other villages use firewood as the main source of fuel. People rely on agriculture, livestock rearing and natural resources (fodder, fuelwood, wild vegetables, medicinal plants and fungi) as an economic base. Culturally fuelwood collection and grass cutting from the forests is being done by the women folk of the area. In addition most men have seasonal (summer) jobs with revenues which vary from 1000 - 5000Rs (20 - 100 $US) per month. A measure of the cost of living is given by the price of main staples: rice (30 - 35 Rs/kg or 0.6 - 0.7 $US) and potatoes (12-14 Rs/kg or 0.24 - 0.28 $US) (Aumeeruddy *et al.*, 1998).

1.5.4. Population

During the last two decades an increase of about 36% has been recorded in the population of communities living around the National Park. This much increase has resulted in virtual exhaustion of all most all the Guzara Forests and the pressure has thus mounted on the Reserved Forests. It is almost certain that if the present rate of exploitation continues the reserve forests of Galliat will face the same fate as that of Guzara's.

Table 5: Population of Ayubia National Park

S.No.	Village	Total Population	Male	Female	Households' Number - Average. Size*
1.	Ayubia	429	228	201	67 ----------(6.4)*
2.	Bagan	7,930	3,754	4,176	1,310 -------(6.1)
3.	Bakot	12,434	6,041	6,393	1,942 -------(6.4)
4.	Darwaza	2,677	1,327	1,350	401 ---------(6.7)
5.	Dungagali	37	20	17	11 ----------(3.4)
6.	Mallach	8,772	4,027	4,745	1,479 ------(5.9)
7.	Rialah	8,029	3,722	4,307	1250 -------(6.4)
8.	Tajwal	9,765	4,304	5,461	787 --------(5.9)
	Total	**50,073**	**23,423**	**26,650**	**8,247**

Source: 1998 District Census Report of Abbottabad published by Population Census Organization, Statistics Division, Govt. of Pakistan, 1999 (Table: 39 Pp. 180-199).

According to Census latest Report of 1998, since 1981 the population has increased by 35.96%. The population of the communities living around Ayubia National Park has increased from 32,547 in 1981 to 50,073 in 1998 (Table 5). However, since independence in 1947 an overall cumulative growth of 176.18% has been recorded in the population of the area (Shah, 2001).

As a matter of chance population of woman have increased more rapidly than men of the area. This much increase in human population along with their increasing number of livestock has posed a serious threat to the integrity of the Park in particular and forests of the area in general.

1.5.5. Land Tenure system

The villages are surrounded by terraced agricultural land located mostly on valley's bottom. Grassland and forest occur on steeper slopes and are proportionally more extensive. Most forest outside the park is gazetted as either Reserved Forest (in which the local people have no legal rights of use) or Guzara Forest (which is owned by individuals or communities). Ayubia National Park is a Reserved Forest as well as a park. Guzara Forest can be used by its individual or communal owners for various purposes - such as to graze livestock and collect deadwood and grass for fodder, but the cutting of timber, in particular conifers, remains under the control of the Forest Department. Some areas designated legally as Reserved or Guzara Forest have been degraded through illegal harvest and mismanagement of trees and other processes, and are now either grasslands or wastelands.

For the fulfillment of the bonafide needs of the local communities, 84.47% of the total area was then left for communities (Table 6). Small fraction of land in remote places was designated as state land. The National Park covers an area of only 3312-hectare, 3.28% of the total land and 21.07% of the Reserved Forests of Galliat.

Table 6: Land Tenure System in and around Ayubia National Park

S. No.	Land Tenure	Area in hectares	% of the total area
1.	Private/Communal Grazing lands	49,280	48.60
2.	Cultivated Private land	27,123	27.00
3.	Reserve Forests	15,716	15.53
4.	Guzara Forests	8,224	8.13
5.	Cantonment Forests	452	0.45
6.	Location Forests	279	0.28
	Total area	**101,074,100.00**	

Source: Shah, 2001

1.5.6. Habitat and Vegetation

Various factors like altitude, topography, climate, soil moisture, exposures, altitudinal variation etc. determine the particular vegetation types and specific habitats. These habitats have been altered over the years by biotic and other factors like overpopulation, urbanization, deforestation, terracing of land for agriculture, overgrazing, forest fires etc. Various National Parks have been established to counter such disasters and Ayubia National Park is one of those natural reserves. In the park area generally three vegetation types have been observed.

1) **Subtropical Pine Forests**

In the lower hills Chirpine (*Pinus roxburghii* Sargent) forms practically the whole of the top canopy but associated with other broad leaved species like Oaks (*Quercus leucotrichophora* A. Camus. and *Q. baloot* Griffith) in depressions coupled with shrubby undergrowths. The mean annual temperature lies between 160 to 220 C, maximum may go up to 440 C in the month of June - July. There is definite cool season with frost and some snow in winter and about 75-125cm of rainfall in monsoon (July-August) winter snow is very little. This geographical range lies on rocks mainly sand stones and conglomerates, the type occur in crystalline rocks adjacent granite, gneisse and schists. Most of the area around the subtropical chir pine zone has been cleared for cultivation.

Pinus roxburghii Sargent (chir pine) is completely dominant with oak species like *Quercus leucotrichophora* A. Camus with the undergrowth's like *Rhamnus* and *Berberis* species, *Maytenus royleanus* (Wall. ex Lawson) Cufodont. and *Daphne mucronata* Royle. At lower elevations shrubs like *Punica granatum* L., *Nerium oleander* L., *Vitex negundo* L., *Colebrookia oppositifolia* Smith, *Debregeasia salicifolia* (D. Don) Rendle, *Otostegia limbata* (Benth.) Boiss., *Dodonaea viscosa* (L.) Jacq., *Justicia adhatoda* L., *Jasminum* sp., *Sageretia theezans* (L.) Brongn., *Rumex hastatus* D. Don, *Mallotus philippensis* (Lam.) Muell.-Arg., *Indigofera atropurpurea* Buch.-Ham. ex Hornem., *Woodfordia fruticosa* (L.) S. Kurz and *Rosa* sp. are fairly common. The herbaceous flora is represented by *Verbascum thapsus* L., *Fumaria indica* (Hausskn.) Pugsley, *Solanum* sp. *Salvia moorcroftiana* Wall. ex Benth., *Senecio* sp., *Inula* sp., etc. Spring flora like *Colchicum luteum* Baker, *Tulipa stellata* Hook. f., *Gagea psuedo-reticulata* Vved., *Medicago sativa* L., *Lathyrus* sp. *Crotalaria madicaginea* Lamk., *Capsella bursa-pastoris* (L.) Medie, *Lamium amplexicaule* L., *Viola serpens* Wall. ex Royle, *Galium* sp., *Brachypodium* sp., *Dicliptera roxburghiana* Nees, *Oenothera rosea* L'Herit ex Ait., *Oxalis corniculata* L., *Bupleurum* sp., *Ajuga bracteosa* Wall. ex Benth., *Evolvulus alsinoides* L., *Chenopodium album* L. and *Micromeria* sp. are common.

2) Moist Temperate Forests

Throughout the moist temperate zone the greater part of the precipitation is derived from monsoon during summer. An appreciable amount is however, brought by westerly disturbances during winter and spring months in the form of snow especially in winter months. The snow by gradual melting in summer provides adequate moisture for the development of good height forests. The main characteristics of moist temperate forests are the extensive development of some of our prominent conifers like *Pinus wallichiana* Jackson (at lower levels to about 2300 m) dominating and above mixing with *Abies pindrow* Royle (at higher levels) and then at more heights (to about 3000-3500 m) mixed with *Picea smithiana* (Wall.) Boiss., *Taxus wallichiana* Zucc. is found in less disturbed areas and not so abundant. *Cedrus deodara* (Roxb. ex D. Don) G. Don is also not very common found in steep valleys. The conifers generally form a fairly complete forest cover of good height (80-150 ft). Populations of *Taxus wallichiana* and *Picea smithiana*

are declining considerably. Among the broad-leaved associates Oaks and Maples are not uncommon specially *Quercus leucotrichophora* and *Acer caesium* Wall. ex Brandis. The other *Quercus* species, i.e. *Q. dilatata* Lindl. ex Royle is not so common but much better developed on good soils and in shelter sites relatively free from lopping etc. Several other broad-leaved species like *Prunus cornuta* (Wall. ex Royle) Steud., *Fraxinus* sp., *Aesculus indica* (Wall. ex Camb.) Hk. f., *Populus ciliata* Wall. ex Royle, *Juglans regia* L. are also found. Considerable damage has already been done to these forests. The shrubby dominant undergrowths are *Viburnum grandiflorum* Wall. ex DC., *Lonicera* sp., *Sarcococa saligna* (Don) Muell., *Indgiofera* sp., *Skimmia laureola* (DC.) Sieb & Zucc. ex Walp., *Rubus fruticosus* L., *Cotoneaster* sp., *Plectranthus rugosus* Wall. ex Bth., *Stachys* sp., *Rhododendron* sp., *Origanum* sp., *Rosa webbiana* Wall. ex Royle etc. It appears that *Taxus wallichiana* Zucc. and *Quercus* spp. specially *Q. leucotrichophora* are heavily lopped. Among the herbaceous flora *Strobilanthus* sp., *Viola serpens* Wall. ex Roxb., *Gentiana kurroo* Royle, *Podophyllum* sp., *Fragaria* sp., *Potentilla nepalensis* Hook. f., *Anemone* sp, *Hedera nepalensis* K. Koch, *Thymus serpyllum* L., *Eremurus* sp., *Impatiens* sp., *Arisaema* sp., *Stipa* sp., *Pennisetum* sp, *Sauromatum venosum* (Ait.) Schott, *Artemisia* sp., *Delphinium* sp. *Primula denticulata* Smith, *Valeriana jatamansi* Jones, *Euphorbia wallichii* Hook. f. etc. are common. In the shady places especially cliffs, several species of ferns are found. (Examples *Adiantum* sp., *Onychim* sp., *Cetrach* sp., *Pteris* sp., *Asplenium* sp., *Pteridim* sp. etc.). Common parasites are *Arceuthobium mimutissimum* Hook. f. (Mistletoe) on pines, *Viscum album* L., on walnuts, horse-chestnuts, willows, apricots and poplars, *Loranthus cordifolius* Wall. ex Roxb. and *Korthasella opuntia* (Thunb.) Merill on oaks. *Orobanche solmsii* Clarke and *O. alba* Stephen ex Willd. are root parasites on *Selinum* and *Origanum* respectively. *Cuscuta* species are common parasites on various shrubs and herbs.

3) Subalpine Scrubs and Scattered Tree line

This area lies between the temperate and alpine zones and the vegetation has the characteristics of both. Mushkpuri and Miranjani plateaus are included in this area both above 3300 m. The tree canopy is open and scattered and restricted to fir, spruce and yew (*Taxus*) species. About 2800-3000 meters, there are only few firs, spruces and some blue

pines. The upper grassy plateau consists mostly of shrubs and perennial herbs having very brief growing period. The plants are generally dwarf and caespitose and this condition is caused by severe winds and frost. Nevertheless, they survive in these harsh conditions due to their very thick perennial rootstocks. Most of the species are densely hairy, an adaptation probably for protection from high intensity ultraviolet rays. A variety of microhabitats are met at the sub alpine pastures including open sunny sites rock slopes steppes and marshy/aquatic places. The species differ in their ecological preferences even when occurring in the same general area. The representative species are *Abies pindrow* Royle, *Picea smithiana* (Wall.) Boiss., *Pinus wallichiana* Jackson, *Taxus wallichiana* Zucc., *Syringa emodi* Wall. ex Royle, *Skimmia laureola* (DC.) Sieb & Zucc ex Walp., *Rhododendron arboreum* Smith, *Corydalis ramosa* Wall., *Valeriana pyrolifera* Decne., *Smilax vaginata* Decne., *Impatiens* sp., *Androsace hazarica* R. R. Stewart & Y. Nasir, *Cerastium* sp., *Thalictrum cultratum* Wall., *Rumex nepalensis* Spreng., *Swertia* sp., *Sibbaldia cuneata* O. Kuntze, *Potentilla nepalensis* Hook. f., *Achillea santolina* L., *Gnaphalium affine* D. Don, *Saussurea candolleana* (Wall. ex DC.) Clarke, *Pleurospermum stylosum* Clarke, *Thymus serpyllum* L., *Polygonum* sp., *Saxifraga* sp., *Pennisetum* sp., *Carex* sp.and *Phleum alpinum* L. etc.

Microhabitats

A variety of microhabitats are met within each of the major habitat types in Ayubia National Park. It includes open sunny sites, dry slopes, cliffs, stony and muddy places, disturbed areas, steppes, water sheds, forest floor/shady places, aquatic places etc. The species differ in their ecological preferences even when occurring in the same general area.

Most of the ferns love shady places whether under the forests or under the cliffs. Similarly *Impatiens, Arisaema, Duchesnea, Valeriana, Smilax, Podophyllum* are found in shades under the forests, on floors where soil is rich in humus. *Eriophorum comosum* (Wall. ex Roxb.) Nees is always found hanging on cliffs. Several members of Asteracae are found in open sunny sites. Members of Ranunculaceae and Scrophulariaceae (*Ranunculus, Caltha, Pedicularis*) are mostly found along the streams or on wet grassy

grounds. Same is true of several *Carex* species and orchids. Weedy species are found in waste places. Among the trees *Cedrus deodara* loves steep slopes, and *Taxus wallichiana* is found where there is less disturbance.

Most if not all of the vegetation in and around Ayubia National Park is heavily influenced by the action of humans. The vegetation of the park, which is fairly well preserved in places, is dominated by coniferous species, principally *Pinus wallichiana* (pine) and *Abies pindrow* (fir), with scattered individuals of broad-leaved trees, such as *Aesculus indica*, *Quercus dilatata* (oak), *Prunus cornuta* and *Ulmus wallichiana* Planch. Undoubtedly, populations of broad-leaved trees have declined over the years as a result of human activities (see further on) and those of conifers such as *Pinus* have increased proportionately. Today, *Pinus wallichiana* is much the commonest tree species in the park, with *Abies pindrow* on higher altitude north-facing slopes.

1.5.7. Tourism

Ayubia National Park is a major recreation area visited by large numbers of local tourists, mostly from Islamabad and Abbottabad. No official figures are available, but local estimates suggest that there are about 100,000 visitors per year. Numerous hotels and summerhouses are located on the periphery of the park in Nathiagali, Ayubia and Khanaspur. The park administration has developed a fairly good system of infrastructure to serve the tourists, many of who walk along a well-demarcated level path that follows a pipeline. In this way they may cross the park from Dungagali to Ayubia.

It is strictly forbidden to extract natural products from the park, but in practice many local villagers depend on the collection of firewood and fodder (arborescent and herbaceous) from within its boundaries. Collectors are almost all women. Apart from collection by villagers, firewood from the park is also gathered for use by hotels and summerhouses. Other products such as wild fungi, vegetables and even medicinal plants are also extracted from the park.

1.5.8.Conservation and development issues of the park

1.5.8.1. Deforestation

Processes inducing deforestation at Ayubia are similar to those observed generally in the Himalayan foothills of Pakistan. All Himalayan forests are important for water catchment. At Ayubia National Park (ANP), it is particularly critical because it serves as one of the sources of water to the major irrigated farming area of the Punjab plain and, through small reservoirs and a pipeline to the large settlement of Murree situated a few kilometers down-slope.

1.5.8.2. Endangered Flora and Fauna

Common leopard and numerous bird species are found in Ayubia National Park. Some of the bird species pass through the park on migration. The population of the Koklass Pheasant (*Pucrasia macrolopha*) and the rare Kalij Pheasant (*Lophura leucomelana*) are the highest known for Pakistan. Only 30 individuals of the Kalij Pheasant are known to exist in the park. Pheasant breeding may be impeded by disturbance from collectors of morelles, since breeding and fungus collecting seasons coincide (April-May). Nationally rare or endangered tree species include *Taxus wallichiana* and *Ulmus wallichiana*. There are several important medicinal plants (e.g. *Paeonia emodi*, *Podophyllum emodi* and *Valeriana jatamansii*), which are restricted locally to the park.

1.5.8.3. Loss of Habitat

The park and its environs provide plant resources critical to the lives of the local villagers. Except for winter, women from most households embark on daily or even twice-daily firewood and fodder collection trips to the park and often have to walk many kilometers. There are many conflicts between local women and the staff of the Wildlife and Forest Departments, who are too few in numbers to enforce park regulations adequately. Although many plant resources are available in larger quantities inside the Park than in surrounding areas, many of these resources are disappearing as a result of poor management. Populations of some tree species have been decimated and many are not regenerating. Reserved and Guzara forests are dominated almost entirely by pines, with some fir at higher altitudes especially on north-facing slopes. The cutting of these

Figure 1: Destruction of *Taxus wallichiana* and its habitat at Ayubia

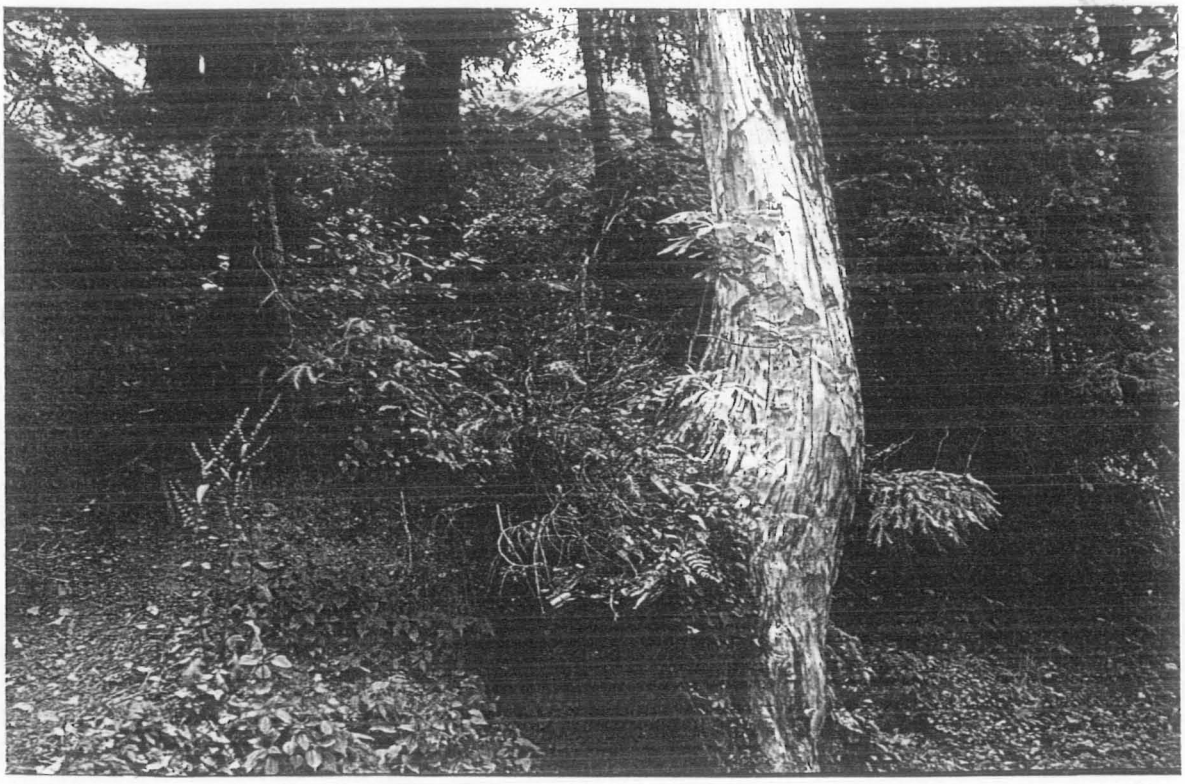

Figure 2: Debarking of tree within Ayubia National Park

conifers is legally restricted wherever they occur, helping to preserve them. Strong official interest is lacking for other tree species and there are either no or unclear rules governing control and access to the remaining plant resources. As a consequence most plant resources tend to be collected opportunistically without any management. Trees of greatest interest to the villagers as sources of firewood and fodder, such as *Quercus dilatata, Taxus wallichiana* and *Ulmus wallichiana*, have disappeared completely from Guzara forests. One critical social issue is that women - while being the main collectors of natural resources - are poorly represented in decision-making processes. Decisions regarding official access to resources, men largely make tree planting and the cutting of timber.

1.5.8.4. Ownership disputes

A serious impediment to the development at Ayubia is the shortage of fertile agricultural land (largely restricted to valley bottoms). Planting of trees outside the park for fodder or firewood is constrained by poorly defined regimes of land tenure and resource ownership, and a disparity in influence between those who are most directly concerned with wild plant resources (women) and those who make official decisions (men). Although pines grow quite well, it would probably be a mistake to promote their further use or planting by the villagers for firewood, given that the Forest Department would likely dispute ownership of the grown trees.

In summary, cultivated land and associated plant resources are private (except for pines), the National Park and Reserved Forests are the exclusive properties of the State (which has insufficient resources to ensure good management) and Guzara Forest has a complex system of tenure.

1.5.8.5. Loss of Indigenous Knowledge about Plants

Some aspects of local knowledge related to plant resources have become eroded, possibly due to the proximity of several cities (one hour drive from Abbottabad, three hours from Islamabad) and because the villages are ethnically diverse as a result of past immigration. Only a few old people have detailed knowledge of the uses of plants as medicines. Links between people and certain aspects of their natural surroundings are therefore weak,

diminishing the incentive for conservation. The general lack of knowledge about medicinal plants is unfortunate from the health-care point of view, given the poor provision of government-supported health services in the region.

1.6. Objectives of the Present Study

The main objectives of the present study has been given below:

- Documentation of traditional knowledge about indigenous medicinal plants of moist temperate Himalayas in general and Ayubia National Park particularly.
- To assess the *In-situ* (on-site) conservation status of selected wild strains of medicinal plants found in Ayubia National Park especially.
- To apply *Ex-situ* (out-site) conservation techniques to the selected wild strains of medicinal plants through experimental cum demonstration plots.
- To take initiative towards development of indigenous technology of medicinal plants cultivation with in Moist Temperate Himalayas.
- To introduce medicinal plants cultivation culture through *ex-situ* cultivation trails on private land for pilot scale cultivation of medicinal plants by communities/ farmers to ensure sustained supply for utilization.

Chapter – 2
Review of Literature

2. Review of Literature

The main cause of depletion of medicinal plants from our wild resources and a matter of prime concern is the large-scale exploitation of medicinal plants for commercial purposes. To meet the growing industrial demands, extensive collection of medicinal plants is undertaken by those engaged in the trade. There has been no attempt to augment the availability of these plants through cultivation. This has naturally led to an imbalance in the plant population of certain species. Much of the damage is confined to species that are from high altitude zones, particularly because the regeneration prospects of individual species found at this alleviation are limited by difficult conditions. A considerable amount of work regarding conservation of medicinal plants has been done in the past, a lot more is going on in different regions of the world but a more comprehensive approach is still needed.

2.1. Conservation as Tradition

In certain parts of the world, conservation of natural resources is part of the traditions of the local communities living in that area e.g., the tribal communities of Meghalaya in northeast India (Tiwari *et al.,* 1998), in Mayamba district of Sierra Lione (Lebbie & Raymond, 1995) and in Gwangxi Karst Region of China (Li & Su, 1995). They all have a tradition of environmental conservation based on various religious beliefs, which have passed from one generation to the other. Based on these beliefs, certain patches of forests on the hills and mountains are designated as sacred grooves or Holly hills under customary laws and are well protected from any product extraction by the community. Such forests are very rich in biological diversity and harbor many endangered plant species including rare herbs and medicinal plants.

2.2. Conservation of Traditional Knowledge

Around 90% of the medicinal species are used by the people, who are native to the area in which the plants occur. This is indicative of the vast repository of knowledge of plant medicine that is still available for global use, provided of course that it does not get lost before it can be tapped or documented. Traditional and indigenous medical knowledge of plants, both oral and codified, are undoubtedly eroding. The main reason for this erosion of indigenous knowledge is the global domination of the monoculture and of only those

knowledge systems that are a part of this dominant culture. (Shankar, 1998). Documentation of Traditional knowledge prevailing in different areas of the world will leads towards its conservation. A considerable work is going on in several parts of the world e.g., there is a study, which documents the abundance, distribution and knowledge of medicinal plant species in a Ransa Dayak village and adjoining forest in West Kalimantan, Indonesia. Over 250 medicinal plant species from 165 genera and 75 families were utilized by the local healer (Caniago & Siebert, 1998). Eighty-one herbal drug species in 51 families and 77 genera have been documented from Nepal (Manandhar, 1995). The results of ethnobotanical fieldwork among two Yanomami communities have been presented. In addition to the 113 species already known to be used by the group, a further 85 species were documented. The origins and significance of this knowledge have been discussed, with particular reference to the use of plants in the treatment of malaria (Milliken & Albert, 1997).

Little is known about traditional knowledge and practices developed by the transhumance society on available plants, animal resources, medicinal herbs and other technologies of high altitude Himalayas, where resources are scarce. Traditional knowledge of some important herbs in their society, traditional cattle breeding achievements, and the traditional handicrafts of high altitude Himalayan is documented and the immediate need for value addition in these sectors in order to save them from extinction and to add to the income of the people has been suggested (Farooquee & Nautiyal, 1999). An inventory of wild edible plants of Indian Himalaya used by local communities has been formulated. Over 675 wild plant species, representing 384 genera and 149 families, are used as food or edible (Samant & Dhar, 1997). By studying the biodiversity of a protected area of West Himalaya (Askot Wildlife Sanctuary), it was reported that plant diversity has been represented by 1262 species of vascular plants, of which about 70 species were found to be used as medicine (Samant *et al.,* 1998).

A checklist of the cultivated plants (581 species belonging to 111 families and 381 genera) of the whole Korean peninsula has been developed (Hodzun *et al.*, 1997). Diversity of medicinal plants in West African habitats have also been studied (Cole, 1996). Medicinal plants of the Western Usambara Mountains in Tanzania have been

inventoried for the first time as an analysis of medicinal plants used in Africa. A total of 328 taxa have been collected and yielded 2260 individual use reports. The most popular species were *Myrica salicifolia* and *Toddalia asiatica* (Schlage *et al.*, 2000).

In Pakistan emphasis on documentation of traditional knowledge about plants has increased in the last one decade specifically. In the past an effort was made to document information on medicinal plants of Balochistan (Hocking, 1958 & 1962). The past and present status of natural tropical thorn forest in Punjab have been described and *Salvadora oleoides* has been given special attention because of its great ecological and ethnobotanical importance. The traditional medicinal uses of about 27 medicinal plants found in Makran were described (Leporatti & Lattanzi, 1994). Similarly, traditional knowledge about 114 plant species was collected from a heterogeneous cultural population living in Balochistan of southwestern Pakistan (Goodman & Ghafoor, 1992). Plant utilization studies of northeastern Balochistan had also been conducted (Shinwari & Malik, 1989). Some preliminary ethnobotanical information was gathered form six districts of Balochistan (Malik *et al.*, 1990). Ethnobotanical information about Kharan district of Balochistan had also been documented (Shinwari *et al.*, 1995).

In the recent years, more efforts have been made to document the traditional knowledge particularly found in the Himalayas. In this regard traditional utilization of 160 plants have been described, collecting the knowledge form Margalla Hills National Park. The conservation status has also been discussed (Shinwari & Khan, 1998; 1999; 2000). About 58 species of medicinal plants have been preliminary listed from Ayubia National Park-Galliat (Shah, 2001). Indigenous knowledge of about 25 medicinal herbs from Kahuta-Rawalpindi district have been reported (Qureishi & Khan, 2001). Similarly traditional uses of about 77 species have been recorded from Shogran valley, Mansehra (Matin *et al.*, 2001). Ethnobotanical importance of about 48 species has been documented from Kaghan valley, Mansehra (Shinwari *et al.*, 1996). The traditional knowledge of about 69 medicinal plants found in Machyara National Park, Azad Kashmir have also been documented (Bukhari, 1996). Indigenous knowledge of about 85 medicinal plants has been described from Northern Chitral (Khan & Le Feure, 1996). Folk utilization of

medicinal plants found in Khair pur district, Nara desert and Cholistan have also been explored (Chaudhri & Arshad, 1987; Ansari *et al.*, 1993; Batti *et al.*, 2000).

2.3. Conservation Criteria

There have been several attempts to construct systems for setting priorities for conservation on a national or regional level (Sparrowe & Wight, 1975; Nieme, 1982; Millsap *et al.*, 1990; Daniels *et al.*, 1991, Master, 1991; Avery *et al.*, 1995; Gärdenfors, 1997; Catling & Porebski, 1998). A variety of different criteria, used in different combinations and systems have been suggested. However, Red Lists and Red Data Books of IUCN have been used for over 30 years to draw attention to threatened species the world over. The IUCN categories of threat have become internationally accepted and are now used, in a wide range of settings, by varied groups of people involved in the conservation of biodiversity.

According to the Red Data Book of IUCN (1970), the status of commercially important indigenous species (in terms of threatened condition) can be determined using the following four parameters: Availability, Collection, Part Used and Growth. Using these parameters the relative importance of specific medicinal plants can be classified into: Endangered, Vulnerable, Rare, Infrequent and Dominant.

In 1994, IUCN adopted new criteria to assess risks of extinction at a global scale, and it became apparent that they could produce misleading results when applied at the regional or national level. Revised criteria are more objective, numerical, and scientific as well as having greater applicability across taxon groups and are meant to be used for all organisms except microorganisms. The consideration for the selection of species are: 1) Global/International recognition of the species; 2) Rapid destruction of its limited habitat; 3) Extensive hunting pressure for food and trade; 4) Representation of each major group; 5) Economic importance of the species; and 6) Distribution of the species. Revised categories (in 2002) are 'Extinct', 'Critically Endangered', 'Extinct in the Wild', 'Endangered', 'Vulnerable', 'Low risk', 'Data Deficient' and 'Not Evaluated'.

Another approach for prioritization of Medicinal Plants for conservation was developed after analyzing the available information on various aspects of medicinal plants of the

Indian Himalayan region. Prioritization was based on three indices: (i) use value index (UVI) indicates threats imposed by users, (ii) sensitivity index (SI) reflect conservation concerns of biologists, and (iii) importance value index (IVI) is the cumulative value of (i) and (ii) to prevent biased approach. Twenty top ranking Medicinal Plants are identified for conservation in each life form (Dhar *et al.*, 2000).

2.4. Conservation Status of Medicinal Plants

Indiscriminate and non-systematic collection of medicinal plants in various parts of the world has led to severe pressure on the availability of medicinal plants, many of which are now rare, threatened or endangered. What is the conservation status of medicinal plants and how many species of medicinal plants are threatened today? No one knows. "Knowing what species are traded commercially is the foundation for identifying threatened plants". According to recent figures from the IUCN Threatened plant database (Walter and Gillet, 1998) approximately 32,000 species of plants are threatened with extinction. This figure represents approximately 13 per cent of the estimated 250,000 species of higher plants and bryophytes on earth, but does not take into account the many species whose status has not yet been assessed. A widely quoted estimate by Farnsworth and Soejarto (1991) based on records in the NAPRALERT database, is that 28 per cent of plants have been used in ethnomedicine. Putting these estimates together (28 per cent of 13 per cent of 250,000 plant species) allows the conclusion that roughly 9,000 species of medicinal plants are threatened worldwide. This figure excludes, of course, all the species with uses still undocumented or unknown (Leaman, 1998).

About 15% i.e., 4000-5000 out of total 30,000 vascular plants in China is estimated to be rare and endangered (An, 1998). Without assigning IUCN threat categories, besides *Bryonia cretica* (almost extinct) 13 taxa have been assessed as 'endangered' and 9 other taxa are regarded as overcollected or otherwise threatened from Egypt (Batanouny, 1999). Six species (viz. *Aconitum heterophyllum*, *Podophyllum hexandrum*, *Nardostachys jatamansi*, *Picrorhiza kurrooa*, *Swertia chirata* and *Bergenia ciliata*) were considered as test cases for successful conservation for a large number of species in Sikkim that are claimed to have therapeutic value and whose survival in the wild is being threatened (Rai *et al.*, 2000).

In Eastern Himalaya, *Coptis teeta* has been found as an endangered species; the scientific information for its conservation is lacking. It has been found endemic to a small area, to occupy a very narrow habitat and to be highly dispersed with very small population sizes. A number of genetic hurdles (e.g. high male sterility, low reproductive success and efficiency, inadequate seed dispersal, and little genetic variability) and external threats in the form of habitat disturbance and over-exploitation for commercial purposes could result in its extinction (Pandit & Babu, 1998). For instance, the small coniferous Himalayan yew has recently become a heavily traded species. It is avidly sought because it contains taxol, used to treat ovarian cancer. Large quantities of this plant are collected and exported annually, although its harvesting is illegal in most South Asian countries. Along the disturbance gradient *Taxus baccata* L. subsp. *wallichiana* (Zucc,) Pilger shows different population patterns. Least disturbed mixed broadleaf forest association shows stable population. The size class distribution of its population indicates that this species is on its way out. The threat is not only because of excessive harvesting but also due to degradation of forest sites for other reasons (Rikhari *et al.*, 2000).

A total of 23 rare and endangered medicinal plants were found in Spiti sub-division of Himachal Pradesh in the Indian trans-Himalaya, distributed over 10 major habitat types. The highest mean density was estimated for *Picrorhiza kurrooa* followed by *Saussurea gnaphaloides* (Kala, 2000). All the results were discussed in the light of rare and endangered medicinal plant conservation with the strong recommendation for the establishment of medicinal plant conservation areas in this part of trans-Himalaya.

In Pakistan there are only few reports available which have indicated the conservation status of some plant species. Without using IUCN criteria about 709 plants (Chaudhri & Qureishi, 1991) and 2 trees (Oldfield *et al.,* 1998) have been declared as threatened and endangered based on herbarium material. Approximately 37 species have been cited as threatened from Ayubia National Park (Shah, 2001). Using IUCN criterion 1970, fifty-five medicinal plant species from 3 districts of Malakand division have been reported as threatened (Gul *et al.,* 2000). Adopting IUCN criteria 1994, twenty plant species have been identified as target species from Pakistan (Shah & Baig, 1999)

2.5. Trade of Medicinal Plants:

One cannot ignore the important role played by the medicinal plant trade in the health and economic well being of individuals, companies/institutions and countries. Directly or indirectly, the trade enables others to have access to the healing benefits of plants, which do no occur, in their areas through the use of herbal preparations and /or pharmaceutical products made from them. For example quinine from the *Cinchona* species, native to the Andes Mountains in South America, helps to treat millions of people suffering from Malaria the world over.

Only less than 10 % of the world's known medicinal plants are in national and global trade. During the past decade, a dramatic increase in exports of medicinal plants attests to worldwide interest in these products as well as in traditional health systems. The annual value of trade of the 12 leading countries of export and import in the botanical drug trade have been estimated as 800 million US$ annually. The world leading country of export is China, main importing countries are Hongkong, Japan and Germany (Lange, 1997). Germany has the largest market in the world for herbal medicines, with annual sales of $1.22 billion representing nearly 25% of the national pharmaceutical market. The USA is the next largest market with sales of $480 million (Thrope & Warrier, 1992).

According to World Health Organization estimates, the present demand for medicinal plants is about US$ 60 billion a year and by the year 2050 it would be US$ 5trillion (Principe, 1991). During 1992, total world trade in medicinal plants was about US$ 171234million, of which 20.9% originated from countries in Asia and the Pacific, Pakistan share was 0.5% of this amount (Saeed, 1995). About 380 thousand tonnes of 40 medicinal plants were imported in 2000-2001 while about 30 thousand tonnes of 20 medicinal plants were exported in that year from Pakistan (FBS, 2001).

Of the 21,000 plant species listed on the CITES appendices, only 14 have been added expressly because of their exploitation as medicinal plants (Schippmann 1996; Lange & Schippmann 1999). These are as follows: *Aquillaria malaccensis*, *Dioscorea deltoidea*, *Guaiacum officinale*, *Hydrastis canadensis*, *Nardostachys grandiflora*, *Panax quinquefolius*, *Picrorhiza kurrooa*, *Podophyllum hexandrum*, *Prunus africana*,

Pterocarpus santalinus, *Rauvolfia serpentina*, *Saussurea costus* and *Taxus wallichiana*. About 230 CITES listed plant species have been identified that have medicinal uses. Many of these -particularly orchid and cactus species-are included as members of widely threatened taxonomic groups (Lange and Schippmann, 1999).

2.6. In Situ Conservation

In situ (on site) conservation involves nature reserves, national parks and other protected areas. Most of the conservationists agree that in situ conservation is preferable as far as it is possible. There is a need to preserve habitats with their whole diversity of organisms. If habitats are managed then plant species will manage themselves. This is probably found true in many cases.

In situ conservation studies have been reported on aromatic plants such as wild *Mentha* and *Origanum* species from southeastern turkey (Özgüven & Kirici, 1998; Özgüven & Tansi, 1998). In China, in situ conservation activities have been taking place for the last more than fifty years. There are 926 reserves occupying 769800 sq. km, which is about 7.64 percent of the total land of the country (An, 1998).

In Pakistan, in situ conservation status of Margalla Hills National Park, Islamabad (Shinwari & Khan, 1999) and Machyara National Park, Azad Kashmir (Khan, 1996) have been discussed and measures have been suggested for their improvement. More than thirty years back quantitative surveys of medicinal plants were conducted in the moist temperate Himalayan region of Pakistan. The quantity of seven important medicinal plants such as *Aconitum heterophyllum*, *Angelica glauca*, *Atropa acuminata*, *Dioscorea deltoidea*, *Paeonia emodi*, *Podophyllum hexandrum* and *Valeriana wallichii* had been surveyed in Kaghan and Gallies Forest Divisions. It has been concluded that from Kaghan valley three species i.e. *D. deltoidea*, *P. hexandrum* and *V. wallichii* could be exploited commercially while artificial regeneration efforts are needed for *Aconitum heterophyllum* and *Angelica glauca* because of their insufficient quantity available in the wild reservoir (Zaman *et al.*, 1972). According to the survey results achieved in Gallies, it was concluded that plants like *D. deltoidea, Paeonia emodi* and *V. wallichii* could be commercially exploited from the area on three-year rotation basis. However, extensive

regeneration of plants like *Angelica glauca, Atropa acuminata, Aconitum heterophyllum* and *Podophyllum emodi* was suggested and their extraction had not been allowed in Bagnoter and Dunga gali localities (Zaman *et al.*, 1971). The survey conducted in Murree, Rawalpindi north and south showed that medicinal plants like *Justicia adhatoda, Valeriana wallichii* and *Viola serpens* had been found sufficient for commercial exploitation while medicinal plants like *D. deltoidea* and *Podophyllum hexandrum* were found in very limited quantity in Murree Hills because of higher density of populations (Khan & Ahmed, 1976).

2.7. Ex situ Conservation

The agronomic practices and uses of eight medicinal and aromatic plants cultivated in Nanda Devi Biosphere Reserve (NDBR) in Garhwal Himalaya, India were described and these plants were suggested not only for the potential of economic betterment of people of this area but also for the cause of conservation in this biosphere reserve (Maikhuri *et al.*, 1998). The germination of four multipurpose species *Semecarpus anacardium, Olea glandulifera, Ehrettia laevis* and *Pittosporum floribundum* after pre sowing treatments was studied (Airi *et al.*, 1998). Seed germination in nine medicinal plants of India (namely *Andrographis paniculata, Abrus precatorius, Coleus forskohlii, Dipteracanthus patulus, Hemidesmus indicus, Ocimum gratissimum, Tylophora indica, Rauvolfia micrantha* and *Embelia ribes*) was studied after storage in liquid nitrogen for one week. The study has revealed a possible link between seed moisture content and liquid nitrogen tolerance (Decruse *et al.*, 1999).

Methods of cultivation of *Colchicum autumnale* has been described to supplement cash income to the farmers in USA (Fuller, 1991). Cultivation of some alpine medicinal plants has been worked out in India showing that alpine medicinal plants such as *Colchicum luteum, Dioscorea deltoidea* and *Paeonia emodi* prefer to grow in the forest habitats with humus and moisture rich soil (Joshi & Rawat, 1997). Field experiments were conducted to determine the conditions for mint cultivation, after rice-vegetable(s), rice-potato, rice-legume and rice-wheat crop sequences, in the northern Indian plains. It was concluded that the late transplanting schedule of mint cropping can save at least three months and thus allows taking of food crops such as mustard, potato, grain legumes, onion, garlic and

wheat in the same field prior to mint. Cultivation of one or more food crops in between rice and seedling transplanted mint can benefit food production and bring to the farmer higher levels of profit per hectare than those accruing from rice-sucker planted mint (Kumar & Ram, 1999).

In Pakistan, the ex situ cultivation of some medicinal plans like *Carum copticum*, *Plantago ovata*, *Glycyrrhiza glabra*, *Hyoscyamus niger*, *Colchicum luteum*, *Rheum emodi*, *Podophyllum hexandrum* and *Dioscorea deltoidea* has been done outside from their native habitats (Khan, 1957). The artificial regeneration of *Dioscorea deltoidea*, *Atropa acuminata*, *Valeriana jatamansi*, *Mentha arvensis*, *Rheum emodi*, *Colchicum luteum*, *Digitalis* species, *Podophyllum emodi*, *Pimpinella anisum*, *Catharanthus roseus*, *Saussurea lappa* and *Solanum khasianum* has also been tested, under controlled environmental conditions and by the application of various agrochemical, in the hill forest of NWFP (Khan *et al.*, 1992). Sandoz pharmaceutical company has worked from 1975 to 1980 on the cultivation of *Crocus sativa*, *Saussurea lappa*, *Podophyllum hexandrum* and *Dioscorea deltoidea* in Utror and Behrain of District Swat (Sher, 2002). Similarly experiments were conducted on the cultivation of *Polygonum amplexicaulis*, *Paeonia emodi*, *Viola serpens*, *Valeriana wallichii* and *Podophyllum hexandrum* resulting in the failure of *Paeonia emodi* and *Podophyllum hexandrum*' growth in agricultural lands (Sher, 2000).

2.8. In-vitro Conservation

Plant tissue culture form the backbone of plant biotechnology, i.e. micro propagation, induction of somaclones, somatic hybridization, and cryopreservation have played an important role. Recently, emphasis has been made on genetic transformation, especially for increased production of secondary metabolites by *Agrobacterium* rhizogenes induced hairy roots. The achievements made are, (1) production of alkaloids, pharmaceutics, nematocidal compounds, and also some novel compounds not found in the whole plant, (2) regeneration of plant resistant to herbicides, diseases, and pests for agronomic cultures and also for germplasm conservation, (3) scale up of cultures in bioreactors, (4) plants with different morphological traits, and (5) transgenic plants for the production of vaccines etc. These developments have far-reaching implications in the improvement of

medicinal plants. Well-developed techniques would help the growers to meet the demand of the pharmaceutical industry in the next century (Bajaj, 1998; Giulietti & Ertola, 1999).

In vitro conservation of diversity in medicinal plants of northwest Himalayan has been conducted (Chandel & Sharma, 1996). Media and incubation conditions have been defined for highly efficient regeneration of shoots from internode explants of slow and fast growing cultivars of *Mentha arvensis*. (Shasany *et al.*, 1998). Propagation and conservation of four pharmaceutically important herbs, *Ocimum americanum* L. (hoary basil); *O. basilicum* L. (sweet basil); *O. gratissimum* L. (shrubby basil); and *O. sanctum* L. (sacred basil) was attempted using synthetic seed technology. The encapsulated buds could be stored for 60 days at 4 degrees Centigrade. Plants retrieved from the encapsulated buds were hardened off and established in soil (Mandal *et al.*, 2000).

2.9. Community Based Conservation

On the social side, local community benefits related to medicinal plants are a matter of serious neglect. Medicinal plants are one biological resource, next to food crops, whose earliest and most knowledgeable custodians are local and indigenous communities. Yet local communities do not get a fair share of the benefits generated from trade, processing or production. They are also not sufficiently involved by government in conservation programs. They are not even adequately acknowledged for their many innovations and practical knowledge about the uses of plants.

Ecologically fragile landscapes of the Himalayas, particularly rained areas, have been experiencing increased degradation of land and water, and loss of biodiversity. Based on the primary information, and constant interaction between the scientists and farmers, an eco-friendly alternative model for sustainable and optimal utilization of land has been developed and demonstrated. The people's participation was considered an essential tool for successful implementation of the action plan. Consequently, subsequent actions and fieldwork were carried out by villagers themselves with the encouragement and guidance of experts (Rawat *et al.*, 1997).

It has been reported that in the Himalayas, the existing attempts to conserve biodiversity, are inadequate and therefore innovative changes in policies and programs are called for,

so as to focus greater attention on people's participation. Harnessing people's creativity and energies through participatory programs will go a long way in furthering the cause of conservation (Dhar *et al.*, 1999).

2.10. Conservation through Plant Part Substitution

The fact that mainly bark and underground parts of medicinal plants are utilized makes them especially sensitive to over exploitation. This concept was outlined to substitute the use of these critical plant parts with other plant organs of the same species. It has been concluded that this seems to be a promising conservation strategy and more investigations need to follow, e.g., the bark of Chilean endemic tree *Quillaja* species is one of the major sources of industrially used triterpenoid saponins. For decades extracts have been used as foaming agents in beverages, emulsifiers in foods, etc. Overexploitation of the bark has caused a dramatic decrease of old *Quillaja* trees. Further damage could be prevented by using not just the bark but also the wood for the production of saponins. This raw material can be obtained in large quantities from pruning operations, reducing the need to fell trees (Martin & Briones, 1999). Similarly, in southern Africa many medicinal plants are slow growing forest trees, bulbous and tuberous plants. Four of the most important and most threatened South African medicinal plants (*Eucomis autumanle*, *Siphonochilus aethiopicus*, *Ocotea bullata* and *Warburgia salutaris*) were used as case studies and extracts of various plant parts were compared chemically. The results showed that the potential for plant part substitution is highly species specific (Zschocke *et al.*, 2000).

2.11. Specific Review on Selected Indigenous Medicinal Herbs and Allied Species

2.11.1. *Asparagus adscendens*

Asparagus is traditionally grown as a temperate crop. In Australia consumption of fresh *Asparagus* is only 0.8 kg per person per year, which is small, compared with the consumption of other vegetables. Consequently, much of production of fresh *Asparagus* is exported with 90% of exports going to Japan (Bonnardeaux, 1994). The potential anti filarial activity of roots of *A. adscendens* against *Setaria cervi* have been studied (Singh & Khan, 1997). Steroid glycosides have been extracted from *Asparagus adscendens*

(Tandon & Shukla, 1990). Chemical and antimicrobial studies of a saponin of *A. adscendens* have also been conducted (Grover & Rao, 1988). Local used, distribution and cultivation of *A. adscendens* have been described (Kamble, 1989). The status of *A. adscendens* have been declared vulnerable to harvesting in Margalla Hills National Park, Islamabad-Pakistan (Shinwari & Khan, 1999; Shinwari & Khan, 2000)

2.11.2. *Atropa acuminata*

For the first time, the analysis of the leaves and roots of *Atropa acuminata* resulted in 0.45% of hyoscyamine contents found in leaves and 0.47% in dried roots. It could be a better substitute for *A. belladonna* (Denston, 1945). Preliminary observations and growth behaviour of *A. acuminata* revealed that hyoscyamine contents found in leaves and roots was 0.5% and 0.8% respectively. It has been also suggested that cultivation *of A. acuminata* in its natural habitat especially in Murree and Azad Kashmir would be worth trying (Chaudhri, 1951). Cultivation of *A. acumi*nata in Jammu and Kashmir obtained very promising results and an average yield of 4.43 tonnes of fresh leaves and root per hactare have been recorded (Chopra, 1958). The experimental cultivation of *A. belladonna* have also been reported from Abbottabad, but success of the experiment in the report have not been mentioned (Khan, 1957). Two new races, namely, atropine race and scoplamine race having higher alkaloid contents have been isolated from the population of 39 different sources grown in Romania. It has also been found that atropine race from Samokov and scopolamine race from Varna area gave highest yield of alkaloid. It was further observed that race from Varna is resistant to Verticulum (Yankulov & Delcher, 1966). Chemical analysis of leaves and roots of *A. acuminata* collected from different areas of North-western forests and Azad Kashmir showed that total alkaloid content varied from 0.2 to 0.4% in leaves collected from Azad Kashmir while it was 0.47% from Dunga-Gali and Kaghan respectively (Malik & Imam, 1968). It has been reported that *A. belladonna* is a dicot with broad leaves and the use of chemical weedicide is not possible (Sandhu, 1969). Cultural and fertilizer trials in various parts of Jammu and Kashmir have been conducted and improved methods of cultivation, harvesting at different stages and drying for obtaining maximum yield have been recommended (Gulatai *et al.,* 1977). Root-rot disease of *A. belladonna* caused by

Phytophthora nicotiana have been reported from Kashmir valley and Himachal Pradesh of India and it was further observed that the frequency of this disease in the area was 60% and 91% respectively. The control measures of this disease have also been suggested (Amin, 1980; Sharma & Jandaik, 1980).

2.11.3. *Colchicum luteum*

Techniques of cultivation, harvesting and drying of *C. autumnale* have been documented and it has been reported that corms contained 0.2 to 0.4 % Colchicine (Denston, 1945). For the first time on the corm of *C. luteum*, a new disease, black scab caused by *Rhizoctonia* has been recorded (Khan, 1951). Blue flowered *Colchicum* plants growing at Lowari Top (3500m) have been observed and it has been concluded that it might be a new species or a new record for Pakistan (Chaudhri, 1951). Extensive studies on ecological distribution of *C. luteum* in temperate Himalayas regions have been conducted and it has been further stated that about 2.5 tonnes of corms could be collected annually from natural resources in Kashmir valley (Chopra, 1958). Two diseases, namely leaf smut and leaf rust which caused great damage and affected regeneration in its natural habitat have been reported (Khan, 1959). Methods of cultivation of *C. autumnale* have been described to supplement cash income of the farmers in United States (Williams, 1960). Cytotaxonomic studies in *C. diampoles* in Bulgaria have been conducted, ideogram has been made and it has been reported that diploid chromosome number was 18 (Scheschmedjiew, 1966). Techniques of harvesting and garbling of *C. luteum* and *C. autumnale* have been described and it has been further reported that European *Colchicum* contained 0.6% Colchicine while it was low in Indian colchicum which ranged from 0.21 to 0.25 % (Wallis, 1967). It has been reported that seeds of *C. autumnale* contained more alkaloids as compared to corms, which varied from 0.6 to 0.25% (Trease, 1966). Alkaloids from *C. arenarium* have been extracted in the form of neutral, phenolic and alkaline alkaloids. Later these alkaloids have been isolated and identified by means of chromatography and physico-chemical methods (Gasic & Popovic, 1980).

2.11.4. *Dioscorea deltoidea*

The crown portion of *D. floribunda* rhizome required 20 days of storage prior to planting as compared to medium and tail - portions which required two to three months of storage

evolution than the number of loci (Zhang & Sang, 1999). Similarly, chromosomal structural rearrangement in *Paeonia brownii* and *P. californica* was studied by in situ hybridization. The results supported previous observations, based on meiotic configurations that chromosomal structural rearrangement occurred frequently in *P. brownii* and *P. californica* (Zhang *et, al.* 1998). Another study was conducted to evaluate the effects of P. radix, one of the most famous tonic traditional Chinese medicines, on the pharmacokinetics of carbamazepine in rats and to determine the possible interaction between them. It is suggested that the faster absorption of carbamazepine might lead to the rapid onset of its clinical effects (Chen *et. al,* 2002).

2.11.6. *Podophyllum hexandrum*

Experimental cultivation of *P. hexandrum* (carried out for the first time in India) has concluded that seed when sown in boxes at an altitude of 660m in August, germination commenced about 3 months after sowing and continued for 7 months. It has been also found that under abnormal conditions of temperature, germination was forced but was unpracticable under field conditions. Growth of the plant through rhizomes cuttings has also been found successful but owing to very slow growth of rhizomes, it would take at least 12 years to produce fair sized marketable rhizomes and therefore could not be cultivated with profit (Troup, 1915). It has also been studied that best time for rhizome collection would be in May, about the time when the plant is in flowering stage because the resin contents are high as compared to autumn collection (Khan *et al.,* 1992).

More light has been elucidated on the cultivation of *P. haxandrum* and it has concluded that plant could be successfully cultivated in those localities situated at higher elevations ranging from 3000-4000 meter with sufficient moisture (Chopra, 1958). Propagation methods have been further elaborated by means of seed sowing along with fruit pulp immediately after fruit collection. It has been reported that 44% of seed germinated when sown with fruit after remaining dormant for 9-10 months in the soil. Germination took place in the month of April when snow melted (Badhwar & Sharma, 1963). The quantitative survey of *P. hexandrum* has already been conducted and the ecological distribution of this endemic species in the hilly areas of the country has been already studied (Zaman *et al.,* 1972).

2.11.7. *Saussurea costus*

More than 200 species of *Saussurea* are distributed in the temperate regions of Europe, Asia and North America; most of which are confined to mountainous regions. The Asian species are found in Himalayas and China (Bailey, 1953). The occurrence of *S. lappa* in adjoining areas of Astore has been reported in Astore and Upper Guraiz Valley. The authors have also suggested the scientific exploitation of this species from this area (Kazmi & Siddiqui, 1953). By studying the ecological distribution of *S. lappa* it has been found that it grew in northwestern regions of Himalayas especially on the moist slopes of mountains around the valley of Kashmir. This species has been used largely in Ayruvedic and Tibbi medicines (Chopra, 1958). More than 35 species of *Saussurea* grew naturally in mountainous regions of Pakistan, out of these species, only *S. lappa* was of pharmacopoeial importance (Nasir & Ali, 1972). By conducting preliminary cultivation trials on *S. lappa* in Neelum valley, it has been found that seed germination and survival percentage of monsoon sowing was more successful, which ranged between 80-90% and 75-80% respectively, while autumn sowing indicated that seed germination was 55-60% and survival of the plants were 40-55% (Katal, 1974). *S. lappa* occurs naturally in Kishanganga valley and at higher elevations of Chenab and Kulu valley in Himachal Pradesh. The plant of that area after chemical analysis was found to contain 1% essential oil. Sizeable quantities of roots have been collected annually from these areas and have been exported to Arab countries by State Trading Corporation where it was used as incense (Vashist & Atal, 1977). During the periods from 1985 to 1988, an average of 22 tonnes per annum roots of *S. lappa* were extracted from Azad Kashmir (Sadiq, 1991).

2.11.8. *Valeriana jatamansi*

It was found by elaborating methods of cultivation and collection of *V. officinalis* that volatile oils content in the root varied from 0.5-1% (Denston, 1945). It has also been reported that *V. wallichii* collected from Chamba contained 1.2 per cent essential oil. Cultivation methods of *V. wallichii* were described, but any information on the yield of roots per hectare of land has not been given (Chopra, 1958).

The ecological distribution, methods of cultivation and collection in its natural habitat, macro and microscopic characters and its medicinal uses have been described briefly

(Datta & Mukerji, 1950). Himalayan *V. wallichii* contain 1 per cent essential oil with esters of isovalerianic and formic acid (Wallis, 1967). Cultivation and breeding of *V. officinalis* has been reported from Germany (Ecsenthus, 1966). It was found that Valeriana roots collected from different forests areas of India worth four million rupees were exported to Germany during 1973-74 (Anon, 1974). It has also been reported that large quantities of *Valeriana* roots collected from Indian Kashmir valley is used for the manufacture of resinoids (Atal & Kapur, 1977).

Chapter – 3
Materials & Methods

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Materials & Methods

3. Materials and Methods

The research work was initiated in February 2000 and continued upto December 2002. The sites selected to carry out research work on medicinal plants were; Ayubia National Park (Nathia Gali), Burban (Murree), Margalla Hills (Kotla Village), Kaghan Valley and Hilkot Valley (Mansehra). All these areas selected are medicinal plant hotspots of Moist Temperate Himalayan region. Ayubia National Park (ANP) has been taken as a focal reference point.

A comprehensive review of the relevant literature has been conducted. It has included the subject matter as well as regional studies. Specific review on the species selected for conservation trials has also been conducted.

3.1. Field Surveys

The time for field surveys was selected in accordance with the life cycle of the plants and the season of collection, processing and utilization of the plant products by the local community. The study trips were arranged from March to May 2000. The fieldwork was totally based on interviews, observations and guided field walk/transect walk during the fieldwork.

3.1.1. Observations

In order to study field condition, keen observations have been made during the walk in the upland during growth period. In the meantime all the voucher specimens have been collected during flowering stage, pressed and preserved. Thus two files of local plant voucher specimens have been developed. One set was submitted to the Herbarium of Quaid-e-Azam University, Islamabad and the other set to Pakistan Forest Institute, Peshawar.

3.1.2. Eco-geographical Survey

In collaboration with the forest department and Pakistan Forest Institute Peshawar, an eco-geographical survey has been conducted for identification of representative areas with significant species diversity of medicinal plants (hot spots) and associated vegetation for investigation of traditional knowledge about medicinal plants, conservation trails and

establishment of conservation cum protected areas in Moist Temperate Himalayan ecosystem.

3.1.3. Survey of Indigenous Knowledge

Interviews have been conducted with the local inhabitants, selected informants, the herbalists (Hakims) and the local authorities and societies. About 150 informants have been interviewed on random basis. A questionnaire has been adopted during the survey; in a way to get quantitative and participatory approach about the status of indigenous medicinal plants and their utilization by the people. A girl student has been involved to interview the women community of the area.

First of all, the focal area; Ayubia National Park has been surveyed. The indigenous medicinal plants having traditional knowledge of utilization among the people have been selected as reference specimens. The traditional knowledge about the indigenous medicinal plants of Ayubia National Park has been checked from other sites (Kaghan, Hilkot, Murree, Margalla and Machyara) selected within Moist Temperate Himalayas by conducting the same exercise.

3.1.4. Market Surveys

Economic and commercial value of the indigenous medicinal plants utilized in the study area has been tested in the market surveys. In this regard, a questionnaire has been adopted to interview the local plant collectors, medicinal plant sellers (Pansaries) in the local market i.e., Rawalpindi and Lahore. Regarding quantitative approach questionnaire has been asked about the quantity of plant resources, uses, rate of sale, consumption, availability, economic and market value etc. (Phillips and Gentry, 1993). Intensive surveys have been conducted.

The comparison of the outcome of the interviews of the surveys have been rechecked and compared with results of the other sites. The variations among information obtained from different sites have been noted.

3.2. Criterion for the Selection of Species

According to the Red Data Book of IUCN, the status of commercially important indigenous species (in terms of threatened condition) in the study area have been

determined by using the following four parameters; Availability, Collection, Growth and Part used providing a total score for each species. Based on this analysis, the relative importance of specific medicinal plants has been classified into; Endangered, Vulnerable, Rare, Infrequent and Dominant species (IUCN, 1970). Key adopted was as follows:

Availability	**Collection**
0=Uncommon or very rare	0=More than 1000 Kg/year
1=Less common or rare	1=Consumed from 500-1000Kg/year
2=Ocassional	2=Consumed from 300-400Kg/year
3=Abundant	3= Consumed from 100-200Kg/year
Growth	**Part Used**
0=Regrowth in more than 3 years	0=Root, Rhizome, Whole plant
1=Regrowth within 3 years	1=Bark
2=Regrowth within 2 years	2=Seeds, Fruits
3=Regrowth in 1 year	3=Flowers
4=Regrowth in a season	4=Gum, Latex, Leaves

Total Score

0-4=Endangered

5-8=Vulnerable

9-12=Rare

12-14=Infrequent

15-16=Dominant

3.3. Conservation Trials for Selected Medicinal Plants

3.3.1. Procurement of Germplasm

Seeds and propagates of a number of rare and endangered medicinal plant species were collected from April to September, 2000 from different location in their natural habitats. The seeds were dried, cleaned and stored in airtight jars. Roots or rhizomes of rare species were stored in pit covered with moist sand and soil in order to prevent it from drying.

3.3.2. Establishment of Nurseries at Medicinal Plant Farm, Pakistan Forest Institute, Peshawar for raising seedlings of Medicinal Plants

Seed germination behavior of four medicinal plant species has been studied in the laboratory. After ascertaining seed viability percentage, seedlings of these four species were raised in polythene tubes in nursery. Three months old seedlings when attained 6-cm height were transported to higher elevations at Burban area for transplanting in regeneration plots.

3.3.3. Establishment and Management of Propagation and Regeneration Plots at Burban Research Station, Murree for Experimentation and Demonstration

Conservation of diversified medicinal plant species has been experimented in selected conservation areas for maintenance of bio-diversity at different locations. Simultaneously, prospective farmers living in the vicinity of conservation areas have been identified to participate in this project. Land for demonstration plots of Margalla Hills has been acquired from farmers, while propagatory material have been provided from the project. Thus experimental demonstration plots, one at Pakistan Forest Institute Research Station Burban and another on private land at Margalla Hills have been established. In total fourteen plots have been established for propagation and regeneration trails at Burban, Murree. The following eight species have been experimented according to described methodology.

3.3.3.1. *Asparagus adscendens*

Propagating material i.e., tubers have been collected from Kuzagali forest enclosure and sown in well-prepared beds at Burban research station, Murree. Four rows in each of the two plots were dug up 15cm deep with the help of hoes maintaining a row to row distance of 45cm. Natural manure was applied and thoroughly mixed in soil before planting according to lay out plan. Tubers were cut into pieces measuring 6cm having one to two sprouting buds. Thus in total 140 tuber pieces were sown in the month of July 2000 to establish experimental or demonstration plots at Burban research station, Murree in two beds. Two weeding and hoeing were carried out during the month of June and July round

the year. Natural manure and urea treatment has been given twice a year. The survival data was recorded in July 2001 and 2002.

3.3.3.2. *Atropa acuminata*

The berries of *A. acuminata* were collected from higher elevation i.e., Sharan (2800m) in September 2000. Five samples of fresh berries weighing 5gm each were taken at random from bulk sample and average number of berries in 5gm was 8. These samples were later on dried in shade for seven days. The dried berries were weighed again and the weight ranged from 2.0gm to 2.2gm. When the berries dried and become brittle, these were crushed by hands, then seeds and chaff were separated.

The average weight of seed sample was recorded to be 1.8gm and average weight of a chaff was determined as 0.4gm. In other words, out of 5gm of fresh berries 1.8gm of dried seed was obtained. About 100 polythene tubes were filled with a mixture of soil, sand and manure (33% each). The seeds were sown in October 2000 and the water was provided with the help of water can with a rose. The tubes were irrigated twice a day i.e, in the morning at 7.00 am and later on at 4.00 pm daily. Seeds started germination after 42 days and continued upto April 2001, when the germination stopped totally. The criteria for considering the seed germination were appearance of two leaves on the soil surface of tube.

To increase the percentage germination of seeds and to reduce the long time taken for germination the seeds were treated with 200 ppm gibbrellic acid for 30 minutes and sown in the polythene tubes in November 2000. The seeds started germination after 22 days of sowing i.e., December 2000. The germination counts were discontinued on March 2001 as no further germination after 15 days was observed.

Seedlings of *A. acuminata* raised in polythene tubes were shifted to beds at Burban Research Station. Three rows of 8cm depth were dug up in the plot at a spacing measuring 18-meter square each. One hundred and twenty seedlings were planted at 30x45cm spacing during second week of May 2001. Necessary cultural operations like weeding and hoeing were carried out twice in a year. Doses of artificial fertilizers having nitrogen and Phosphorus alone or in combinations were applied as side dressing to the

plots as per experimental design after weeding and hoeing. Plucking of leaves were carried out in July.

3.3.3.3. *Colchicum luteum*

The study to judge the effect of gibbrellic acid and chilling treatments on the seed germination of *C. luteum* was planned at Pakistan Forest Institute, Peshawar. In this context, the seeds were divided into three lots of hundred seeds each. First lot was treated with 200ppm of gibbrellic acid by soaking the seed for one hour. The second lot was given chilling treatment at 0°C for 48 hours. Third lot was kept as controlled. The pretreated seeds were later on sown in polythene tubes filled with a mixture of soil, sand and manure in equal proportions (33% each) in October 2000. Thus 300 tubes were sown under this experiment, time taken for initiation of seed germination and number of days taken for complete germination were recorded. The criterion for recording seed germination was appearance of needle like leaves on the soil surface of polythene tubes.

In order to perform propagation tests corms were collected from Abbottabad areas in the last week of February 2001 when the plants were in flowering condition and were planted in rows 30cm apart with a plant to plant distance of 6cm in March 2001. Thus 90 corms were planted. The plot was irrigated after planting. Usual weeding and hoeing was carried out during May, July and September 2001. Irrigation was provided when required. The plot remained under constant observation. Sprouting of rhizomes started in first week of January 2002.

3.3.3.4. *Dioscorea deltoidea*

Propagating material i.e., rhizomes/tubers have been collected from Kuzagali enclosure and sown in well-prepared beds at Burban Research station, Murree. Four rows in each of three plots were dug up 15cm deep with the help of hoes maintaining a row to row distance of 45cm. Natural manure were applied and thoroughly mixed in soil before planting according to lay out plan. Rhizomes were cut into pieces measuring 6cm having one to two sprouting buds and weighing 25gm each.

In total 260 rhizome pieces weighing 6.5kg collected from Kuzagali in the month of July 2001 were sown to establish experimental or demonstration plots at Burban Research Station Murree in three beds. Two weeding and hoeing were carried out during the month

of June and July round the year. Natural manure and urea treatment has been given twice a year. The survival data was recorded in the last week of June 2002.

3.3.3.5. *Paeonia emodi*

The seeds collected from Thandiani were sown in polythene tubes filled with a mixture of sand, soil and manure in equal proportion (33% each) in October, 2001 at Pakistan Forest Institute, Peshawar, the tubes were hand mattered daily with a rose-cane. Seedlings of *P. emodi* raised were transported to Burban Research Station, Murree. One hundred seedlings were planted in three of the demonstration plots, at a distance of 60cm from row to row and 30cm from plant to plant in May 2002. Weeding and Hoeing were given in the month of June 2002.

3.3.3.6. *Podophyllum hexandrum*

Efforts have been made to germinate freshly collected *Podophyllum* seeds by various treatment i.e., scarification, soaking in water, hot water and acid treatments did not succeed. The experimental site (Demonstration plot) was thoroughly prepared by digging the soil with the help of hoes and later on area was leveled. Rhizomes of *P. hexandrum* collected from Kuzagali area was cut into different pieces having 2,3,4 segments and full rhizomes. Later on 85 rhizome pieces of each type were planted at a distance of 45cm from row to row and 30cm from plant to plant in May 2001. Weeding was done in the month of June and July.

3.3.3.7. *Saussurea costus*

Seeds were collected from Kaghan Valley in September 2000. Ten random samples of 5gm each taken from bulk were weighed and the number of seeds were counted in each lot. The number of seeds in 5gm sample was found to range from 310 to 340. Four samples of one hundred and ten seeds were taken at random from the bulk seed and were cut open with the help of blade. About 90 % of seeds were sound, 3% empty, 5% immature and 2% insect attacked.

Seed germination studies to determine seed viability percentage of *S. costus* were carried out at Medicinal Plant Farm, Pakistan Forest Institute, Peshawar during the month of January 2001. The seeds were divided into four lots and two samples were treated with 200 ppm, 100ppm-gibbrellic acid by soaking the seeds for 30 minutes. The third sample

was given chilling treatment at zero degree for 48 hours, and the fourth sample was kept as control. The seeds were sown in polythene tubes filled with a mixture of soil, sand and manure in equal proportion i.e. (33% each) in January 2001. Germination studies were set up in RCB design with four replications, consisting of 400 polythene tubes in each replication under various treatments as explained above. Thus 1600 tubes were sown under the experiments, time taken for initiation of seed germination and number of days taken for complete germination was recorded. The criterion for recording germination was appearance of first two leaves on the surface of soil of polythene tube. The germination count was stopped in March 2001. When no further germination was observed for 18 days. Results obtained were summarized. Seedlings raised in polythene tubes were transported to Burban Research Station.

Later on one hundred and ten seedlings were planted at a distance of 45cm from row to row and 30cm from plant to plant in May 2001. Weeding was done in the month of June and July.

3.3.3.8. *Valeriana jatamansi*

Seedlings of *V. jatamansi* were collected from surrounding areas of Kuzagali. Prior to laying out trials, the experimental sites were well prepared and leveled with the help of hoes. The seedlings were transplanted in four rows, 45 cm apart with a distance of 30cm from plant to plant in August 2001. One hundred and fifty seedlings were planted in one of the demonstration plots for briefing to the local farmers. Fertilizers; (N 150, P100 and NP 150+100Kg/Ha) were applied as a basal dose to the plot during April-May, 2002 according to lay out plan. Appropriate cultural operations like weeding and hoeing were performed regularly during growing seasons. Yields of rhizomes were recorded in the month of July 2002.

3.4. Establishment of Demonstration Plots

Two demonstration plots located near Kotla village at foot-hill of Margalla (about 20 Km north of Islamabad) were established as seeing is believing. After convincing, many farmers became interested in the cultivation of medicinal plants for additional income generation and a 600 meter square plot (1/8th of an acre) was selected for each specialized medicinal crops. Seeds of two profitable drug plants; *Carum copticum* Benth

& Hook (Ajwain) and *Nigella sativa* Linn. (Kalonji) were sown in October 2001 at Kotla village. The crops were harvested in the month of May/June 2002. The yield obtained was later projected on acre basis to determine the economics of growing these profitable drug crops.

Questionnaire No. 1

Documentation of Traditional Knowledge about Medicinal Plants

Locality of the Medicinal Plants collection site:

Date:

Name of the collector:

Age of the collector:

Education level of the collector:

Local name of the plant species collected:

Scientific name of the species collected:

Habitat of the species collected:

Uses of the plant species:

Quantity harvested per day/month/year:

Who collect the plant (Child/Woman/Man):

Why?

Is it sold?

Quantity sold per day/month/year:

To whom is it sold:

Price/Kg:

Is the plant perceived by the informant to be abundant/common/rare?

Changes in abundance of the plant for the last 10 years (more abundant/same/rare)

Are methods used to regenerate or other wise actively manages the plant?

What?

What kinds of tools are being used for harvesting?

What kinds of traditional methods are being used for the processing of medicinal plants after harvesting?

Are these traditional methods bringing good results? Yes/No

If, No. Then what are the problems faced in this regard?

Questionnaire No. 2 Drug Market Survey

Name of the person doing Medicinal Plants business:

Age:

Name of business:

Locality:

Date:

Type of business: Permanent/Temporary/Ambulatory

Percentage of people in the area doing medicinal plant business:

What is the trend of the Medicinal Plant business? Increasing/Same/Decreasing

Local/Trade Name of the plant traded:

Geographical name of the source area (village):

Vegetation:

Plant part used:

Cultivated status: Cultivated/Managed/Wild

Who collects? Yourself/People/Traders

Condition of the plant: Fresh/Dried/Preserved

Amount obtained/Year

Name of other ingredients

Purchase/Sale price (price/unit)

Brought to the Market: Daily/Weekly/On occasion

Estimated quantity: Per business man----------/Whole market----------

Availability: Jan. to Dec.

How much sold now compared to the past: More/Same/Less

Why? Less available for harvest/ Less depend by buyers/Any other reason

What are problems faced by you in this business

Chapter – 4
Results

4. Results

4.1. Traditional Knowledge of Indigenous Medicinal Plants

Traditional knowledge about medicinal plants of Ayubia National Park has been collected and also verified from other Moist Temperate Himalayan areas i.e., Kaghan, Murree, Machyara, Hilkot.

It is found that usually plants are harvested by the application of certain picking tools as knife, digging stick, 'kudal' and sometimes manually. Flowers and leaves are dried in shade. They are placed under the sun for a very brief period to prevent fungal attack. Barks, woods and twigs are dried under the sun or in thin layers in the open air. Fibrous roots are dried under the sun. Transversely cut fleshy roots and rhizomes have been dried and stored in a cool dry place. A number of traditional methods were used to make herbal remedies, such as infusion, decoction, tincture, syrup, jelly, oils, creams, ointment, pills, compress, poultice, steam inhalants, juice etc.

Infusion has been made fresh each day for three doses and drink hot or cold in the same way as tea. In this method, the plant part is kept in boiling water for about half an hour. Decoction has been made by heating the plant part in a water and simmer up to an hour. After straining it has been used hot or cold. This is a sort of soup. Tincture has been prepared by extracting the plants active ingredients in diluted alcohol, which also act as a preservative. Medicine has been taken in dilution. Syrup has been made by gently heating honey or sugar with infusion or decoction. This makes an ideal cough remedy. Oils have been prepared by packing the jar with herb and cover completely with oil. It has been kept for two to three weeks then used in creams, ointments and for external massage. Cream has been made by blending the plant juice, fat or oil or wax with skin. Bees wax has been used as hardener in this regard. Ointment has been prepared by heating oil or fat with the plant till the oil has absorbed and not blend with skin. No water is mixed. The plant is strained out and bees wax has been added to harden. A cloth pad soaked in herbal extract has been applied to accelerate healing of wounds, muscle injuries or for headaches. Poultice has been prepared by chopping fresh herbs and then boiled in water for few

minutes. It has been spread on the effected area. Gauze or cotton cloth has been applied to hold the poultice in peace. The poultice is replaced every 2-4 hours.

1) ***Abies pindrow*** Royle — Family: Pinaceae

Flowering period: April-May — Habit: Tree

Part Used: Leaves — Local Name: Partal/Palundar

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Swat, Dir)

Medicinal Uses: It is used in cough and chronic bronchitis.

Other Uses: Wood is soft, light, not very durable, used for internal building work, rough furniture, tea chests and general carpentry also used for making matches and paper pulp. Also used as a fuelwood. Foliage used as a fodder. (Voucher specimen No. 44)

2) ***Achillea millefolium*** L. — Family: Asteraceae

Flowering period: June-August — Habit: Herb

Part Used: Whole plant — Local Name: Sultani Buti

Distribution: North Western Frontier Province (Hazara), Punjab

Medicinal Uses: Syrup is used in fever, flu, toothache, earache and sexual disorders. Also used in bone pain, heart diseases, stomachache, and regulating menstrual period. Used to stop internal bleeding and heart burn. Fresh or dried ground leaves are taken for relieving headaches, anorexia and constipation. (Voucher specimen No. 83)

3) ***Aconitum heterophyllum*** Wall. ex Royle — Family: Ranunculaceae

Flowering period: June — Habit: Herb

Part Used: Leaves, Tuber — Local Name: Atis

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Swat, Chitral, Dir, Hazara)

Medicinal Uses: Root is used as tonic, aphrodisiac and pain reliever and is also used in dyspepsia and cough. Juice of the fresh leaves is applied to the pigmentation of the skin. (Voucher specimen No. 101)

4) ***Acorus calamus*** L. Family: Araceae

Flowering period: May-September Habit: Herb

Part Used: Rhizome, leaves Local Name: Bach

Distribution: Baluchistan (Pabi hills, Jhalawan), North Western Frontier Province (Swat, Dir, Hazara), Punjab (Murree)

Medicinal Uses: It is used in insectbite and snakebite. Dried rhizome is given in colic and fresh leaves are used for paralysis in animals. (Voucher specimen No. 82)

5) ***Adiantum capillus - veneris*** L. Family: Polypodiaceae

Flowering period: No Habit: Herb

Part Used: Whole plant Local Name: Pakhi/Hansraj

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Swat, Chitral, Hazara), Punjab (Murree)

Medicinal Uses: Entire plant is used as emollient in cough. Leaves are used as febrifuge. Used by women in childbirth problems and amenorrohoea. Decoction of fresh leaves is used as a cooling agent and of dried leaves for all kinds of fever for all age groups. (Voucher specimen No. 05)

6) ***Aesculus indica*** (Wall. ex Camb.) Hk. Family: Hippocastinaceae

Flowering period: Apr-Jun Habit: Tree

Part Used: Leaves, bark, fruit, seed Local Name: Bankhor

Distribution: Azad Kashmir, Baluchistan, Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Dir), Punjab (Murree)

Medicinal Uses: Bark is astringent and used as a tonic. The fruit is applied in rheumatic pains. Oil from fresh fruit is applied on wounds. Fruit is given to cattle in fever, also used in cough. Seeds are used for removing intestinal worms. Dried ground leaves are taken orally to treat hyperpyrexia and pruritis of skin.

Other Uses: Wood is used for making furniture, turned articles, agricultural appliances and household utensils. The leaves are used as fodder. (Voucher specimen No. 45)

7) ***Ajuga parviflora*** Benthm — Family: Labiatae

Flowering period: Mar-Apr — Habit: Herb

Part Used: Whole plant — Local Name: Ratti Buti

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Swat, Chitral, Hazara, Kurram), Punjab (Murree hills)

Medicinal Uses: Decoction of this plant is used in headache and earache also effective in jaundice, malarial fever and hypertension. Decoction of the fresh leaves is gargled for sore throat. Juice of the fresh ground leaves is taken for hyperpigmentation of the skin. Decoction of the fresh or dried leaves is also swallowed for hyperpyrexia, pruritis and fever. (Voucher specimen No. 43)

8) ***Amaranthus viridis*** Linn. (Syn: *A. gracilis* Desf.) — Family: Amaranthaceae

Flowering period: Mar-Nov — Habit: Herb

Part Used: Leaves — Local Name: Chaleri

Distribution: Common throughout Pakistan

Medicinal Uses: Leaves are used as emollient. Also used in scorpion sting and snakebite. Juice of the leaves is mixed with oil, applied to the scalp as hair tonic.

Other Uses: Cooked as a vegetable. (Voucher specimen No. 42)

9) ***Angelica glauca*** Edgew — Family: Umbelliferae

Flowering period: July to October — Habit: Herb

Part Used: Roots — Local Name: Chora

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Swat, Chitral, Dir, Hazara) & Punjab (Murree)

Medicinal Uses: It is useful in dyspepsia and constipation.

Other Uses: Roots are valuable for oil used as condiments and spices. (Voucher specimen No. 100)

10) ***Arisaema flavum*** (Forsskal) Schott — Family: Araceae

Flowering period: June-July — Habit: Herb

Part Used: Root, seed — Local Name: Obais

Distribution: Azad Kashmir, Baluchistan, North Western Frontier Province (Swat, Dir, Hazara, Kurram, Kaghan) & Punjab (Murree)

Medicinal Uses: Juice of the fresh root is applied as an antidote to the snakebite. Few seeds (twice a day) are given to poultry against 'Rani khait' disease.

Other Uses: Mixture of milk from different cattle is protected from souring by placing its dried root in wooden pot before pouring (Ayubia). Also used as a fodder. (Voucher specimen No. 84)

11) ***Artemisia roxburghiana*** Wall.ex Besser — Family: Asteraceae

Flowering period: August-September — Habit: Herb

Part Used: Leaves — Local Name: Chao

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Kaghan, Dir, Hazara)

Medicinal Uses: Anthelmintic and antiseptic. Used in earache, toothache and asthma. Decoction of leaves is given to children against worms or applied over wounds (Ayubia). (Voucher specimen No. 102)

12) ***Artemisia indica*** Willd. — Family: Asteraceae

Flowering period: July-September — Habit: Herb

Part Used: Whole plant — Local Name: Matura

Distribution: North Western Frontier Province (Swat, Chitral, Peshawar, Hazara)

Medicinal Uses: It is used in stomach problems, nappy rash, irritated eyes and ear diseases. Improves hair length and health.

Other Uses: As an insecticide for clothes. (Voucher specimen No. 99)

13) ***Artemisia scoperia*** Walds & Kit. Family: Asteraceae

Flowering period: August November Habit: Herb

Part Used: Whole plant Local Name: Dona Jhan

Distribution: Baluchistan, North Western Frontier Province (Hazara) & Punjab (Plains)

Medicinal Uses: Infusion of the plant is used as purgative. Plant is also used as cure for earache. Smoke is known to be good for burns. (Voucher specimen No. 103)

14) ***Asparagus adscendens*** Roxb. Family: Liliaceae

Flowering period: October-November Habit: Herb

Part Used: Root Local Name: Musli Sufad

Distribution: Azad Kashmir (Kotli, Mirpur), North Western Frontier Province (Hazara) & Punjab (Rawalpindi hills)

Medicinal Uses: Root is useful in diarrhea, dysentery, asthma and general debility and also used to increase lactation after delivery. (Voucher specimen No. 112)

15) ***Atropa acuminata*** Royle ex Lindley Family: Solanaceae

Flowering period: Throughout the year Habit: Herb

Part Used: Whole Plant Local Name: Cheela Lubar/Pulara

Distribution: Azad Kashmir, Baluchistan, Northern Areas, North Western Frontier Province (Swat, Chitral, Dir, Hazara, Dungagali, Thandiani) & Punjab (Changla)

Medicinal Uses: Used as a sedative, antispasmodic and in convulsive disorders and asthma. As an antidote for poisoning. (Voucher specimen No. 06)

16) ***Barleria cristata*** L. Family: Acanthaceae

Flowering period: July-October Habit: Herb

Part Used: Whole plant Local Name: Tadrelu

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Hazara) & Punjab (Murree & Rawalpindi)

Medicinal Uses: Its roots and leaves are used to reduce swelling. Infusion is given in

cough. Root is also used in rheumatism and pneumonia. Decoction of the whole plant is used as a substitute for human milk. Used in snakebite. Leaves boiled within oil are used in ear and eye ailments (Margalla). (Voucher specimen No. 98)

17) ***Berberis lycium*** Royle — Family: Berberidaceae

Flowering period: Mar-Jun — Habit: Shrub

Part Used: Whole plant — Local Name: Kashmal/Sumbal

Distribution: Azad Kashmir, Baluchistan (Shahrig & Harboi hills), North Western Frontier Province (Hazara, Swat, Dir) & Punjab (Hills)

Medicinal Uses: The watery extract from the root and stem is called "Rasout" which is used in opthalmia & jaundice. Fruit is cooling and laxative, and used for the relief of intestinal colic (antispasmodic) and for the treatment of pharyngitis. Plant bark is used for the improvement of internal wounds and throat pains. The bark of the root is also used against diabetes. Powdered root bark mixed with mustard oil is massaged over fractured bones. Powdered root and stem barks is effective in headache, ear injury, lumbago and whooping cough (Ayubia). Decoction of fruit is used in typhoid and common fever (Hilkot). For curing backache, rheumatism, jaundice, urinary tract infection, cystitis, dried ground root bark is taken orally with water. Decoction of the dried ground root bark is used for general health maintenance of the adults.

Other Uses: Also used as a fodder. (Voucher specimen No. 41)

18) ***Bergenia ciliata*** (Haw.) Sternb. — Family: Saxifragaceae

Flowering period: March-July — Habit: Herb

Part Used: Leaves, root — Local Name: Zakham-e-Hayat

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Hazara, Swat, Dir, Chitral)

Medicinal Uses: It is used in fevers, dyspepsia and bronchitis. Dried pulverized root is sprinkled over wound for healing and decoction is used against indigestion and restoration of vitality in men (Hilkot). Fresh boiled leaves are applied externally as a cosmetic to the skin. Rhizome mixed in milk and sugar is used in colon cancer and

muscular pains daily before breakfast. Powdered rhizome is applied over wounds (Ayubia). (Voucher specimen No. 40)

19) ***Bergenia himalaica*** Boiss. Family: Saxifragaceae

Flowering period: March-August Habit: Herb

Part Used: Root Local Name: Zakham-e-Hayat

Distribution: North Western Frontier Province (Gallies) & Punjab (Murree hills)

Medicinal Uses: Root is tonic used in fevers, diarrhea and applied to boils and ophthalmia. (Voucher specimen No. 39)

20) ***Bistorta amplexicaulis*** (D. Don.) Green

(Syn: *Polygonum amplexicaule* D. Don.) Family: Polygonaceae

Flowering period: June-September Habit: Herb

Part Used: Leaves, rhizome, root Local Name: Maslun

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Hazara, Chitral, Swat, Kurram) & Punjab (Murree)

Medicinal Uses: Febrifuge. Tea made from fresh roots and leaves is used in flu, joint pain and colic, give warmth to body in winter. Used in menstruation problems, leucorrhoea, backache, wound healing and ulcers. Whole plant or syrup of the dried root is considered as a general body tonic. Decoction of rhizome is used in cough and stomach problems.

Other Uses: Also used as a fodder. (Voucher specimen No. 85)

21) ***Boerhavia procumbens*** Banks ex Roxb. Family: Nyctaginaceae

Flowering period: August-September Habit: Herb

Part Used: Bark, roots Local Name: Itsit

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Hazara) & Punjab (Murree & Rawalpindi)

Medicinal Uses: The roots are purgative and diuretic and is also used in scorpion bite. (Voucher specimen No. 104)

22) ***Cannabis sativa*** L. Family: Cannabinaceae

Flowering period: April-October Habit: Herb

Part Used: Whole plant Local Name: Bhang

Distribution: North Western Frontier Province, Baluchistan (Jhal) & Punjab (Plains)

Medicinal Uses: Decoction of the leaves is given to females in infertility, while poultice of the leaves is applied to the hypogastrium for dysmenorrhoea. Dried and crushed leaves are taken as a drink for their narcotic action also used as refrigerant. The plant is used as astringent, tonic, narcotic, sedative and anodyne, causes dyspepsia, cough, hyperpyrixia and insanity. Crushed leaves are given to animals as appetizer. Seeds are given to poultry to enhance egg production and oil is used to keep body warm in cold season (Hilkot).

Other Uses: The fiber hemp obtained from the stem of the plant is used for weaving cloth. The intoxicating drugs 'bhang' 'ganja; and 'charas' are obtained from the resinous exudation of the stem, young leaves and flowers. (Voucher specimen No. 46)

23) ***Carissa opaca*** Stapf. ex Haines Family: Apocynaceae

(Syn: *C. spinarum* non L.)

Flowering period: April-June Habit: Shrub

Part Used: Whole plant Local Name: Garanda

Distribution: North Western Frontier Province & Punjab (Murree)

Medicinal Uses: Grounded root is put in worm infested sores of animals. Fruit and leaves are known as cardiac stimulants. Leaf decoction is used for asthma (Margalla).

Other Uses: Fruit is edible. Also used as fly repellent. (Voucher specimen No. 47)

24) ***Cedrus deodara*** (Roxb. ex. D. Don.) G. Don Family: Pinaceae

Flowering period: October Habit: Tree

Part Used: Wood, bark Local Name: Deodar/Diar

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Hazara, Dir, Swat, Chitral, Kaghan, Kurram)

Medicinal Uses: Wood is used to cure rheumatism, pulmonary and urinary disorders, piles, kidney stone and also as an antidote to poison. Wood is boiled in water and this

water called 'loh' is taken as a tonic. Gum is taken with milk for allergic disorders of the skin. Oil is known as effective for ulcer and skin diseases. Bark is known as useful for fever, diarrhea and dysentery.

Other Uses: Wood is durable, aromatic and of excellent quality and extensively used for construction, furniture, vehicles and boat. Oil is used as a seal for skin boats. Used poorly as fuelwood also. (Voucher specimen No. 111)

25) ***Cichorium intybus*** L. Family: Asteraceae

Flowering period: July- September Habit: Herb

Part Used: Root, seed Local Name: Kasni

Distribution: North Western Frontier Province & Punjab

Medicinal Uses: Decoction of the fresh and ground root is taken for all kinds of fevers (e.g., typhoid, malaria, tuberculosis) and good mental capabilities. Decoction of fresh ground root is made kept overnight used for lowering blood pressure in a hypersensitive status. Decoction of powdered seed is used in amenorrhoea and menorrhagia.

Other Uses: As a fodder for cattle. (Voucher specimen No. 97)

26) ***Cirsium arvense*** (L.) Scop. Family: Asteraceae

Flowering period: Mar-May Habit: Herb

Part Used: Whole plant Local Name: Kandehara

Distribution: North Western Frontier Province, Baluchistan & Punjab (Rawalpindi)

Medicinal Uses: Leaves when chewed causes vomiting. Plant is diaphoretic and tonic. (Voucher specimen No. 38)

27) ***Cissampelos pariera*** Linn. Family: Menispermaceae

Flowering period: Whole year Habit: Climbing shrub

Part Used: Leaves, roots Local Name: Bilri, Pilligar

Distribution: North Western Frontier Province, Punjab & Sind

Medicinal Uses: The root is used as stomachic in dyspepsia and diarrhea. Leaves are applied to abscesses, wounds including snakebites and to relieve itching. The whole plant

is used in malaria. (Voucher specimen No. 37)

28) ***Colchicum luteum*** Baker — Family: Colchicaceae

Flowering period: January-March — Habit: Herb

Part Used: Corm — Local Name: Surinjan talkh

Distribution: Azad Kashmir, North Western Frontier Province (Hazara, Dir, Swat, Chitral, Kaghan) & Punjab(Murree)

Medicinal Uses: Corm is used for rheumatism, gout and disease of spleen and liver, externally it is applied to reduce inflammation and pain.

Other Uses: The seeds and corm contain an alkaloid colchicine, which is used in plant breeding work to induce doubling of chromosomes. (Voucher specimen No. 01)

29) ***Convolvulus arvensis*** L. — Family: Convolvulaceae

Flowering period: Throughout the year — Habit: Herb

Part Used: Whole Plant — Local Name: Lehli /Hiran padi

Distribution: North Western Frontier Province (Hazara) & Punjab (Lahore & Rawalpindi) & Sind (Karachi, Indus delta)

Medicinal Uses: Its roots are known as purgative. For pinworms leaves along with fruit are used. The whole plant is used for skin diseases and as antidandruff.

Other Uses: As fodder for goats and cattle. (Voucher specimen No. 37)

30) ***Corydalis stewartii*** Fedde — Family: Fumariaceae

Flowering period: July-August — Habit: Herb

Part Used: Whole plant — Local Name: Momiran/Mamiri

Distribution: North Western Frontier Province (Nathiagali)

Medicinal Uses: Decoction of immature leaves and twigs or sap of plant is used in eye diseaeses (Ayubia). (Voucher specimen No. 96)

31) ***Cuscuta reflexa*** Roxb. Family: Cuscutaceae

Flowering period: August-October Habit: Herb(Climber)

Part Used: Stem, seed Local Name: Ghasbel/Nilatar

Distribution: Baluchistan, North Western Frontier Province, Punjab, Sind (Karachi & Kutch)

Medicinal Uses: The plant is known as anthelmintic, carminative, alterative, purgative and diuretic. Used in jaundice, joint pain, paralysis, vomiting & toothache. Seed is known to be carminative, alterative, anthelmintic. Stem is used in bilious disorders. Juice of the fresh stem is taken for general health maintenance. Also used in eye and heart diseases. (Voucher specimen No. 105)

32) ***Cynodon dactylon*** (L.) Piers. Family: Poaceae

(Syn: *Panicum dactylon* L.)

Flowering period: April-October Habit: Herb

Part Used: Whole plant Local Name: Talla

Distribution: Throughout Pakistan

Medicinal Uses: An infusion of the grass with milk is used for bleeding piles, irritation of urinary organs, dropsy and vomiting. Crushed plant in the form of paste is applied for checking bleeding (Siran). The juice is also given in dysentery. It is also given to cows for increasing milk and butter production. (Voucher specimen No. 48)

Other Uses: As fodder for cattle.

33) ***Cynoglossum lanceolatum*** Forsskal Family: Boraginaceae

Flowering period: July-September Habit: Herb

Part Used: Leaves, branches Local Name: Choro

Distribution: Azad Kashmir, North Western Frontier Province (Kaghan, Siran, Shangla hills & Kurram), Punjab (Rawalpindi)

Medicinal Uses: Fresh leaves and branches are chewed as expectorant. (Voucher specimen No. 95)

34) ***Daphne mucronata*** Royle — Family: Thymeleaceae

(Syn: *D. angustifolia* C. Kock)

Flowering period: Mar-May — Habit: Shrub

Part Used: Whole plant — Local Name: Kuttilal

Distribution: Azad Kashmir (Poonch), Baluchistan (Quetta, Ziarat, Harnai & Lorali), Northern Areas (Gilgit), North Western Frontier Province (Hazara, Swat, Chitral & Kaghan)

Medicinal Uses: Bark is used in the form of poultice in tumors, swellings and bone diseases. Fresh fruit is taken as a mild laxative in constipation. (Voucher specimen No. 35)

Other Uses: Fruit is eaten.

35) ***Datura stramonium*** L. — Family: Solanaceae

Flowering period: March-September — Habit: Herb

Part Used: Leaves, flower, fruit — Local Name: Dhatura

Distribution: Azad Kashmir (Poonch), Baluchistan, Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Dir), Punjab (Murree)

Medicinal Uses: The plant parts are used in fevers, skin diseases, dyspepsia and for removing abdominal worms. Juice of the fruit is applied to scalp for falling hairs and as antidandruff. Juice of the flower is used in earache. Leaves are applied to boils, sores and fish bite.

Other Uses: Seeds and leaves are used as narcotic. (Voucher specimen No. 34)

36) ***Dioscorea deltoidea*** Wall. — Family: Dioscoreaceae

Flowering period: May-July — Habit: Herb Climbing

Part Used: Tuber — Local Name: Kanis

Distribution: Azad Kashmir, Baluchistan, Northern Areas, North Western Frontier Province (Kaghan, Hazara, Swat), Punjab(Murree)

Medicinal Uses: It is useful in kidney problems and rheumatism and also used as antilice and pain reliever.

Other Uses: Used as a fish poison. (Voucher specimen No. 81)

37) ***Diospyros lotus*** Linn. Family: Ebenaceae

Flowering period: May Habit: Tree

Part Used: Bark, fruit Local Name: Kala Amlok

Distribution: North Western Frontier Province (Hazara)& Punjab(Rawalpindi)

Medicinal Uses: Bark is used in the form of poultice for boils and tumors. Infusion of fruit is used as a gargle in sore throat. Juice of the unripe fruit is given in chronic diarrhoea and dysentery.

Other Uses: Fruit is edible. Also used for furniture making and as a fuelwood. Foliafe is used as a fodder. (Voucher specimen No. 80)

38) ***Dodonaea viscosa*** (Linn.) Jacq. Family: Sapindaceae

Flowering period: February-March Habit: Shrub

Part Used: Leaves, bark Local Name: Sanatha

Distribution: Baluchistan (Harnai & Pabi hills), North Western Frontier Province (Hazara, Swat, part of Dir), Punjab(Rawalpindi)

Medicinal Uses: Leaves are known as bitter, astringent; used in gout, rheumatism, swelling and burns. Bark is employed as astringent in bath and fomentation. Warm poultice of the leaves is used to reduce the pain in myalgia, arthralgia and arthritis.

Other Uses: Wood is hard; used for walking sticks and tool handles, excellent firewood also used as a hedge plant and fruit is used as fish poison. Also used in the construction of roof. (Voucher specimen No. 07)

39) ***Dryopteris ramosa*** (Hope) C. Chr. Family: Pteridaceae

Flowering period: No flower Habit: Herb

Part Used: Leaves Local Name: Pakha

Distribution: Azad Kashmir (Poonch), Northern Areas (Gilgit), North Western Frontier Province (Chitral, Swat, Hazara, Kaghan) & Punjab (Murree)

Medicinal Uses: Young leaves are cooked and eaten in stomach ulcer, constipation and

used as a tonic. (Voucher specimen No. 02)

40) ***Ephedra gerardiana*** Wallich ex Stapf. Family: Ephedraceae

Flowering period: May-July Habit: Shrub

Part Used: Stem, root, fruit Local Name: Asmani

Distribution: Azad Kashmir, Baluchistan, Northern Areas (Gilgit), North Western Frontier Province (Hazara, Swat, Upper Kaghan, Chitral)

Medicinal Uses: Taken as stimulant and antiallergic. Tincture is used in circulatory collapse or shock. Decoction of stem and root is used for overcoming asthmatic attack. Juice of berries is effective in respiratory disorders.

Other Uses: Fuelwood, used in snuff, goat and yaks feed on winter. (Voucher specimen No. 79)

41) ***Euphorbia helioscopia*** L. Family: Euphorbiaceae

Flowering period: February-March Habit: Herb

Part Used: Root, seed Local Name: Dhodal

Distribution: Baluchistan(Plains), North Western Frontier Province & Punjab(Plains)

Medicinal Uses: The plant is used as cathartic. Seeds with roasted peppers are given in cholera. Milky juice is applied to eruption. Roots are known as anthelmintic. Milky latex is known to be poisonous and causes swelling on the skin.

Other Uses: Also used as a fodder. (Voucher specimen No. 08)

42) ***Euphorbia wallichii*** Hook f. Family: Euphorbiaceae

Flowering period: April-May Habit: Herb

Part Used: Whole plant Local Name: Harvi

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Chitral, Kurram, Hazara, Kaghan)

Medicinal Uses: Milky juice is applied over affected skin portions

Other Uses: It is also used as a fodder. (Voucher specimen No. 49)

43) ***Ficus virgata*** Wall. ex Roxb. Family: Moraceae

(Syn: *F. palmata* Forsskal)

Flowering period: May-November Habit: Shrub

Part Used: Leaves, fruit Local Name: Phagwara

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Swat & Hazara), Punjab (Rawalpindi & Murree)

Medicinal Uses: Its fruit is known as laxative and demulcent; used as diet in constipation. It is useful in lung and bladder diseases. Leaves are boiled in the milk of goat used to soften the arteries (Margalla).

Other Uses: Fruit edible; Branches and leaves are used as a cattle fodder. (Voucher specimen No. 78)

44) ***Flacourtia indica*** (Burm.) Merrill. Family: Flacourtiaceae

(Syn: *F. ramontchi* L' Herit)

Flowering period: March-April Habit: Tree

Part Used: Fruit, Gum Local Name: Kokoh

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Swat, Hazara) & Punjab (Rawalpindi)

Medicinal Uses: Its fruit is recommended in jaundice and enlarged spleen. Gum is used with other ingredient in cholera.

Other Uses: Fully ripened fruit is normally eaten by people. Unripened fruit is considered to be toxic to human and is avoided to eat. (Voucher specimen No. 33)

45) ***Fragaria nubicola*** Lindley ex Lacaita Family: Rosaceae

Flowering period: April-June Habit: Herb

Part Used: Leaves, fruit Local Name: Panjakha/Budimeva

Distribution: Azad Kashmir (Poonch), Northern Areas (Gilgit), North Western Frontier Province (Kurram, Dir, Chitral, Swat, Hazara)

Medicinal Uses: Its leaves and fruits are used as antiseptic and carminative; crushed leaves are effective in stomach ulcer and extract of leaves and fruit is applied over

wounds.

Other Uses: Berries are edible. It is also used as a fodder. (Voucher specimen No. 50)

46) ***Fumaria indica*** (Hausskn.) Pugsley — Family: Fumariaceae

Flowering period: March-June — Habit: Herb

Part Used: Whole plant — Local Name: Pitpapra

Distribution: Baluchistan, North Western Frontier Province (Hazara & Kurram), Punjab & Sind

Medicinal Uses: Juice of the plant is given in common fever, for the treatment of simple goiter and skin eruption; also used as vermifuge, antipyretic, blood purifier and antiperiodic. Also used in diarrhea of cattle. Decoction of whole plant is taken as a cooling agent and decoction of fresh leaves is taken against jaundice, diabetes, dyspepsia and joint pains. Decoction or infusion of herb is recommended in constipation, leprosy, serofula & syphilis also.

Other Uses: It is also used as a fodder. (Voucher specimen No. 51)

47) ***Galium aparine*** L. — Family: Rubiaceae

Flowering period: April-July — Habit: Herb

Part Used: Whole Plant — Local Name: Kochan

Distribution: Baluchistan, North Western Frontier Province & Punjab (Rawalpindi)

Medicinal Uses: It is found useful in jaundice and injury. Whole plant is wrapped over wound till recovery in case of injury. Decoction of whole plant is used in jaundice taken daily (Ayubia).

Other Uses: It is also used as a fodder. (Voucher specimen No. 52)

48) ***Gentianodes kurroo*** Royle. — Family: Gentianaceae

(Syn: *Gentiana kurroo* (Royle) Omer, Ali & Qaiser)

Flowering period: Sep-Oct — Habit: Herb

Part Used: Root — Local Name: Nilkant

Distribution: Punjab (Murree hills) & North Western Frontier Province (Gallies)

Medicinal Uses: Decoction of its root is effective in stomachache and in complains of bladder. (Voucher specimen No. 110)

49) ***Geranium wallichianum*** D. Don. ex Sweet — Family: Geraniaceae

Flowering period: July-September — Habit: Herb

Part Used: Whole plant — Local Name: Rattanjot

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Chitral, Dir, Hazara, Gallies) & Punjab (Murree)

Medicinal Uses: Dried ground stem is used for diarrhea, powdered root with milk or oil is also used for myalgia. Cooked 'halwa' of powdered roots is useful in muscular pains and painful joints especially backache. Effective in complains of kidney and spleen, used in toothache and irritating eyes. Burnished root is used in hay fever, diabetes and urinary diseases (Hilkot).

Other Uses: It is also used as a fodder. (Voucher specimen No. 94)

50) ***Hedera nepalensis*** K. Koch.(Syn: *H. helix* L.) — Family: Araliaceae

Flowering period: September-October — Habit: Woody climber

Part Used: Leaves, fruit — Local Name: Kurie/Albumber

Distribution: North Western Frontier Province (Gallies) & Punjab (Murree hills)

Medicinal Uses: Its leaves are chewed and swallowed to control diabetes and also given to cattle for increasing milk supply (Ayubia). Berries are purgative.

Other Uses: Also used as a fodder. (Voucher specimen No. 109)

51) ***Hyoscyamus niger*** L. — Family: Solanaceae

Flowering period: February-March — Habit: Herb

Part Used: Leaves, seeds — Local Name: Ajwain Khurasani

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Swat, Chitral) & Punjab (Murree)

Medicinal Uses: It is used as sedative. Dried ground seeds are mixed with ghee and taken for myalgia. Leaves are used in asthma and whooping cough (Hilkot).

Other Uses: Used for narcotic purposes. (Voucher specimen No. 09)

52) ***Hypericum perforatum*** Linn. Family: Hyperiaceae

Flowering period: May-August Habit: Herb

Part Used: Leaves, stem Local Name: Balsana

Distribution: Azad Kashmir (Poonch), Northern Areas, North Western Frontier Province (Swat, Hazara, Chitral), Punjab (Murree)

Medicinal Uses: Its leaves are used for making tea; also used as a diuretic and anti depression. Dried ground stem is taken to enhance wound healing, while powdered extract is applied to wounds. Decoction of leaves is especially useful for women who are suffering from insomnia due to depression. (Voucher specimen No. 77)

53) ***Ipomoea hederacea*** (L.) Jacq. Family: Convolvulaceae

Flowering period: September-October Habit: Climbing herb

Part Used: Seed Local Name: Kaladana

Distribution: North Western Frontier Province (Hazara) & Punjab (Plains)

Medicinal Uses: Its seeds are purgative. (Voucher specimen No. 117)

54) ***Isodon rugosus*** (Wall. ex Benth.) Codd. Family: Labiatae

(Syn: *Plectranthus rugosus* Wallich ex Benth.)

Flowering period: May-September Habit: Herb

Part Used: Leaves Local Name: Boei

Distribution: Azad Kashmir (Poonch), Baluchistan, Northern Areas, North Western Frontier Province (Chitral, Swat, Hazara), Punjab (Murree)

Medicinal Uses: Decoction of its fresh leaves is effective in earache and body itching. (Voucher specimen No. 76)

55) ***Jasminum humile*** Linn. Family: Oleaceae

Flowering period: April-June Habit: Shrub

Part Used: Root, flower Local Name: Peeli Chammbeli

Distribution: Baluchistan, North Western Frontier Province & Punjab

Medicinal Uses: Its flowers used as astringent and tonic to heart and bowels. Root is used in ringworm. Milky juice of plant is used for destroying the unhealthy lining walls of chronic sinuses and fistulas.

Other Uses: Perfume made from the flower is highly prized. It is eaten by grazing animals. (Voucher specimen No. 53)

56) ***J. officinale*** Linn. Family: Oleaceae

Flowering period: May-July Habit: Shrub

Part Used: Whole plant Local Name: Chammbeli

Distribution: Salt range & Hazara

Medicinal Uses: The plant is used as diuretic, emmenagogue and anthelmintic. Flowers are applied in skin diseases, headache, weak and tired eyes and in scorpion bite. Leaves are chewed as a treatment against ulceration or eruptions in the mouth.

Other Uses: Perfume made from the flower is highly prized. The plant is eaten by grazing animals. (Voucher specimen No. 75)

57) ***Justicia adhatoda*** Linn. Family: Acanthaceae

(Syn: *Adhatoda vasica* Nees.)

Flowering period: February-April Habit: Shrub

Part Used: Leaves, root, stem, flower Local Name: Bhekar

Distribution: North Western Frontier Province (Kohat, Hazara, Salt & Suleman ranges), Punjab (Rawalpindi), Sind (Karachi)

Medicinal Uses: Its crushed leaves and roots are used for cough, bronchitis, asthma and rheumatism. Leaves are also used for stomachache, joint pain and eruption. Used in dysentery, especially in case of cattle. Leaf buds are used in diabetes (Margalla). Decoction of the fresh leaves is applied to the vaginal canal to treat a prolapsed uterus. Infusion of flower and fruit is used as anthelmintic.

Other Uses: As a hedge plant. (Voucher specimen No. 11)

58) ***Lavatera kashmiriana*** Cambess Family: Malvaceae

Flowering period: June-August Habit: Herb (Sub-shrub)

Part Used: Whole plant Local Name: Raisha khatmi

Distribution: Azad Kashmir, Baluchistan, Northern Areas, North Western Frontier Province (Swat & Hazara) & Punjab (Murree)

Medicinal Uses: Its root is used as an efficient emollient, used in making constituent of various cough mixtures. Leaves are used as poultice and fomentation. Oil of the seed is known useful in kidney and bladder ailments.

Other Uses: The flower yields a red dye, which is used as an indicator. (Voucher specimen No. 86)

59) ***Mallotus phillipensis*** (Lam.) Muell.-Arg. Family: Euphorbiaceae

Flowering period: February-November Habit: Tree

Part Used: Fruits, leaves, bark Local Name: Kamila

Distribution: North Western Frontier Province (foothills of Hazara, Swat & Dir)

Medicinal Uses: Powder obtained from its fruit is used as a vermifuge, purgative and in certain parasitic skin diseases. The leaves and barks are used for poulticing in skin problems. Decoction of the bark is used as tonic.

Other Uses : It is also used as a dye. (Voucher specimen No. 12)

60) ***Mentha longifolia*** (L.) Huds. Family: Labiatae

(Syn: *M. sylvestris* L.)

Flowering period: July-August Habit: Herb

Part Used: Leaves Local Name: Bareena/Chitta Pudina

Distribution: Azad Kashmir (Poonch), Baluchistan, North Western Frontier Province (Swat & Hazara)

Medicinal Uses: Decoction of its root with cardamoms is given to children to check vomiting. Leaves are chewed in toothache and dry or fresh leaves are taken in diarrhea,

stomachache, dyspepsia, colic, cough and vomiting with water, green tea or curd till recovery. Infusion of leaves is taken as a cooling medicine. Leaves are also used to relieve dryness of mouth. Warm poultice of the fresh leaves is applied to blisters for pain relief and pus release. (Voucher specimen No. 93)

61) ***Morus alba*** L. Family: Moraceae

Flowering period: March-April Habit: Tree

Part Used: Leaves, stem, bark, fruit Local Name: Toot

Distribution: Baluchistan, North Western Frontier Province & Punjab

Medicinal Uses: Its leaves are known as diaphoretic and emollient. A decoction of leaves is used as gargle in inflammation of throat. A warm poultice of the fresh leaves is applied to burns and small ulcers of the skin for quick healing. The fruit is used as cooling and laxative. It is used for sore throat, dyspepsia and melancholia. Root bark is known as anthelmintic and astringent. Leaves are given to cows as galactogogue.

Other Uses: Fruit is edible. Leaves are used for sericulture and as fodder. Wood yield timber for making furniture and as a fuelwood. (Voucher specimen No. 32)

62) ***Myrsine africana*** Linn. Family: Myrsinaceae

Flowering period: February-April Habit: Shrub

Part Used: Leaves, flower Local Name: Chapra/Bebrang

Distribution: North Western Frontier Province (Hazara, Chitral, Salt & Suleman ranges)

Medicinal Uses: Cathartic, stomachic and vermifuge. (Voucher specimen No. 13)

63) ***Nasturtium officinale*** R. Br. Family: Brassicaceae

Flowering period: February-July Habit: Herb

Part Used: Whole plant Local Name: Taramera

Distribution: North Western Frontier Province, Punjab (Plains & hills) & Waziristan

Medicinal Uses: It is used in the complaints of chest; also used as an appetizer. (Voucher specimen No. 14)

64) ***Nerium oleander*** L. Family: Apocynaceae

Flowering period: April-October Habit: Shrub

Part Used: Whole plant Local Name: Kanair

Distribution: North Western Frontier Province(Hazara, Salt & Suleman ranges)

Medicinal Uses: Its bark is used in skin diseases, especially leprosy. Root is used for abortion. Root paste is useful in scorpion sting and snakebite. Decoction of leaves is applied externally to reduce swellings (Margalla). Decoction of fresh stem is taken for allergies and applied for leucoderma. (Voucher specimen No. 54)

65) ***Paeonia emodi*** Wallich ex Royle Family: Paeoniaceae

Flowering period: May-June Habit: Herb

Part Used: Tuber, flower, seed Local Name: Mamekh

Distribution: Azad Kashmir(Poonch), North Western Frontier Province(Hazara, Swat, Chitral, Dir, Kaghan) & Punjab(Murree)

Medicinal Uses: It is used as tonic, also found useful in nervous disorders. The dried flowers are used for stomach complaints (Diarrhea). Dried tubers mixed with rattanjot and boiled in milk or fried in food are used once daily for all kinds of pains especially lumbago, rheumatism, arithritis, muscular pain and backache (Ayubia). Seeds are purgative and emetic. (Voucher specimen No. 74)

66) ***Pinus roxburghii*** Sargent (Syn: *P. longifolia* Roxb.) Family: Pinaceae

Flowering period: January-April Habit: Tree

Part Used: Leaves, resin, wood Local Name: Chir

Distribution: North Western Frontier Province(Swat, Dir, Hazara) & Punjab(Murree)

Medicinal Uses: Its wood is used to cool the burning sensation of the body. Resin is employed as a stimulating application for ulcer and abscesses and as basis for plaster. Paste is used for painful chest. Wood and resin used in snakebite and scorpion sting. Decoction of the dried leaves is used as an anti allergic to treat utricaria and pruritis.

Other Uses: Its seeds are edible, wood is used for general construction purposes and as a fuelwood. Resin used in the manufacture of bangles, charcoal and also for removing

unwanted hairs from skin. Bark yield tannins used for dyeing leather. Twigs are also used for roof making. (Voucher specimen No. 03)

67) ***Plantago lanceolata*** Linn. Family: Plantaginaceae

Flowering period: April-September Habit: Herb

Part Used: Whole plant Local Name: Ispaghol

Distribution: Throughout Pakistan excluding Sind

Medicinal Uses: It is found useful in toothache and in dysentery also. Effective for wound bruises and inflamed areas. Lotion of the oil from the fresh ground leaves is applied externally to burns and ulcers of the skin. Powder of the dried seed is applied to tooth for pain relief. Seeds are also taken for diarrhea and constipation. (Voucher specimen No. 55)

68) ***Plantago major*** Linn. Family: Plantaginaceae

Flowering period: April-May Habit: Herb

Part Used: Whole plant Local Name: Chamchipatra/Batti

Distribution: Throughout Pakistan excluding Sind

Medicinal Uses: Its dried seeds are either chewed or taken in powder form in dyspepsia, constipation and stomachache. For treating 'Mavakhar' in cattles, crushed plant material is applied on affected hoof and the remaining is placed between hooves till recovery (Ayubia). Leaves are applied to burns in the form of poultice.

Other Uses: It is also used as a fodder. (Voucher specimen No. 56)

69) ***Plantago ovata*** Linn. Family: Plantaginaceae

Flowering period: March-May Habit: Herb

Part Used: Seed Local Name: Isabghol

Distribution: Throughout Pakistan

Medicinal Uses: Its dried seeds are taken orally with water in dyspepsia, dysentery and constipation. (Voucher specimen No. 31)

70) ***Podophyllum hexandrum*** Royle Family: Podophyllaceae

(Syn: *P. emodi* Wall. ex Royle)

Flowering period: May-August Habit: Herb

Part Used: Rhizome, fruit, seed Local Name: Bankakri

Distribution: Azad Kashmir(Poonch), Baluchistan, Northern Areas, North Western Frontier Province(Hazara, Swat, Chitral, Dir) & Punjab(Murree)

Medicinal Uses: Its rhizome and roots are hepatic stimulant and purgative. Fruit syrup is used as a tonic. Seeds are used for the complaints of liver and stomach. Also used in cardiac problems. Used in cough, skin diseases and as a slow purgative (Hilkot). Rhizomes are known to be used in cancer. Dried ground root is used with water for arthritis. Fruit is eaten as aphrodisiac.

Other Uses: Also used as a fodder. (Voucher specimen No. 73)

71) ***Polygonum plebeium*** R. Brown Family: Polygonaceae

Flowering period: December-May Habit: Herb

Part Used: Whole plant Local Name: Dremak

Distribution: Throughout Pakistan

Medicinal Uses: Dried and powdered plant is taken internally in pneumonia. Root is used in bowel complaints. (Voucher specimen No. 113)

72) ***Potentilla nepalensis*** Hk. Family: Rosaceae

Flowering period: June-September Habit: Herb

Part Used: Root Local Name: Rattan jot/Mammhar

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Hazara, Swat, Kalam) & Punjab

Medicinal Uses: It is used as febrifuge, blood purifier and stomachic. Ashes mixed with oil are applied to burnt parts. (Voucher specimen No. 87)

73) ***Punica granatum*** Linn. Family: Punicaceae

Flowering period: April-July Habit: Shrub

Part Used: Fruit, root, bark, seed Local Name: Daruna

Distribution: Azad Kashmir, Baluchistan, Northern Areas, North Western Frontier Province(Hazara, Swat, Chitral, Dir, Kurram, Salt ranges)

Medicinal Uses: Its seeds are used as stomachic; pulp is used as cardiac and stomachic. Fresh juice is known as cooling, refrigerant and used as a tonic in fever. Decoction of root and stem bark is used as astringent and anthelmintic for tapeworm. Powdered rind mixed with sugar used for diarrhea and dysentery control (Hilkot). Dried ground rind of fruit is mixed in curd for coughs and sore throat, also nocturnal enuresis in child. Dried ground pericarp is applied to cuts as an antiseptic and taken in dysmenorrhoea, vomiting and diarrhoea.

Other Uses: Fruit is edible. A number of dyes can be extracted from it. Also used as fuelwood. Black writing ink is also made from it. Dried seeds are used to add taste to certain foods. Foliage given to cattle as a fodder. (Voucher specimen No. 57)

74) ***Pyrus pashia*** Buch.-Ham. ex D. Don. Family: Rosaceae

Flowering period: March-April Habit: Tree

Part Used: Fruit, leaves, wood Local Name: Batangi

Distribution: Azad Kashmir, North Western Frontier Province(Hazara, Swat, Chitral) & Punjab(Murree)

Medicinal Uses: Its fruit is used as laxative, febrifuge, sedative and astringent.

Other Uses: Fruit is edible when half rotten, Leaves are eaten as fodder. Wood used for fuel and small agricultural implements are made from it. (Voucher specimen No. 30)

75) ***Quercus leucotrichophora*** A. Camus (Syn: *Q. incana* Roxb.) Family: Fagaceae

Flowering period: Apr-May Habit: Tree

Part Used: Stem, wood, fruit Local Name: Ban/Reen

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province(Hazara, Swat, Chitral, Dir) & Punjab(Murree)

Medicinal Uses: Its acorn is used as astringent and diuretic; also given in diarrhea, indigestion, asthma and gonorrhea.

Other Uses: The wood is used for building purposes and foliage as fodder. Also used as fuelwood. (Voucher specimen No. 58)

76) ***Rheum australe*** D. Don — Family: Polygonaceae

(Syn: *R. emodi* Wall. ex Meisn.)

Flowering period: June-August — Habit: Herb

Part Used: Root — Local Name: Chutial/Revand chinni

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province(Hazara, Swat, Chitral) & Punjab(Murree)

Medicinal Uses: it is a tonic, fresh juice used as a purgative and stomachic in dyspepsia (Hilkot). Known as useful to remove kidney stone. Fresh leaf stalk is eaten to relieve fever. (Voucher specimen No. 108)

77) ***Rosa macrophylla*** Lindley — Family: Rosaceae

Flowering period: April-June — Habit: Climber

Part Used: Whole plant — Local Name: Chal

Distribution: Azad Kashmir(Poonch), Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Dir) & Punjab(Murree)

Medicinal Uses: Decoction of its flower is used in constipation and abdominal pain (Ayubia). Flower is used in skin and eye diseases and also as a heart tonic; recommended by indigenous people in biliousness. (Voucher specimen No. 59)

78) ***Rubia cordifolia*** L. (Syn: *R. purpurea* DC.) — Family: Rubiaceae

Flowering period: Jun-Jul — Habit: Woody climber

Part Used: Root, stem, leaves — Local Name: Manjit

Distribution: Azad Kashmir, Baluchistan, Northern Areas, North Western Frontier Province & Punjab(Murree)

Medicinal Uses: Its stem is used in snakebite and scorpionbite. Dried root powder is

effective in toothache. Decoction of leaves and stem is used as vermifuge, used in amenorrhoea, leucorrhoea, dysmenorrhoea and as diuretic for bladder and kidney problems.

Other Uses: Red dye 'manjit' is made from root and used to dye clothes. (Voucher specimen No. 88)

79) ***Rubus fruticosus*** L. Family: Rosaceae

Flowering period: February-April Habit: Shrub

Part Used: Leaves Local Name: Gharacha

Distribution: Azad Kashmir(Poonch), Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Kurram) & Punjab(Murree)

Medicinal Uses: Decoction of its young leaves is used for urticaria. Old leaves are used in the treatment of diarrhea, cough, reducing fevers and as diuretic.

Other Uses: Used as a hedge plant. The fruits are made into juice and are also eaten. Also used as a fodder. (Voucher specimen No. 15)

80) ***Rumex nepalensis*** Sprengel Family: Polygonaceae

(Syn: *R. peregrinus* Boiss.)

Flowering period: June-September Habit: Herb

Part Used: Leaves, root Local Name: Hula

Distribution: Azad Kashmir(Poonch), Baluchistan(Ziarat), Northern Areas (Gilgit), North Western Frontier Province (Swat, Chitral, Dir, Kurram, Peshawar), Punjab (Murree) & Waziristan

Medicinal Uses: Decoction of its leaves is used in jaundice and also as an antiseptic and haemostatic. Allergy due to the leaves of 'Kikar' (*Acacia nilotica*) can be overcome by rubbing its leaves. Warm poultice of the leaves is applied to boils and carbuncles. Juice of the fresh ground leaves is mixed with mustard oil and applied to scalp as antidandruff. Root is used as purgative.

Other Uses: It is also used as a fodder. (Voucher specimen No. 89)

81) ***Sauromatum venosum*** (Ait.) Schott Family: Araceae

(Syn: *Arum venosum* Ait.)

Flowering period: April-May Habit: Herb

Part Used: Rhizome Local Name: Sap ki booti

Distribution: Azad Kashmir (Poonch, Mirpur), North Western Frontier Province (Hazara, Swat) & Punjab (Murree, Rawalpindi, Saidpur)

Medicinal Uses: Rhizome is used as stimulating poultice in snakebite. (Voucher specimen No. 60)

82) ***Saussurea costus*** (Falc.) Lipsch Family: Asteraceae

(Syn: *S. lappa* (Decne.)Sch. Bip.)

Flowering period: July-August Habit: Herb

Part Used: Root Local Name: Kuth

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Hazara, Kaghan)

Medicinal Uses: It is known as a useful tonic, stomachic, stimulant and carminative. Also used as spasmodic in asthma, cough and cholera and as alterative in skin diseases and rheumatism. (Voucher specimen No. 92)

83) ***Saussurea heteromalla*** (D. Don.) Hand.-Mazz. Family: Asteraceae

Flowering period: August-September Habit: Herb

Part Used: Seed Local Name: Butt peva/Batula

Distribution: Baluchistan, Northern Areas (Gilgit), North Western Frontier Province (Hazara, Swat, Chitral, Kurram) & Punjab (Murree, Lahore)

Medicinal Uses: Seeds are given to horses for digestive complaints and also used in horsebite. To cure wounds and burnt parts of the body.

Other Uses: It is also used as a nutrition rich fodder for cattle. (Voucher specimen No. 107)

84) ***Sida cordifolia*** L. Family: Malvaceae

Flowering period: Throughout the year Habit: Shrub

Part Used: Whole plant Local Name: Bekh Bandal

Distribution: North Western Frontier Province (Swat, Hazara) & Punjab (Lahore, Multan, Jhelum), Sind (Lasbella)

Medicinal Uses: Juice of whole plant is applied in rheumatism, gonorrhea and elephantiasis. Leaves are used in eye diseases. Seeds are considered aphrodisiac. (Voucher specimen No. 16)

85) ***Silene conoidea*** L. Family: Caryophyllaceae

Flowering period: May-June Habit: Herb

Part Used: Whole plant Local Name: Chota takla

Distribution: Baluchistan (Mastung, Qalat, Harboi hills, Kharan), North Western Frontier Province (Hazara)

Medicinal Uses: The plant is known as emollient and is used in bath or as fumigant. Juice of the fresh seeds is rubbed onto pimples and spots. (Voucher specimen No. 72)

86) ***Silybum marianum*** (L.) Gaertn. Family: Asteraceae

Flowering period: March-April Habit: Herb

Part Used: Leaves, seeds Local Name: Kandiali

Distribution: North Western Frontier Province (Hazara, Swat, Peshawar, Kohat, Mansehra, Abbottabad) & Punjab (Lahore, Rawalpindi)

Medicinal Uses: Its leaves are used as aperient and sudorific. Seeds are known as demulcent and are used in hemorrhage. (Voucher specimen No. 29)

87) ***Sisymbrium irio*** Linn. Family: Brassicaceae

Flowering period: February-April Habit: Herb

Part Used: Seed Local Name: Khub Kalan

Distribution: Baluchistan, North Western Frontier Province (Hazara, Kohat, Peshawar, Abbottabad) & Punjab (Rawlapindi)

Medicinal Uses: The seeds are described as having expectorant, stimulant and restorative properties; it is also used externally as a stimulant poultice. Dried ground seeds are taken in food for throat infections. It is also useful for fever. (Voucher specimen No. 17)

88) ***Skimmia laureola*** (DC.) Sieb. & Zucc. ex Walp. Family: Rutaceae

Flowering period: April-June Habit: Shrub

Part Used: Leaves Local Name: Ner

Distribution: Azad Kashmir (Poonch), Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Dir, Kaghan) & Punjab (Murree)

Medicinal Uses: Febrifuge and carminative. Decoction of leaves is used in complains of liver and stomach. Used as incense and fumigant for skin diseases and headache. Dried ground leaves are taken orally with water as an antacid and also for flatulence, colic and heartburn. Dried ground stem and leaves are taken with water to treat insomnia in adults. Leaves are used in small pox.

Other Uses: It is used as an insect repellent, for removal of evils and as preservative in cereal storage. (Voucher specimen No. 61)

89) ***Smilax aspera*** L. Family: Liliaceae

Flowering period: September-November Habit: Climber

Part Used: Root Local Name: Chobchini

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Haripur) & Punjab (Jhelum, Murree, Ghora gali)

Medicinal Uses: It is used as a blood purifier, also used in asthma, cold, in chronic rheumatism, syphilis and skin diseases. (Voucher specimen No. 106)

90) ***Solanum miniatum*** Bernh. ex Willd. Family: Solanaceae

Flowering period: Throughout the year Habit: Herb

Part Used: Leaves, fruit Local Name: Mako/Kachmach

Distribution: Baluchistan, North Western Frontier Province (Hazara, Salt & Suleman ranges), Punjab (Plains), Sind (Karachi, Indus delta, Kutch)

Medicinal Uses: Juice of this plant is diuretic and used in the treatment of enlarged liver. Cooked leaves are useful in constipation and for removing worms. Decoction of the fresh ground leaves is taken orally as an antipyretic. Leaves are applied as poultice in rheumatism, gouty joint and in skin diseases. Fruit is used in heart diseases. (Voucher specimen No. 18)

91) ***Solena amplexicaulis*** (Lam.) Gandhi — Family: Cucurbitaceae

Flowering period: February-June — Habit: Climber

Part Used: Root, leaves, seed — Local Name: Bankakra

Distribution: Azad Kashmir, North Western Frontier Province (Hazara, Swat) & Punjab (Murree)

Medicinal Uses: Its roots, leaves and seeds are considered stimulant and purgative. Juice of leaves applied to inflamed parts. Juice of root mixed with sugar and cumin in cold milk is given to cure spermatorrhoea. (Voucher specimen No. 19)

92) ***Sonchus asper*** (L.) Hill. (Syn: *S. oleraceus* L. var *asper* L.) — Family: Asteraceae

Flowering Period: December-April — Habit: Herb

Part Used: Leaves, root — Local Name: Hind

Distribution: Throughout Pakistan except extreme south

Medicinal Uses: It is used as febrifuge. Decoction of leaves and roots is effective in inflammation, constipation, itching & heart problems.

Other Uses: Cooked as vegetable. (Voucher specimen No. 62)

93) ***Swertia angustifolia*** Buch.-Ham. ex D. Don — Family: Gentianaceae

Flowering period: September-October — Habit: Herb

Part Used: Whole plant — Local Name: Chirayita

Distribution: Azad Kashmir (Poonch), Northern Areas (Gilgit), North Western Frontier Province (Hazara, Swat) & Punjab (Murree)

Medicinal Uses: Febrifuge. Decoction of fresh leaves is used thrice a day for any kind of fever e.g. malaria, typhoid and pneumonia.

Other Uses: Also used as a fodder. (Voucher specimen No. 116)

94) ***Taxus wallichiana*** Zucc. Family: Taxaceae

(Syn: *T. virgata* Wall. ex Hook. f.)

Flowering period: February-March Habit: Tree

Part Used: Leaves, bark, fruit Local Name: Burmi

Distribution: Azad Kashmir (Poonch), Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Kurram, Dir) & Punjab(Murree)

Medicinal Uses: Its bark is used in lung cancers. Ripened fruit and bark are used in bronchitis and hiccough. Powder of dried ground leaves is applied on wounds.

Other Uses: Fleshy fruit is edible. Wood is used for cabinet making, furniture, poles & axles of carts. Foliage is fed to cattle. Also used as a fuelwood. (Voucher specimen No. 20)

95) ***Thymus serphyllum*** L. Family: Labiatae

Flowering period: May-October Habit: Shrub

Part Used: Whole Plant Local Name: Bezori boti

Distribution: Azad Kashmir (Poonch), Baluchistan, Northern Areas (Gilgit), North Western Frontier Province (Hazara, Swat, Chitral, Dir), Punjab(Murree)

Medicinal Uses: It is used in whooping cough, bronchitis, liver and stomach diseases. Decoction of dried ground seed is taken for joint pain and asthma. (Voucher specimen No. 71)

96) ***Tribulus terrestris*** Linn. Family: Zygophyllaceae

Flowering period: August-November Habit: Herb

Part Used: Whole plant Local Name: Bhakra

Distribution: Throughout Pakistan

Medicinal Uses: Its fruit is regarded as tonic diuretic, cooling and aphrodisiac. Also used in urinary disorders, impotency, cough and heart diseases. Seeds are recommended in hemorrhages, diseases of the bladder, kidney stone and gout. Root is used in stomachache

and ulcers. Dried ground stem and leaves are used as a cure for lumbago in old age. (Voucher specimen No. 115)

97) ***Urtica diocia*** L. Family: Urticaceae

Flowering period: March-June Habit: Herb

Part Used: Whole plant Local Name: Bichu boti

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Hazara, Swat, Abbottabad, Kaghan) & Punjab(Murree)

Medicinal Uses: Decoction of leaves useful in rheumatic pain, while part of peeled leaves and twigs or juice of stem applied externally to burns and blisters (Hilkot). Decoction of plant is used as emmenagogue, astringent, anthelmitic and diuretic. (Voucher specimen No. 28)

98) ***Valeriana jatamansi*** Jones. (Syn: *V. wallichii* DC.) Family: Valerianaceae

Flowering period: March-May Habit: Herb

Part Used: Leaves, root, stem Local Name: Mushkbala

Distribution: Azad Kashmir (Poonch), Northern Areas (Gilgit), North Western Frontier Province (Hazara, Swat, Chitral, Dir, Kurram), Punjab(Murree) &Waziristan

Medicinal Uses: Cooling, carminative, powdered roots are given to infants in malnutrition for seven days (Ayubia). Also used in, neurosis, hysteria, epilepsy, cholera. Useful in cough (Hilkot). Dried ground root is taken with water for promoting mental capabilities and general health. Dried ground stem is used orally to cure myalgia, neuralgia, gastritis and heaviness in the chest. Rhizome yields oil, which is used as a remedy for the suppression of urine.

Other Uses: Used for milk clotting and butter making. Protects clothes against insects. Used as an important ingredient in perfumed powders. Also used as a fodder. (Voucher specimen No. 27)

99) ***Verbascum thapsus*** L. Family: Scrophulariaceae

Flowering period: March-October Habit: Herb

Part Used: Whole plant Local Name: Geedar Tamaku

Distribution: Azad Kashmir (Poonch), Baluchistan, Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Dir, Kurram, Ladakh)

Medicinal Uses: The plant is used against diarrhea and dysentery of cattle. Some times used as supporting material and analgesic. Also used as antiseptic. Leaves in powdered form are used for healing the wounds. Seeds are known as aphrodisiac. Also used in cough, fever and pulmonary disease. Warm poultice of the fresh leaves is externally applied to blisters and carbuncles. Decoction of the seed is taken orally as cooling agent and also for fever. Decoction of fresh and ground root is taken in dyspepsia and colic.

Other Uses: Used as a narcotic and fish poison. (Voucher specimen No. 26)

100) ***Verbena officinalis*** Linn. Family: Verbenaceae

Flowering period: February-June Habit: Herb

Part Used: Leaves, root Local Name: Karanta/Pamukh

Distribution: Baluchistan, North Western Frontier Province (Lower Swat, Northern), Punjab & Waziristan

Medicinal Uses: Fresh leaves are used as tonic and febrifuge, roots as cure from scorpion and snakebite. (Voucher specimen No. 21)

101) ***Veronica melissifolia*** Desf. ex Poir. Family: Scrophulariaceae

(Syn: *V. laxa* Benth.)

Flowering period: May-August Habit: Herb

Part Used: Leaves Local Name: Mashkanna

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Hazara, Kaghan, Dir) & Punjab (Murree)

Medicinal Uses: Decoction of leaves is known as effective in abdominal pain.

Other Uses: Also used as a fodder. (Voucher specimen No. 70)

102) ***Viburnum grandiflorum*** Wall. ex DC. Family: Sambucaceae

Flowering period: April-May Habit: Shrub

Part used: Root, bark, fruit Local Name: Guch

Distribution: Azad Kashmir (Poonch), Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Dir) & Punjab(Murree)

Medicinal Uses: Decoction of the root is used to cure urine diseases. Juice of the bark is known to be useful in hemorrhage.

Other Uses: Fruit is edible. (Voucher specimen No. 63)

103) ***Viola canescens*** Wall. ex Roxb. Family: Violaceae

Flowering period: March-May Habit: Herb

Part used: Whole plant Local Name: Banafsha

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Dir) & Punjab (Murree)

Medicinal Uses: The whole plant is taken as blood purifier, refrigerant and emetic. Flower and seeds are used as a mild purgative. Known as useful in constipation, colic and stomach problems. Decoction of dried ground leaves and flowers is used for sore throat, cough, diarrhea, tuberculosis and allergies. Known to improve vision. Tea made from dried roots and flower is effective in cough, fever and migraine.

Other Uses: Also used as a fodder. (Voucher specimen No. 25)

104) ***V. pilosa*** Blume (Syn: *V. serpens* Wallich ex Ging.) Family: Violaceae

Flowering period: March-May Habit:Herb

Part Used: Leaves Local Name: Banafsha

Distribution: Azad Kashmir (Poonch), Northern Areas, North Western Frontier Province (Hazara, Swat, Chitral, Dir, Salt range) & Punjab (Murree)

Medicinal Uses: Taken as blood purifier and refrigerant. Poultice of the fresh ground leaves is applied to the eyes to correct short-sightedness. Decoction of plant is used in fever (Hilkot). Root is used as emetic. (Voucher specimen No. 24)

105) ***Vitex negundo*** L. (Syn: *V. incisa* Lam.) Family: Verbenaceae

Flowering period: March-June Habit: Herb

Part Used: Whole plant Local Name: Nargandi/Marwan

Distribution: Azad Kashmir, Northern Areas, North Western Frontier Province (Lower Hazara, Swat, Kurram) & Punjab (Rawalpindi hills, Murree)

Medicinal Uses: Seed in the powder form is used in leprosy and other skin diseases. Decoction of leaves is used in headache and catarrhal fever. Decoction of root is used in fever and cough. Dried fruit is vermifuge. (Voucher specimen No. 23)

106) ***Withania sominifera*** (L.) Dunal Family: Solanaceae

Flowering period: Throughout the year Habit: Herb

Part Used: Whole plant Local Name: Asgan

Distribution: Throughout Pakistan

Medicinal Uses: Its green leaves are used to relieve the pain from joints and swelling. Roots are used as diuretic and tonic. Juice of the whole plant is useful in rheumatism. The plant is also known as tonic, alterative, astringent, aphrodisiac and sedative. Dried and ground root is taken for general health maintenance.

Other Uses: Seeds are used to coagulate milk. (Voucher specimen No. 04)

107) ***Xanthium strumariam*** L. Family: Asteraceae

Flowering period: July-August Habit: Herb

Part Used: Leaves, root Local Name: Katula

Distribution: Baluchistan (Quetta), Northern Areas (Gilgit, Baltistan), North Western Frontier Province (Hazara, Swat, Chitral) & Punjab, Sind (Karachi)

Medicinal Uses: Used in long standing malarial fever and skin diseases. Fresh and ground root is taken for controlling diarrhea and dysentery. (Voucher specimen No. 91)

108) ***Zanthoxylum armatum*** DC. Family: Rutaceae

Flowering period: Mach-April Habit: Shrub

Part Used: Leaves, stem, bark, fruit, seed Local Name: Timbar

Distribution: Azad Kashmir (Poonch), North Western Frontier Province (Hazara, Swat, Abbottabad, Dir) & Punjab (Murree)

Medicinal Uses: Its branches and fruits are used as stomachic and carminative. Also used for livestock to raise the temperature. Branches are used in toothache. Seed and bark are used in fever, cholera and dyspepsia and also used as tonic. Leaves are eaten in fritters and are much appreciated. Stem sticks (not cut with iron) are used for walking to heal piles (Margalla). Dried ground fruit is mixed with food or taken orally for hyperpyrexia.

Other Uses: Fruit used as a condiment. Bark used for fish poisoning. The twigs are used as "Miswak" for teeth and stems are utilized as walking sticks and the seeds are utilized in chatni and also used as preservative and in preparation of hair lotion. (Voucher specimen No. 22)

4.2. Traditional Knowledge about Cultivated Medicinal Plants

109) ***Althaea rosea*** (L.) Cav. Family: Malvaceae

Flowering period: Jul-Oct Habit: Shrub

Part Used: Whole Plant Local Name: Gul-e-khaira

Medicinal Uses: Flowers are used as cooling, emollient, demulcent, and diuretic. Dried ground leaves are taken in bleeding of rectum. Seeds are also used as demulcent, diuretic and febrifuge. Root is soaked in water for 24 hours and then this extract is taken daily before breakfast in jaundice and in complains of liver, bladder and stomach (Ayubia). (Voucher specimen No. 90)

110) ***Coriandrum sativa*** L. Family: Umbelliferae

Flowering period: February-March Habit: Herb

Part Used: Seeds Local Name: Dhaniya

Medicinal Uses: Seeds are chewed to stop bad breath also used in dyspepsia, flatulence and vomiting. Externally decoction of seeds is used as eyewash and seed in the form of poultice is applied to ulcers and carbuncles. (Voucher specimen No. 67)

111) ***Ficus carica*** L. Family: Moraceae

Flowering period: February-March Habit: Tree

Part Used: Fruit Local Name: Anjir

Medicinal Uses: Fruit is used as a laxative, while latex of the green fruit soothes the bee sting and is used to destroy warts. Dried and fresh fruit is used for general health maintenance.

Other Uses: Fruit edible. Ash is used in snuff. Also used as fuel wood and shade plant. (Voucher specimen No. 66)

112) ***Foeniculum vulgare*** Mill. Family: Apiaceae

Flowering period: March-April Habit: Herb

Part Used: Whole plant Local Name: Sonf

Medicinal Uses: Fruit is stomachic, carminative, stimulant, emmenagogue and aromatic. Leaves are diuretic. Root is purgative and seed oil is useful as vermicide. Dried and ground fruit is taken for enhancing digestion, also whole fruit is masticated for vomiting, and also used for diarrhea and flatulence. Decoction of dried fruit is used as anti pyretic and also considered to improve eyesight.

Other Uses: Used in food as condiment. (Voucher specimen No. 64)

113) ***Grewia asiatica*** L. (Syn: *G. subinaequalis* Parker) Family: Tiliaceae

Flowering period: April-August Habit: Tree

Part Used: Fruit, bark, leaves Local Name: Falsa

Medicinal Uses: The sherbat or squash is prepared from its fruit pulp that is used as an astringent, stomachic and cooling agent. Leaves poultice is applied to pustular eruptions. Root bark is considered effective in rheumatism.

Other Uses: Fruit is edible. (Voucher specimen No. 65)

114) ***Juglans regia*** L. Family: Juglandaceae

Flowering period: February-April Habit: Tree

Part Used: Whole plant Local Name: Akhrot

Medicinal Uses: Used as aphrodisiac and anthelmintic. Stem and leaves are used in toothache and mouth ulcer. Seeds are considered good for brain. Decoction of dried ground fruit kernel in milk is used to cure dysentery, also believed to enhance memory.

Other Uses: Walnut is valued for its wood and edible fruit. The bark is used to clean the teeth and is sold under the name "dandasa". Wood is valuable for furniture, wood carving, gun-stocks and veneers. Also used as firewood. Pericarp and root bark is used as a lipstick. Rind of unripe fruit is used to intoxicate fish and for tanning and dyeing. (Voucher specimen No. 10)

115) ***Murraya koenigii*** Spreng. Family: Rutaceae

Flowering period: April-June Habit: Tree

Part Used: Leaves Local Name: Kamni

Medicinal Uses: Leaves are eaten to cure dysentery and applied externally to cure eruptions and insectbites.

Other Uses: Leaves are used as a condiment to flavor curries. (Voucher specimen No. 68)

116) ***Ocimum basilicum*** L. Family: Labiatae

Flowering period: Oct-Dec Habit: Herb

Part Used: Whole Plant Local Name: Niazbo

Medicinal Uses: Root is used in bowel complaints. Infusion of seed is used in diarrhea and dysentery. Decoction of leaves with honey is used against spasmodic laryngitis. (Voucher specimen No.114)

117) ***Trigonella foenum-graecum*** Linn. Family: Papilionaceae

Flowering period: Nov-Feb Habit: Herb

Part Used: Seed, leaves Local Name: Methi

Medicinal Uses: Seed is used as aphrodisiac. Infusion of seed is used in small pox. (Voucher specimen No. 69)

Medicinal Uses: Leaves are eaten to cure dysentery and applied externally to cure eruptions and insectbites.

Other Uses: Leaves are used as a condiment to flavor curries. (Voucher specimen No. 68)

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Flowering period: Oct-Dec Habit: Herb

Part Used: Whole Plant Local Name: Niazbo

Medicinal Uses: Root is used in bowel complaints. Infusion of seed is used in diarrhea and dysentery. Decoction of leaves with honey is used against spasmodic laryngitis. (Voucher specimen No.114)

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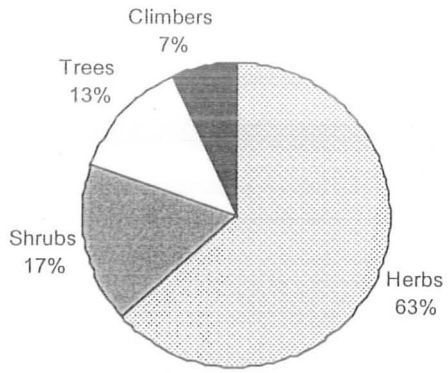
Flowering period: Nov-Feb Habit: Herb

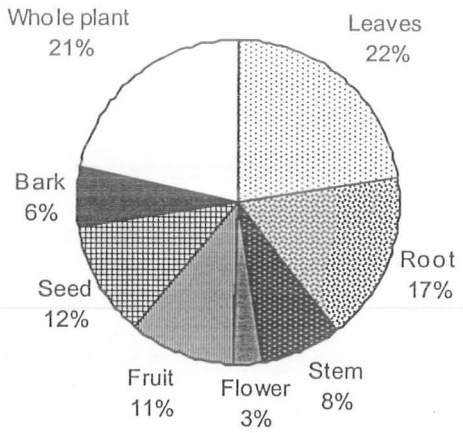
Part Used: Seed, leaves Local Name: Methi

Medicinal Uses: Seed is used as aphrodisiac. Infusion of seed is used in small pox. (Voucher specimen No. 69)

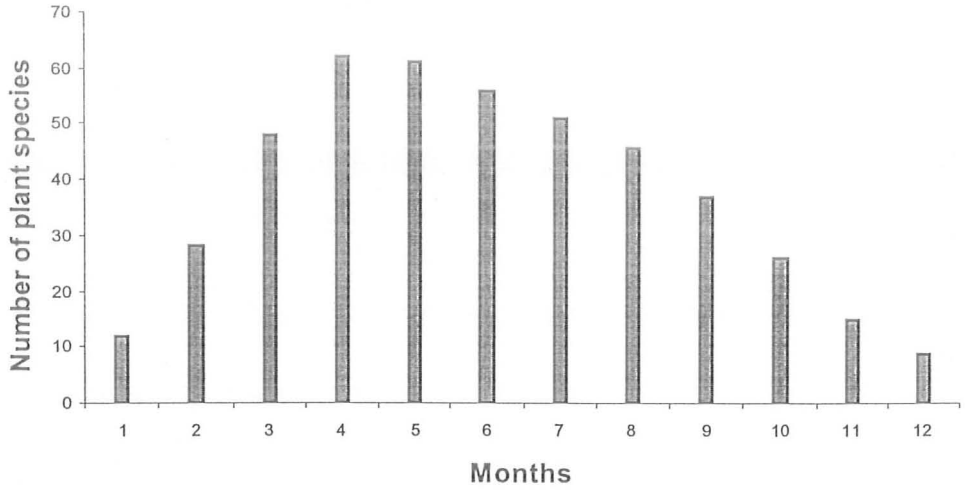
Graph 1: Proportional Representation of Life Forms



Graph 2: Diversity of Medicinal Plant Part Used



Graph 3: Phenological Variations



Graph 4: Variation Among Treatment of Different Diseases

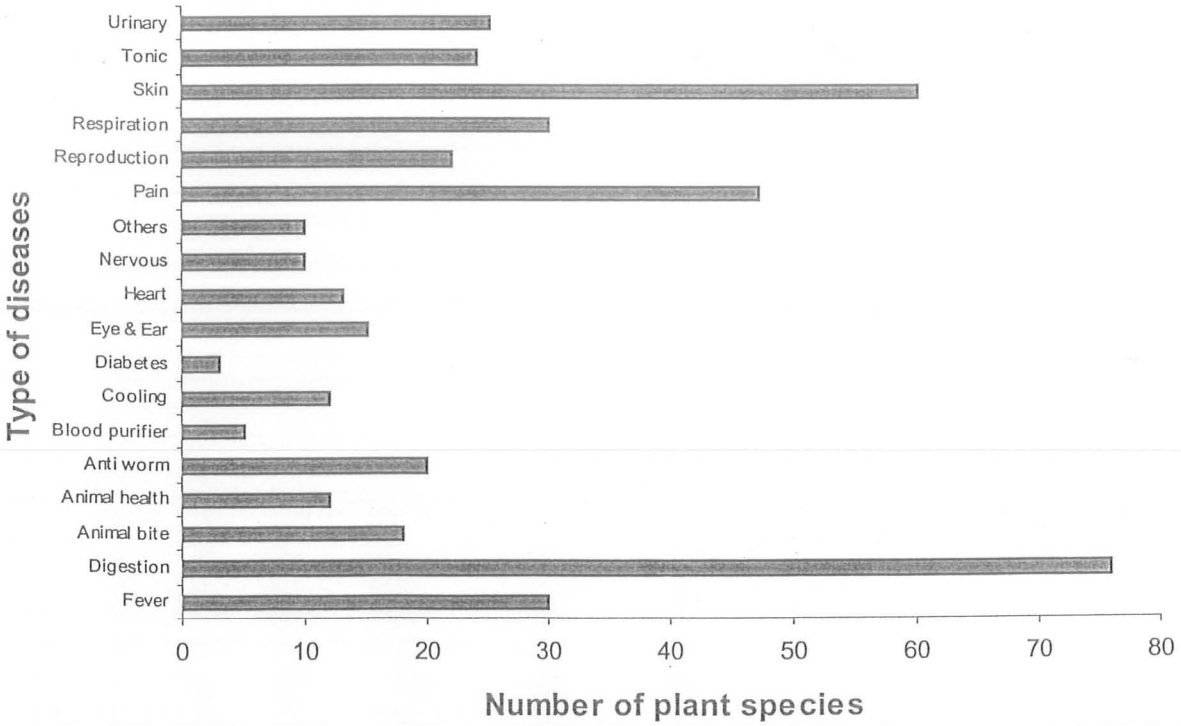


Table 7: Medicinal Plants Used against Different Animal Bites.

Sr. no.	Name of species	Family	Local Name	Type
1	*Acorus calamus*	Araceae	Bach	Insect & Snake
2	*Amaranthus viridis*	Amaranthaceae	Chaleri	Scorpion & Snake
3	*Arisaema flavum*	Araceae	Obais	Snake
4	*Barleria cristata*	Acanthaceae	Tadrelu	Snake
5	*Boerhavia procumbens*	Nyctaginaceae	Itsit	Scorpion
6	*Cissampelos pariera*	Menispermaceae	Bili/Pilligar	Snake
7	*Datura stramonium*	Solanaceae	Dhatura	Fish
8	*Ficus carica*	Moraceae	Anjir	Bee
9	*Jasminum officinalis*	Oleaceae	Chambeli	Scorpion
10	*Murraya koeniji*	Rutaceae	Kamni	Insect
11	*Pinus roxburghii*	Pinaceae	Chir	Scorpion & Snake
12	*Rubia cordifolia*	Rubiaceae	Manjit	Scorpion & Snake
13	*Sauromatum venosum*	Araceae	Sap ki booti	Snake
14	*Saussurea heteromalla*	Asteraceae	Butt peva	Horse
15	*Verbena officinale*	Verbenaceae	Karanta/Pamukh	Scorpion & Snake

Table 8: Medicinal Plants Used in Veterinary Medicines.

Sr. no.	Name of species	Family	Local Name	Remarks
1	*Aesculus indica*	Hippocastenaceae	Bankhor	Fever& cough
2	*Arisaema flavum*	Araceae	Obais	Rani khait
3	*Cannabis sativa*	Cannabinaceae	Bhang	Appetizer
4	*Carisa oppaca*	Apocynaceae	Garanda	Sore
5	*Cynodon dactylon*	Poaceae	Talla	Milk & butter
6	*Fumaria indica*	Fumariaceae	Pitpapra	Diarrhea
7	*Hedera nepalensis*	Araliceae	Kurie/Albumber	Milk supply
8	*Morus alba*	Moraceae	Toot	Milk supply
9	*Plantago major*	Plantaginaceae	Batti	Mavakhar
10	*Saussurea heteromala*	Asteraceae	Butt peva	Dyspepsia
11	*Verbascum thapsus*	Scrophulariaceae	Geedar tamaku	Diarrhea
12	*Zanthoxylum armatum*	Rutaceae	Timber	Give warmth

Graph 5: Magnitude of Pressure of Utilization Other than Medicinal Value

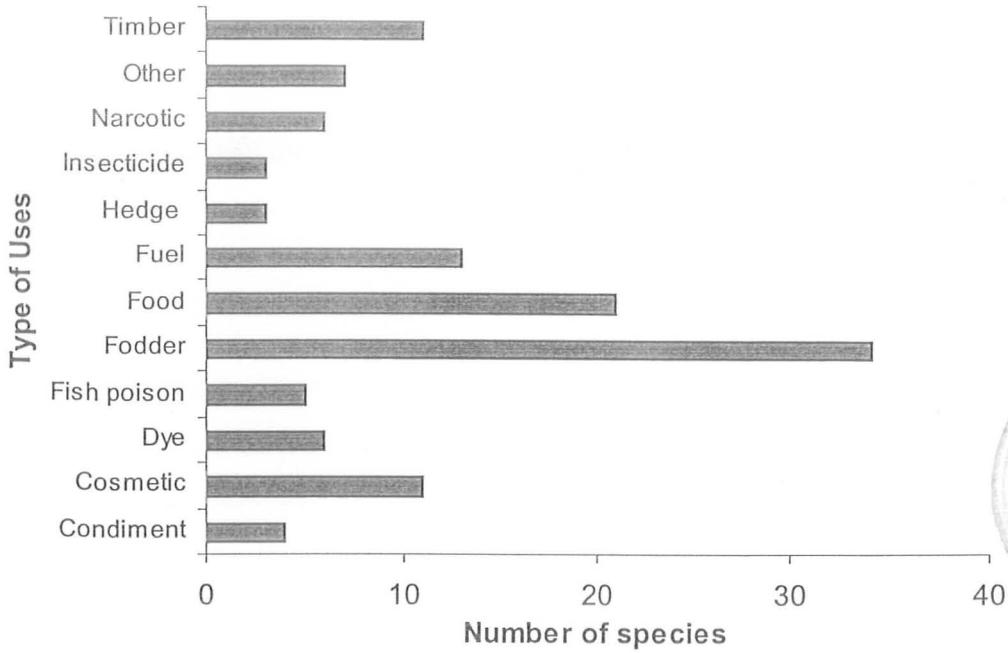


Table 9: Medicinal Plants Used as Fuelwood

Sr. no.	Name of species	Family	Local Name	Habit
1	*Abies pindrow*	Pinaceae	Partal/Palundar	Tree
2	*Cedrus deodara*	Pinaceae	Deodar/Diar	Tree
3	*Diospyros lotus*	Ebenaceae	Kala Amlok	Tree
4	*Dodonaea viscosa*	Sapindaceae	Sanatha	Shrub
5	*Ephedra gerardiana*	Ephedraceae	Asmani	Shrub
6	*Ficus carica*	Moraceae	Anjir	Tree
7	*Juglans regia*	Juglandaceae	Akhrot	Tree
8	*Morus alba*	Moraceae	Toot	Tree
9	*Pinus roxburghii*	Pinaceae	Chir	Tree
10	*Punica granatum*	Punicaceae	Anar/Darunna	Shrub
11	*Pyrus pashia*	Rosaceae	Batangi	Tree
12	*Quercus leucotrichophora*	Fagaceae	Ban/Reen	Tree
13	*Taxus wallichiana*	Taaxaceae	Burmi	Tree

Table 10: Medicinal Plants Used as Fodder

Sr. no.	Name of species	Family	Local Name	Habit
1	*Abies pindrow*	Pinaceae	Partal/Palundar	Tree
2	*Aesculus indica*	Hippocastenaceae	Bankhor	Tree
3	*Arisaema flavum*	Araceae	Obais	Herb
4	*Berberis lycium*	Berberidaceae	Kashmal	Shrub
5	*Bistorta amplexicaule*	Polygonaceae	Maslun	Herb
6	*Cichorium intybus*	Asteraceae	Kasni	Herb
7	*Convolvulus arvensis*	Convolvulaceae	Lehli/Hiran padi	Herb
8	*Cynodon dactylon*	Poaceae	Talla	Herb
9	*Diospyros lotus*	Ebenaceae	Kala Amlok	Tree
10	*Ephedra gerardiana*	Ephedraceae	Asmani	Shrub
11	*Euphorbia helioscopia*	Euphorbiaceae	Dhodal	Herb
12	*Euphorbia wallichii*	Euphorbiaceae	Harvi	Herb
13	*Ficus virgata*	Moraceae	Phagwara	Shrub
14	*Fumaria indica*	Fumariaceae	Pitpapra	Herb
15	*Fragaria nubicola*	Rosaceae	Panjakha	Herb
16	*Galium aparine*	Rubiaceae	Kochan	Herb
17	*Geranium wallichianum*	Geraniaceae	Rattanjot	Herb
18	*Hedera nepalensis*	Araliaceae	Albumber	Climber
19	*Jasminum humile*	Oleaceae	Peeli Chambeli	Shrub
20	*Jasminum officinalis*	Oleaceae	Chambeli	Shrub
21	*Juglans regia*	Juglandaceae	Akhrot	Tree
22	*Morus alba*	Moraceae	Toot	Tree
23	*Plantago major*	Plantaginaceae	Chamchipatra	Herb
24	*Podophyllum hexandrum*	Podophyllaceae	Bankakri	Herb
25	*Punica granatum*	Punicaceae	Darunna	Shrub
26	*Pyrus pashia*	Rosaceae	Batangi	Tree
27	*Rubus fruticosus*	Rosaceae	Gharacha	Shrub
28	*Rumex nepalensis*	Polygonaceae	Hula	Herb
29	*Quercus leucotrichophora*	Fagaceae	Ban/Reen	Tree
30	*Swertia angustifolia*	Gentianaceae	Chirayita	Herb
31	*Taxus wallichiana*	Taxaceae	Burmi	Tree
32	*Valeriana jatamansi*	Valerinaceae	Mushkbala	Herb
33	*Veronica melissifolia*	Scrophulariaceae	Mashkanna	Herb
34	*Viola canescens*	Violaceae	Banafsha	Herb

Table 11: Medicinal Plants Used as Food

Sr. no.	Name of species	Family	Local Name	Type
1	*Amaranthus viridis*	Amaranthaceae	Chaleri	Vegetable
2	*Daphne mucronata*	Thymeliaceae	Kuttilal	Edible fruit
3	*Diospyros lotus*	Ebeanceae	Kala amlok	Edible fruit
4	*Dryopteris ramosus*	Pteridaceae	Pakha	Vegetable
5	*Ficus carica*	Moraceae	Anjir	Edible fruit
6	*Ficus virgata*	Moraceae	Phagwara	Edible fruit
7	*Flacourtia indica*	Flacourtiaceae	Kokoh	Edible fruit
8	*Foeniculum vulgare*	Umbelliferae	Sonf	Condiment
9	*Fragria nubicola*	Rosaceae	Panjakha	Edible fruit
10	*Grewia asiatica*	Tiliaceae	Falsa	Edible fruit
11	*Hypericum perforatum*	Hypericaceae	Balsana	Vegetable
12	*Juglans regia*	Juglandaceae	Akhrot	Edible fruit
13	*Morus alba*	Moraceae	Toot	Edible fruit
14	*Murraya koenniji*	Rutaceeae	Kamni	Condiment
15	*Pinus roxburghii*	Pinaceae	Chir	Edible fruit
16	*Podophyllum hexandrum*	Podophyllaceae	Bankakri	Edible fruit
17	*Punica granatum*	Punicaceae	Darunna	Condiment
18	*Pyrus pashia*	Rosaceae	Batangi	Edible fruit
19	*Rubus fruiticosus*	Rubiaceae	Garacha	Edible fruit
20	*Solanum miniatum*	Solanaceae	Mako	Vegetable
21	*Sonchus asper*	Asteraceae	Hind	Vegetable
22	*Taxus wallichiana*	Taxaceae	Burmi	Edible fruit
23	*Viburnum grandiflorum*	Sambucaeae	Guch	Edible fruit
24	*Zanthhoxylum armatum*	Rutaceae	Timber	Condiment

4.2. Market Survey of Medicinal Plants

4.2.1. Extraction of Indigenous Medicinal Plants

Table 12: Extraction of Indigenous Medicinal Plants from Area

Scientific name	Local Name	Quantity in Kgs			
		Hilkot	*Kaghan	Ayubia	Murree
1) *Aconitum heterophyllum*	Atis		80	64	
2) *Acorus calamus*	Bach	1200			
3) *Adiantum capillus-veneris*	Persioshan			24	
4) *Berberis lycium*	Kashmal	1000	25		
5) *Bergenia ciliata*	Zakham-e hayat			10	40
6) *Bistorta amplexicaule*	Maslun		780		
7) *Dioscorea deltoidea*	Angoor-e-shifa		4480		
8) *Geranium wallichianum*	Rattanjot	1200		16	
9) *Juglans regia*	Akhrot			80	100
10) *Justicia adhatoda*	Bhekar		50	56	
11) *Lavetera kashmeriana*	Raisha khatmi		2760		
12) *Mentha longifolia*	Pudina			240	45
13) *Paeonia emodi*	Mamekh	4000	520	75	
14) *Podophyllum hexandrum*	Bankakri		13960		
15) *Punica granatum*	Darunna		10	140	160
16) *Rheum australe*	Chutial	2000			
17) *Saussurea costus*	Kuth		8000	80	
18) *Skimmia laureola*	Ner	160			64
19) *Swertia angustifolia*	Chirayita			32	
20) *Taxus wallichiana*	Burmi		5920		
21) *Valeriana jatamansi*	Mushkbala	500	18920	40	
22) *Viola canescens*	Thandi-booti	2000		48	40
23) *Zanthoxylum armatum*	Timmer	200	10		56

(Source: Survey of local crude drug dealers and community collectors)
(*Source: Kaghan Forest Division, Forestry Department, Government of NWFP)

4.2.2. Market Value of Indigenous Medicinal Plants

Table 13: Market Value of Indigenous Medicinal Plants

No.	Botanical Name	Trade Name	Part used	Rawalpindi & Lahore	
				Price/Kg	Consumption (Tons/year)
1	*Achillea millefolium*	Baranjasif	Whole	50	01.56
2	*Aconitum heterophyllum*	Atis	Root	800	05.00
3	*Acorus calamus*	Bach	Rhizome	375	25.00
4	*Adiantum capillus-veneris*	Persioshan	Whole	40	04.32
5	*Asparagus adscendens*	Musli sufaid	Root	260	1.135
6	*Atropa acuminata*	Angoor-e-shifa	Root	12	10.00
7	*Berberis lycium*	Rasout	Sap	240	01.02

8	*Bistoria amplexicaulis*	Bekh-e-anjabar	Root	24	00.44
9	*Boerhavia diffusa*	Tukhm-e-aspat	Seed	120	00.10
10	*Cichorium intybus*	Bekh-e-kasni	Root	40	02.64
	Cichorium intybus	Tukhm-e-kasni	Seed	60	06.54
11	*Colchicum luteum*	Suranjan-e-talkh	Rhizome	400	02.76
12	*Coriandrum sativum*	Dhaniya	Fruit	40	10.08
13	*Cusuta reflexa*	Afsitamone	Shoot	120	00.61
	Cusuta reflexa	Tukhm-e-kasoos	Seed	100	0.84
14	*Dioscorea deltoidea*	Kanis sabz	Root	25	00.12
15	*Ficus carica*	Anjir zard	Fruit	140	03.80
16	*Foeniculum vulgare*	Badyan	Fruit	50	07.00
	Foeniculum vulgare	Bekh-e-badyan	Root	40	02.34
17	*Fumaria indica*	Burg-e-shahtra	Leaves	24	02.94
18	*Geranium wallichianum*	Rattanjot	Root	50	28.00
19	*Hyocyamus niger*	Ajwain khurasani	Fruit	60	00.40
20	*Juglans regia*	Maghz-e-akhrot	Seed	170	20.00
21	*Justicia adhatoda*	Berg-e-bansa	Leaves	121	00.88
22	*Lavetera kashmeriana*	Tukhm-e-khatmi	Seed	50	54.40
23	*Mallotus philipensis*	Kamila	Fruit	120	00.27
24	*Mentha longifolia*	Podina desi	Whole	20	17.20
25	*Ocimum basilicum*	Tukhm-e-rehan	Seed	120	2.540
26	*Paeonia emodi*	Ud-e-salep	Root	50	50.42
27	*Plantago major*	Tukhm-e-panwar	Seed	40	00.82
28	*Plantago ovata*	Ispaghol musullum	Seed	60	53.50
	Plantago ovata	Bhosi ispaghol	Seed	160	19.58
29	*Podophyllum hexandrum*	Bankakri	Rhizome	90	30.00
30	*Punica granatum*	Anardana	Seed	50	120.04
31	*Quercus leucotrichophora*	Juft-e-baloot	Seed	24	00.41
32	*Rubia cordifolia*	Majheet	Root	70	01.22
33	*Rheum australe*	Asarat-e-revand	Root Sap	400	00.21
	Rheum australe	Revandchini	Root	100	00.12
34	*Saussurea costus*	Qast-e-talkh	Root	140	00.76
35	*Sida cordifolia*	Beejband siah	Seed	80	00.40
36	*Sisymbrium irio*	Khaksi	Seed	70	00.44
37	*Skimmia laureola*	Berg-e ner	Leaves	12	24.00
38	*Smilax aspera*	Chobchini	Root	240	00.61
39	*Solanum nigrum*	Mako khushk	Fruit	40	00.20
40	*Swertia angustifolia*	Charaita shirin	Shoot	30	00.30
41	*Taxus wallichiana*	Zarnabad	Leaves	30	02.04
42	*Tribulus terristris*	Gokhrokhurd	Fruit	30	02.04
43	*Trigonella foenum-graecum*	Tukhm-e-methi	Seed	32	01.35
44	*Valeriana jatamansi*	Mushkbala	Root	50	100
45	*Viola canescens*	Burg-e-banafsha	Leaves	25	03.14
	Viola canescens	Gul-e-banafsha	Flower	200	02.94
46	*Vitex negundo*	Tukhm-e-sumbhaloo	Seed	30	00.70
47	*Withania sominifera*	Asgand nagori	Root	150	11.18
48	*Zanthoxylum armatum*	Timmer/Timber	Seed	10	31.00

4.3. Conservation Status

Table 14: Status of Commercially Important Indigenous Medicinal Species

No.	Botanical name	Availability	Consumption	Growth	Part Used	Score
1	*Achillea millefolium*	2	0	3	0	5
2	*Aconitum heterophyllum*	2	0	3	0	5
3	*Acorus calamus*	3	0	4	0	7
4	*Adiantum capillus-veneris*	4	0	4	0	8
5	*Asparagus adscendens*	2	0	2	0	4
6	*Atropa acuminata*	1	0	0	0	1
7	*Berberis lycium*	3	0	1	0	4
8	*Bistorta amplexicaulis*	3	2	1	0	6
9	*Boerhavia procumbens*	3	3	3	2	11
10	*Cichorium intybus*	3	0	3	0	6
11	*Colchicum luteum*	0	0	1	0	1
12	*Cuscuta reflexa*	3	1	3	2	9
13	*Dioscorea deltoidea*	1	3	0	0	4
14	*Fumaria indica*	3	0	3	0	6
15	*Geranium wallichianum*	3	0	4	0	7
16	*Hyocyamus niger*	2	2	3	2	9
17	*Justicia adhatoda*	3	1	2	3	9
18	*Lavetera kashmeriana*	1	0	3	2	6
19	*Mallotus philipensis*	3	2	0	2	7
20	*Mentha longifolia*	3	0	4	3	10
21	*Paeonia emodi*	1	0	1	3	5
22	*Plantago major*	2	1	4	0	7
23	*Plantago ovata*	3	0	4	2	9
24	*Podophyllum hexandrum*	1	0	3	0	4
25	*Punica granatum*	3	0	0	2	5
26	*Quercus leucotrichophora*	3	2	0	2	7
27	*Rubia cordifolia*	3	0	0	2	5
28	*Rheum australe*	1	3	1	0	5
29	*Saussurea costus*	0	1	1	0	2
30	*Sida cordifolia*	3	2	3	0	8
31	*Sisymbrium irio*	3	2	3	2	10
32	*Skimmia laureola*	3	0	3	4	10
33	*Smilax aspera*	2	1	3	0	6
34	*Solanum nigrum*	3	3	3	3	12
35	*Swertia angustifolia*	3	2	4	0	9
36	*Taxus wallichiana*	1	0	0	0	1
37	*Tribulus terristris*	2	0	3	2	7
38	*Valeriana jatamansi*	3	0	1	0	4
39	*Viola canescens*	3	0	4	0	7
40	*Vitex negundo*	3	1	3	0	7
41	*Withania sominifera*	3	0	2	0	5
42	*Zanthoxylum armatum*	3	0	3	1	7

Total Score=0-4=Endangered, 5-8=Vulnerable, 9-12=Rare, 13-14=Infrequent, 15-16=Dominant

4.4. Taxonomic Descriptions of Endangered Medicinal Herbs Selected for Ex-situ Cultivation Trials

4.4.1. *Asparagus adescendens* Roxb.

A straggling or scrambling shrub up to 1.5m tall, with woody, striate, minutely scabrid, erect stem; spines 1.2-2.0cm long, straight or very slightly curved, stem modified into leaf-like structures (cladodes); cladodes 1.2-2.0cm long, in tufts of 6-20 at the nodes, straight, filiform. Leaves reduced to scales. Flowers small, bracteate, white, in numerous racemes 2.5-5.0cm long, racemes simple or branched often bearing cladodes towards the top; pedicels 3-5mm long, filiform, jointed above or below the middle. Perianth scarcely 3mm long. Stamens shorter than the perianth; anthers medium sized. Berry 3-5mm in diameter, red, globose.

Global Distribution: Sub-Himalayan tract and outer Himalaya.

Note: It prefers to grow on deep rich moist soil up to 1500m. It starts flowering in July and August, producing seeds in October and November. It is easily propagated by seeds and vegetative means, and prefers to grow on deep rich moist soil.

4.4.2. *Atropa acuminata* Royle

About 1.5m tall, erect, perennial, glabrous herb with dichotomously branched and fistular stem, young shoots puberulous. Leaves 7-14 x 4-8cm, alternate, exstipulate, elliptic-lanceolate to ovate-lanceolate, apex acuminate, margin entire, unicostate with reticulate venation; petiole up to 2cm long. Flowers solitary, axillary, showy, yellow, bracteate, bisexual, regular, arranged in a cinicinni, campanulate shaped and pale purple tinged with yellow or green color. Calyx 5 partite, 0.9-1.5cm long, up to 2cm in fruit, bell shaped, puberulous, lobes 0.6-1cm long, imbricate ovate-acute, unequal but persistent. Corolla bell shaped with 5 short broad blunt spreading lobes, about 2.1cm long, lobes obtuse. Stamens included; Anthers c. 0.3cm long, oblong, dehiscing longitudinally; filaments 1.0-1.1cm long, attached near the base of the corolla, dense villous and swollen basally. Ovary superior, placentation axile bilocular, style slender; stigma bilobed. Fruit globose,

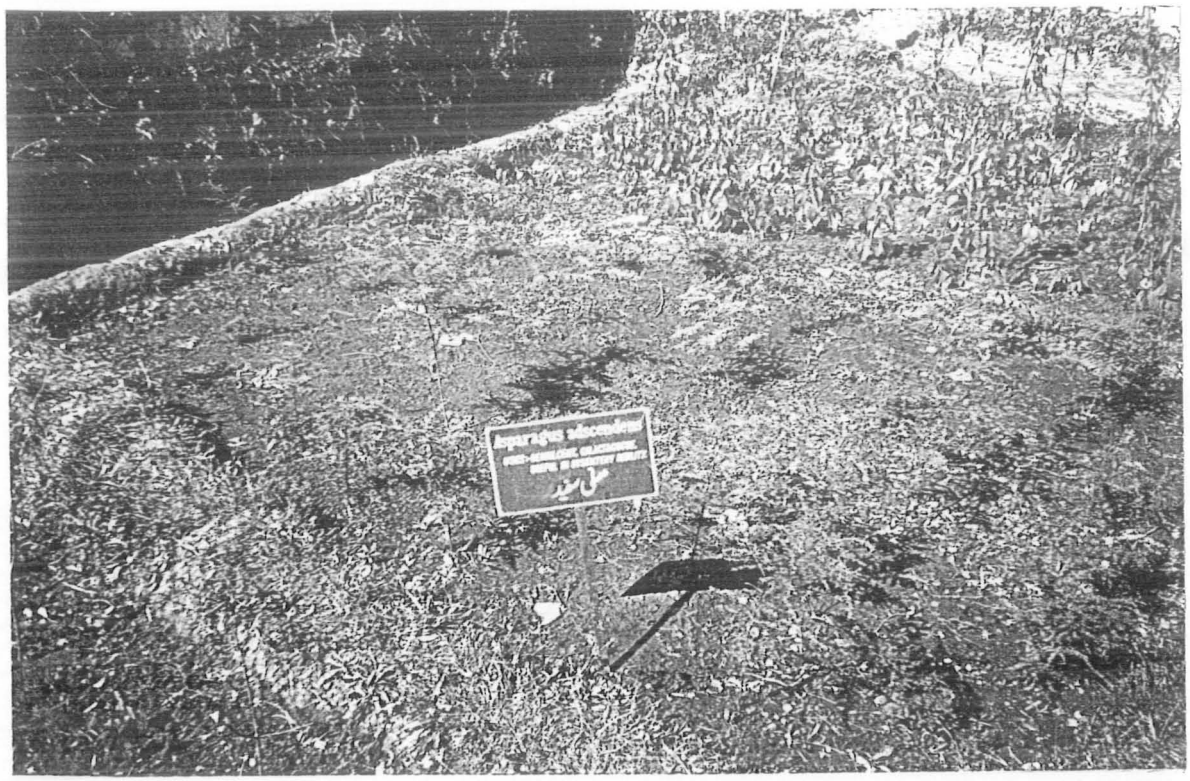


Figure 3: A plot of *Asparagus adscendens* at Burban Research Station

Figure 4: A plot of *Atropa acuminata* at Burban Research Station

purple black berry surrounded by persistent calyx, 1.2cm broad and black when ripe. Seeds numerous, small, compressed, brown, about 0.2cm long.

Global Distribution: E. Iran, E. Afghanistan, and eastwards to Kashmir, Mongolia.

Note: The 'deadly nightshade'exists in the Himalayas from 1800-3040m. Roots generally sprout in Aril or May depending upon melting of snow. Flowers are produced in June and July and fruits ripen in August or September. The root takes 3-4 years to attain marketable size for harvesting. It can be easily regenerated through seeds and rhizomes.

4.4.3. *Colchicum luteum* Baker

An unbranched small perennial herb with fibrous roots, arising from one side of the basal part of the corm. Corm solid, ovoid, oblong, 1.5-3.5x1-2cm, flattened at the base, longitudinal groove on one side, coated with numerous brown to dark brown membranous scales. Leaves radical, 3-6 appearing at flowering time, enclosed in leaf sheaths when young, linear to broadly linear, 15-30 x 0.5-2cm, blunt, short, at the flowering longer at the fruiting time. Flowers 1-3, bisexual, golden-yellow, infundibuliform, 3-4cm across on a very short main flower stalk. Calyx funnel-shaped, lobes 6, nearly equal. Tepals 6, united below into a long, narrow tube up to 7-10cm long which is partly below ground, segments linear to oblanceolate, 2-3cm long, apex acute to obtuse. Stamens 6, attached at the base of the perianth segments, included; filaments 4-5mm long; anthers yellow, linear, 1-1.5cm long, basifixed. Ovary superior, trilocular; styles 3, free, filiform, longer than the stamens; stgima minute; ovules many. Fruit capsular, ovoid, up to 3cm long, dehiscence septicidal with recurved beaks. Seeds numerous, globose, 2mm in diameter.

Global Distribution: Central Asia, Afghanistan, Himalaya in Pakistan to Himachal Pradesh in India.

Note: It is one of the earliest plants to flower in spring. It grows on relatively open and exposed sites of the hills and and adjacent plains from 1500 to 3000m altitude. It occurs in a moderate west-facing slope in a glade between coniferous woodland or in forest shrubby sites. Its flowers appear before the leaves (or when the leaves are very young) in March or April after snowmelts, the fruiting occurs in June and July. It is reproduced by

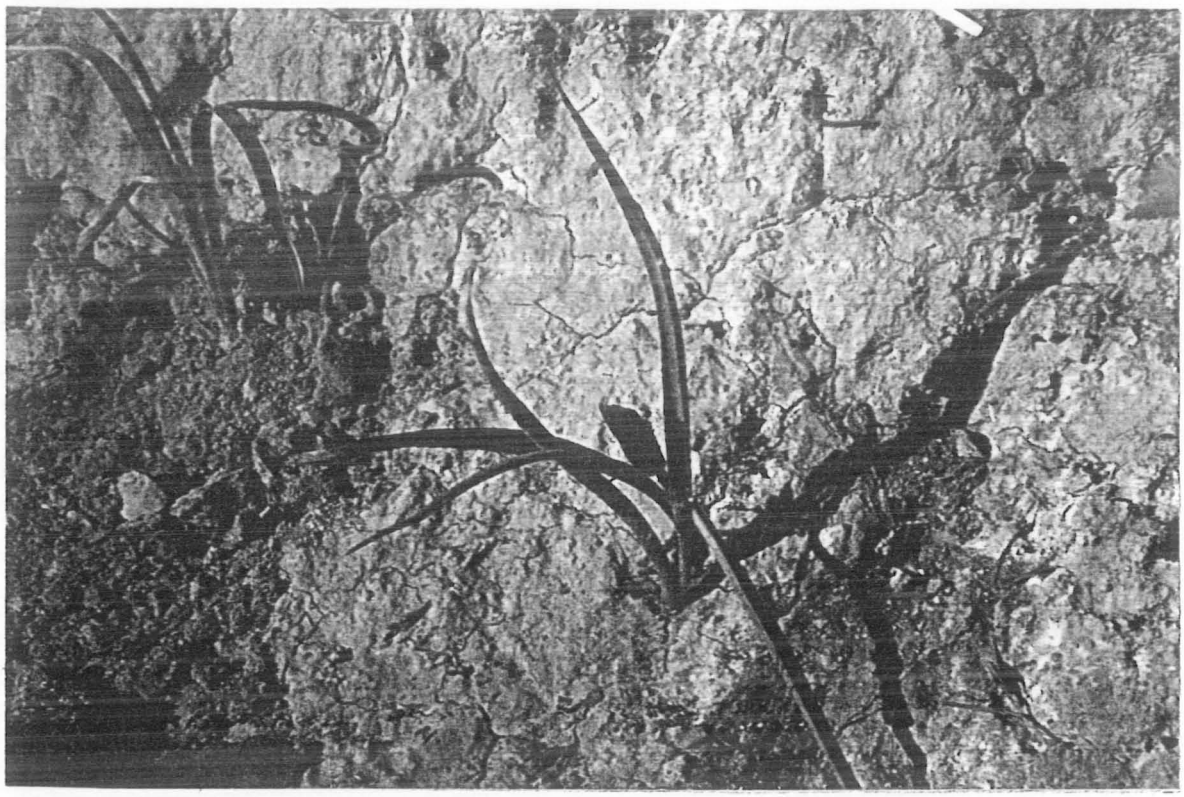


Figure 5: *Colchicum luteum* with capsulate fruit in a plot

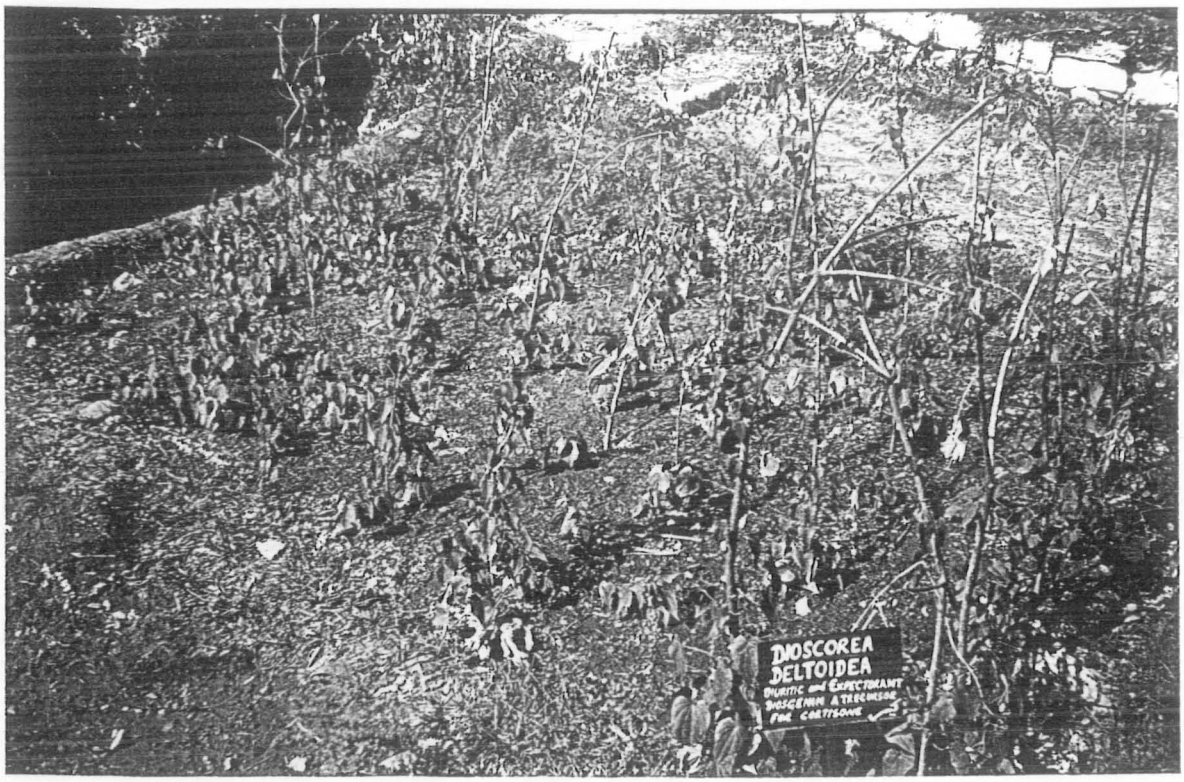


Figure 6: A plot of *Dioscorea deltoidea* at Burban Research Station

seeds. It is very similar to *Colchicum kesselringii* Regel but differs in size and flower colour (whitish with blue violet stripes). Could be mistaken for *C. luteum* since at the time of harvesting no flowers are present.

4.4.4. *Dioscorea deltoidea* Wallich

Tall, slender, herbaceous, dioecious perennial herbs with ligneous, irregular tubers. Stem annual, glabrous, twinning clockwise, arising from tubers. Leaves exstipulate, petiolate, alternate, simple, 5-11.5 x 4-10.5cm, ovate or subdeltoid-ovate, often cordate, the basal lobes rounded or sometimes dilated outwards, 7-9-nerved, acuminate, glabrous above, pubescent on the nerves beneath; petiole 5-10cm long, slender. Flowers bracteate, unisexual, and actinomorphic. Male spikes solitary, perianth 6-cleft, axillary, simple or sometimes branched, slender, lax, 7.5-25cm long in small distant clusters. Stamens 6, antheriferous; anthers small, incurved, 2-celled, dehiscing longitudinally. Female spikes solitary, few-flowered, slender, up to 15 cm long perianth of 6, small, free, persistent tepals; ovary inferior, 3-quetrous, trilocular, 2-superposed ovules, suspended from axile placentas in each locule; stigmas reflexed. Capsule 2 x 3cm, obovate or obcordate, 3-winged loculicidal. Seeds winged unequally all round.

Global Distribution: East Afghanistan, Pakistan to Nepal and Southwest China and throughout the Himalyas.

Note: The 'Himalayan Yam' is a shade loving species and grows on the northern aspects with moderate slope from 2000 to 3500m altitude. It has close ecological associations with *Pinus wallichiana*, *Cedrus deodara*, *Picea smithiana* and *Abies pindrow*. It initiates sprouting after snow melts i.e. April and May. It statrs flowering in June and July and the fruits ripen between August and September. It is easily regenerated by seeds and by vegetative means.

4.4.5. *Paeonia emodi* Wallich ex Royle

A robust rather shrubby perennial, 50-70cm or more tall, glabrous. Leaves 30-50cm long, biternate or terante, alternate, exstipulate, glabrous, lamina pale on under surface, decurrent, median segment deeply 3-incised, the lateral segment ellipteic-lanceolate or lanceolate, larger ones up to 14 x 4.5cm, acuminate; petiole of lower leaves 5-8cm long,

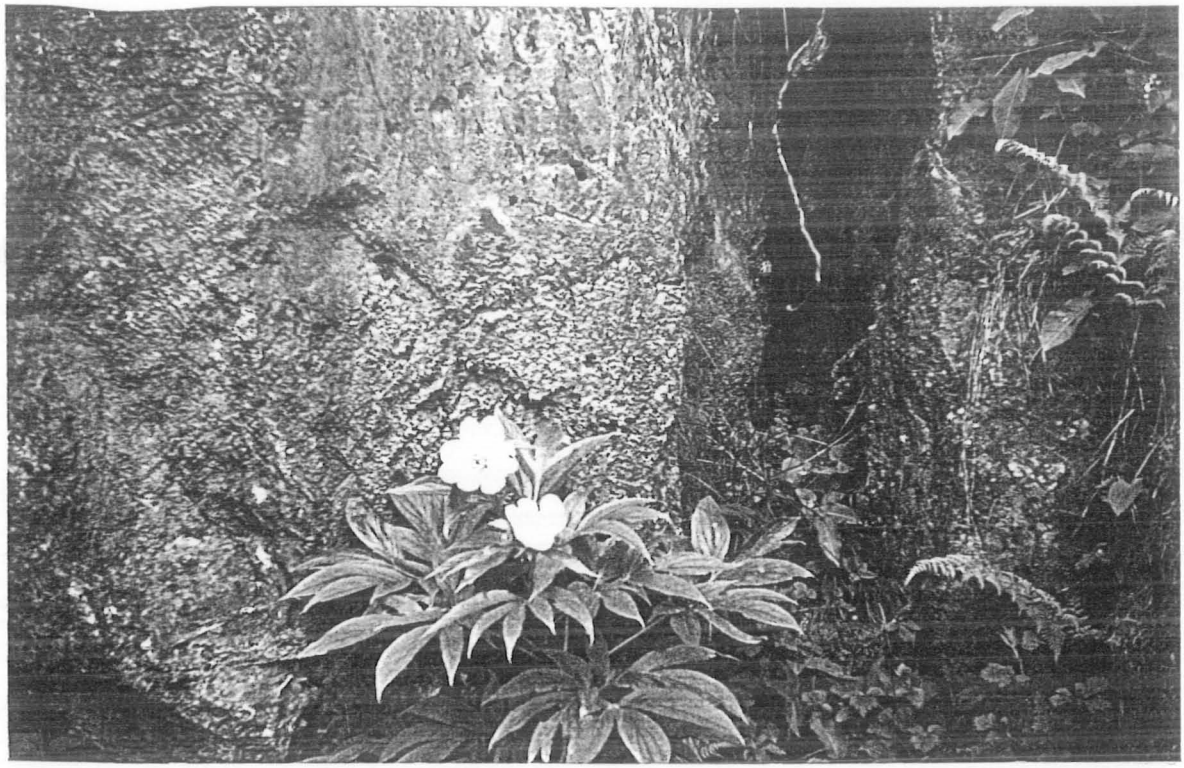


Figure 7: *Paeonia emodi* among boulders in wild

Figure 8: Seedlings of *Paeonia emodi* at Burban Research Station

of uppermost leaves 2-3cm long. Flowers large, axilary, solitary, whiteor pale pink, 8-9cm broad and bracteate; bracts leafy. Sepals 5, persistent, imbricate, oblong to suborbicular, 2 x 2.5cm, outer ones smaller and long acuminate. Petals 8, obovate, 4-5 x 3-4cm, apex ± wavy and reflexed. Stamens numerous, orange–yellow and spirally arranged. Ovary ovoid, 6-7 x 5-6mm, strigose. Follicle usually 1 rarely 2 in number, globose-ovoid, dense yellow-white tomentose sometimes hairless, 2.5-3.0cm long, splitting along the ventral sutures. Seeds 3-5, woody, large c. 7-8mm broad, globose ovoid, minutely rugose, brown-black, bright scarlet red when unripe.

Global Distribution: E. Afghanistan to Himachal Pradeshin India and West Nepal.

Note: The 'Himalayan Paeony'is the only member of the genus native to the Himalaya. It grows from 2000 to 3200m altitude in humus and moisture rich soil among boulders with *Sambucus wightiana* on open west facing slope in glades between coniferous woodlands. It statrs sprouting after snow mwlts i.e. March and April and starts blooming in May and June. Its fruit matures in August and September. It is usually reproduced from seeds and by vegetative means.

4.4.6. *Podophyllum hexandrum* Royle

An erect perennial herb c. 15-30cm tall, with a underground rhizome; smooth, glabrous, somewhat fleshy or succulent, simple, short, horizontally creeping, scaly above, with dense thick fibrous roots; scales up to 5 cm long, c. 1-2cm broad, ovate-lanceolate, striated, pale, entire; stem scapigerous, simple, erect terete, naked below with usually 2 alternate leaves above the middle and usually single supra axillary flower (or fruit). Leaves exstipulate, palmate, deepy deeply 3 lobed rarely more, somewhat peltate, hanging down like an umbrella in young stages, petiolate; lamina 10-20 cm in diameter, with petiole about as long as the lobe and somewhat swollen at base; lateral lobes obliquely ovate, sometimes 2-lobulate; middle lobe broadly elliptic and symmetriacal; all lobes sharply toothed, acute to slightly acuminate, 5-12 x 3-5cm, sessile, coarsely veined below. Flowers bisexual, regular, white to pink, c. 2-4cm in diameter, ± terminal in bud but becoming supra axillary later; peduncle short, elongating up to 2cm in fruit, erect or ascending, somewhat thickened. Sepals 3, imbricate, broadly oblong, cauducous,

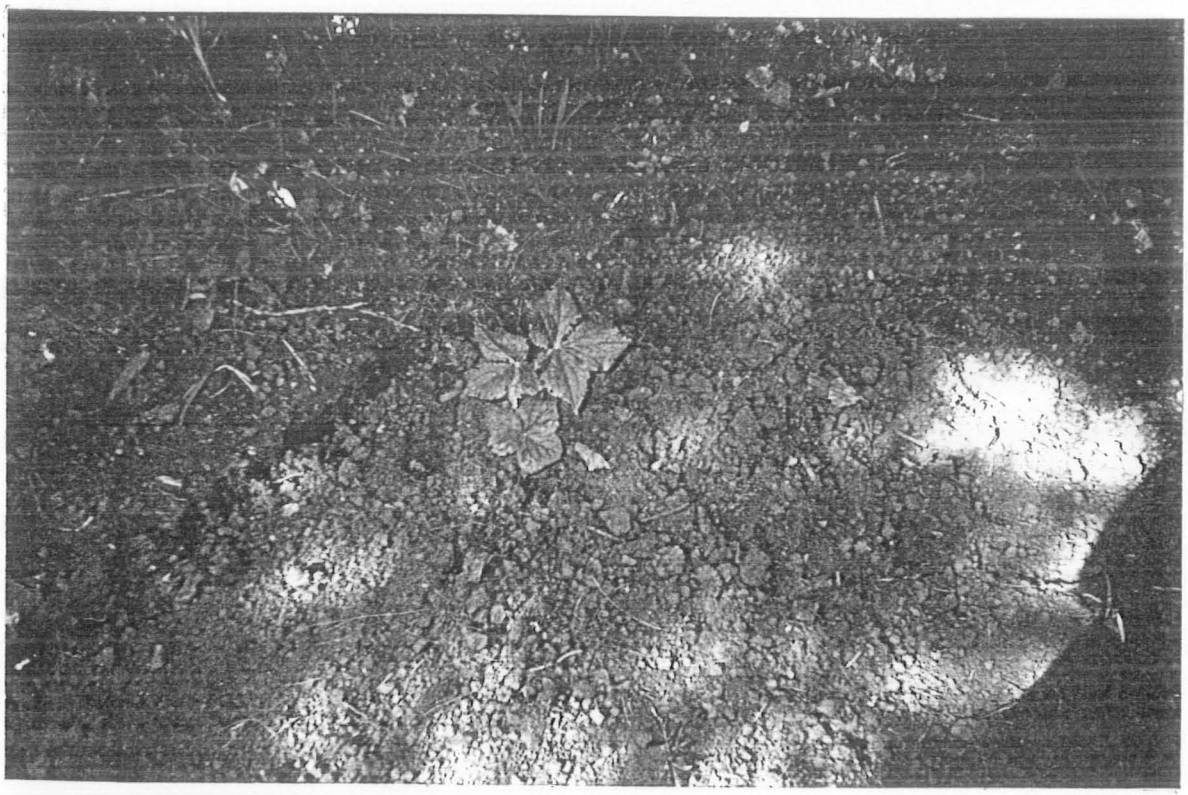


Figure 9: A seedling of *Podophyllum hexandrum*

Figure 10: A plot of *Podophyllum hexandrum* at Burban Research Station

petaloid. Petals usually 6 sometimes 4, obovate-oblong, 2-3 x 1-1.5cm. Stamens usually 6, about half as long as the petals; filaments slightly flattened; anthers c. 3mm long, oblong, obtuse. Ovary monocarpellary, unilocular with many ovules on a broad ventral or lateral, many serriate placentas; stigma large, peltate. Berry oblong-ovoid, or oblong-ellipsoid, 2-4 x 1.5-2.5cm, scarlet or red, indehiscent, pulpy, narrowed below the stigma, many seeded; seeds 2-3mm in diameter, obovoid or suborbicular, embedded in pulp.

Global Distribution: it ranges in distribution from Afghanistan, Pakistan to Southwest China.

Note: It grows wild in the interior mountain ranges from 2200 to 4200m. It statrs its vegetative growth after snow melts i.e. April and May and produces a fancy flower in May and June and its fruit matures between August and September. It is a shade loving species grows in humus rich and moist soil on the northern aspect with moderate slope. It has close ecological associations with *Cedrus deodara*, *Pinus wallichiana*, *Abies pindrow* and *Picea smithiana*. It is easily reproduced from seeds and by vegetative means from rhizomes.

4.4.7. *Saussurea costus* (Falc.) Lipsch.

A tall robust perennial; stem 2m or more unbranched, with large, triangular, long-stalked basal leaves and large clasping upper leaves. Leaves without spines, rough above, smooth beneath; radical leaves pinnate, c. 30-40cm long, with an irregularly winged leaf stalk and often triangular terminal lobe c. 30cm across; cauline leaves smaller to 30cm, all irregularly toothed. Flower-heads, dense, subglobose, terminal, few, c. 2.5-3.5cm across, with numerous purple involucral bracts, ovate-lanceolate, slender-pointed, rigid, with twisted and recurved tips, without spiny tips, hairless or nearly so, ray florets absent; receptacle bristles very long. Calyx modified into pappus of bristles. Corolla 5, fused, dark purple, c. 2cm long. Stamens 5, fused into a tube surrounding the style. Ovary inferior, unilocular, with single ovule; anthers tail fimbriate. Achenes compressed, top cupped, tip narrowed with brown pappus of two rows 1cm long, the outer usually of rigid bristles, the inner longer feathery, with their bases fused in a ring.

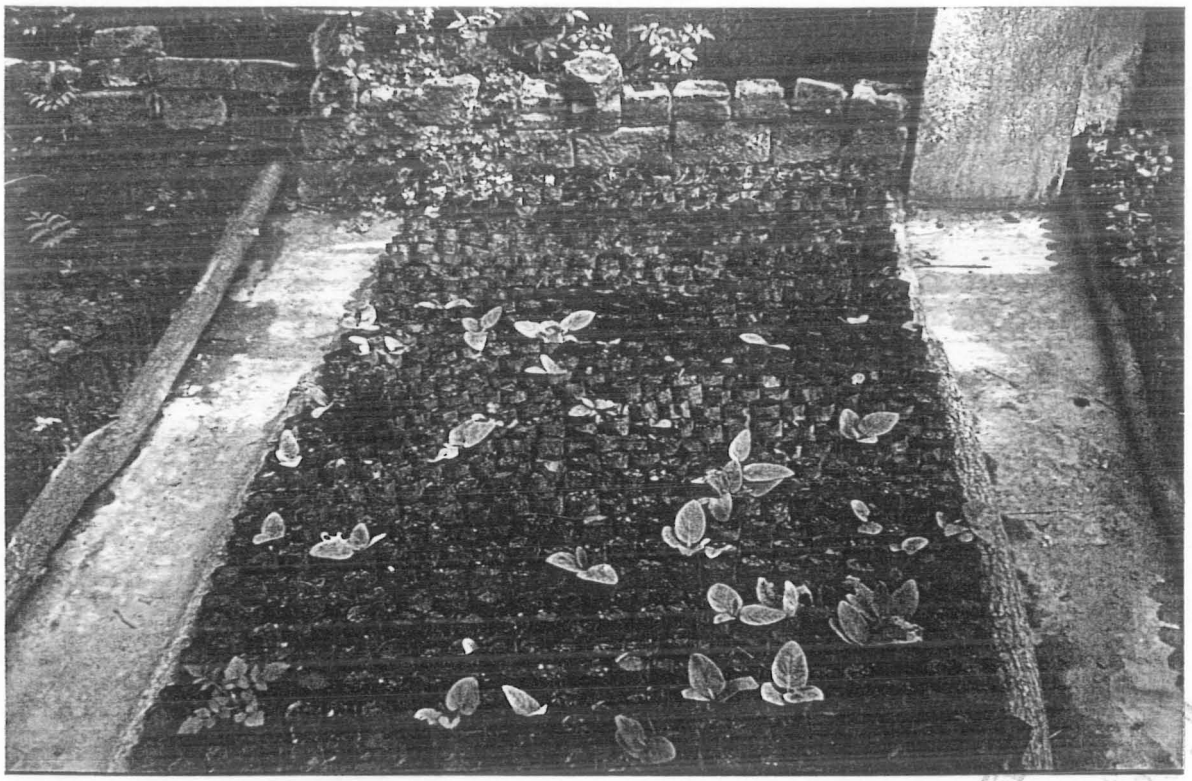


Figure 11: Germination tests of *Saussurea costus*

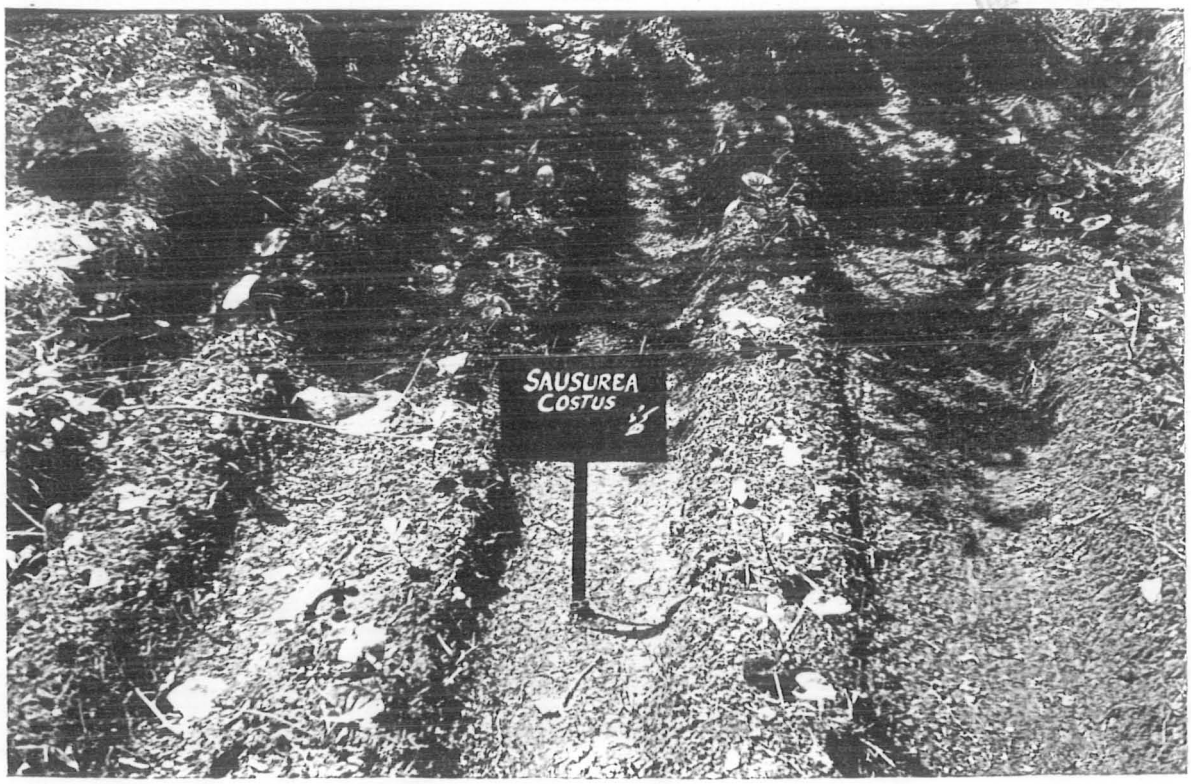


Figure 12: A plot of *Saussurea costus* at Burban Research Station

Global Distribution: Afghanistan, Pakistan, Kashmir to Bhutan and Southwestern China.

Note: It grows naturally in northwestern regions of Himalayas on the moist slopes of mountains around the valleys at an elevation of 2000 to 3300m. It is found in the open stony pastures in association with *Nepeta*, *Cotinus dipsacus* and scattered *Juniperus* and *Rosa* species. It starts flowering in May to June and the fruit matures between July and August. It is easily propagated by seeds and by vegetative means.

4.4.8. *Valeriana jatamansi* Jones.

A tall, perennial herb up to 20-60cm in length, tomentose to pilose, with horizontal, aromatic rhizome, c. 4-15 cm in diameter, elongate, having thick descending fibrous roots. Stems 3-6 rarely more in number. Leaves exstipulate, opposite; radical leaves cordate or ovate, 2-10 x 1.5-8cm, sinuate or crenulate; cauline leaves sessile, smaller, entire uppermost often 3-fid. Flowers in lax corymbose cymes or dense corymbs, white or pink tinged, irregular, bisexual and bracteate; upper bracts linear-lanceolate, c. 3mm long and opposite. Calyx unrolled in fruit into a plumose pappus. Corolla funnel shaped with 5 blunt lobes spreading to c. 5mm. Stamens 3, alternating with the corolla lobes. Carpels 3 united; style simple, sometimes pilose; stigma 3-fid; ovary inferior, trilocular with only one fertile locule or ovule. Achene nearly globose tomentose, shorter than the upper bracts, crowned by the persistent pappose calyx, dorsally 3-ribbed, ventrally 1-ribbed, glabrous to hairy.

Global Distribution: In the mountainous area of Afghanistan, Pakistan to Bhutan, Assam, Tibet, Burma, West and Central China.

Note: It occurs on the northwestern aspect with moderate slope and mostly associated with coniferous forest species of *Cedrus deodara*, *Pinus wallichiana*, *Picea smithiana* and *Abies pindrow* with the ground vegetation of species of *Potentilla, Persicaria, Swertia* and *Bergenia*. It flowers in and fruit matures between July and August. It can be easily propagated by seed and vegetative means. At higher elevations i.e. 2300-4500m replaced by a very similar species i.e. *Valeriana pyrolifolia* Decne.

Figure 13: A plot of *Valeriana jatamansi* at Burban Research Station

Table 16: Germination Tests Results

No.	Species	Treatment	Days to Initiate Germination	Days to Complete Germination	Percentage Germination
1	*Atropa acuminata*	Controlled	42	143	53
		200ppm GA	22	98	93
2	*Colchicum luteum*	Controlled	76	35	09
		Chilling	56	42	47
		200ppm GA	56	42	33
3	*Saussurea costus*	Controlled	35	65	60
		Chilling	21	50	89
		100 ppm GA	14	40	91
		200ppm GA	14	40	97

Table 17: Ex-situ Conservation Trials Conducted at Burban Research Station, Murree.

No.	Species	Plot No.	No. of Propagates	No. of seedlings	Survival %age
1	*Asparagus adscendens*	2,3	140	129	92
2	*Atropa acuminata*	8	120	72	60
3	*Colchicum luteum*	10	90	36	40
4	*Dioscorea deltoidea*	1,4,5	260	252	97
5	*Paeonia emodi*	7,12,13	100	45	45
6	*Podophyllum hexandrum*	9	85	38	45
7	*Saussurea costus*	11,14	110	104	95
8	*Valeriana jatamansi*	6	150	144	96

Table-18: Cultivation Trials of Exotic Species Conducted at Kotla Village, Margalla Hills.

No.	Species	Area (Acre)	Seed yield (Kgs)	Cultivation Cost (Rupees)	Net Income (Rs./Acre)	Comparative Income from Maize
1	*Carum copticum*	1	280	5300	8700	4300
2	*Nigella sativa*	1	330	5300	9500	4300

Elevation=1500m Farmer's Name: Haji Suleman Khan

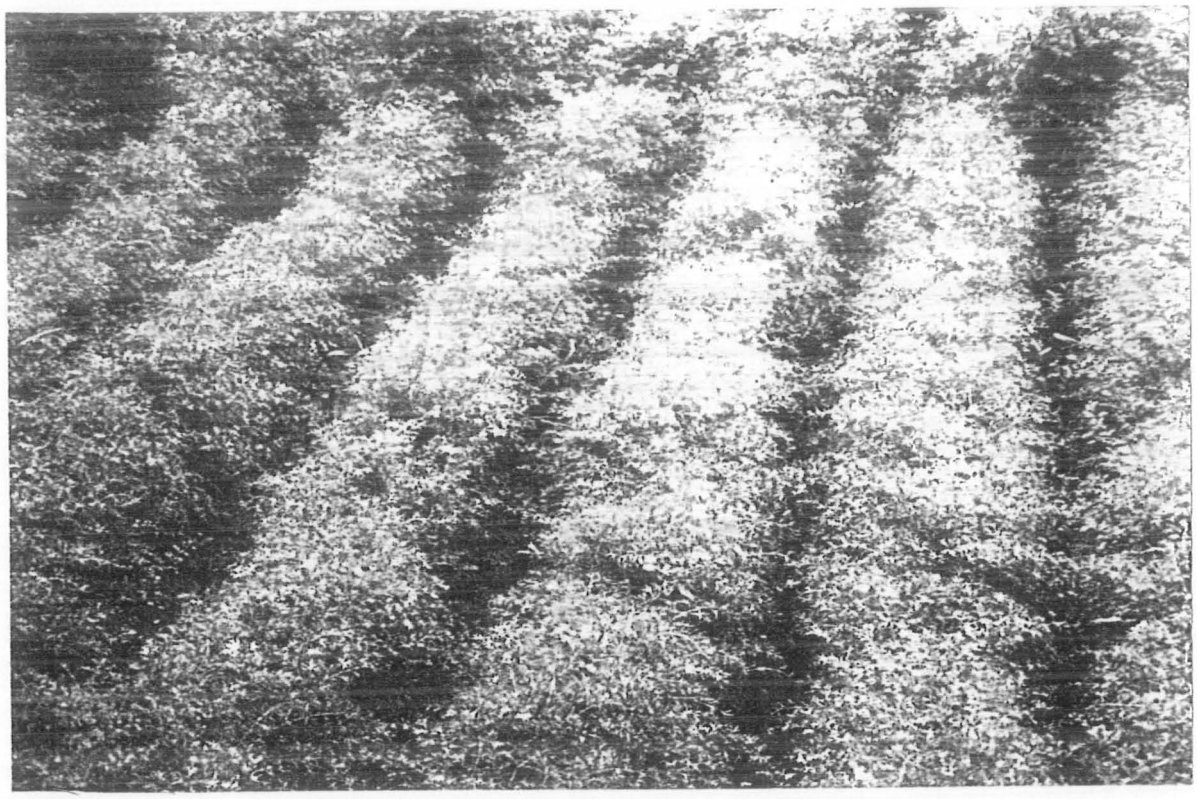


Figure 14: Demonstration plot of *Carum copticum* at Margalla Hills

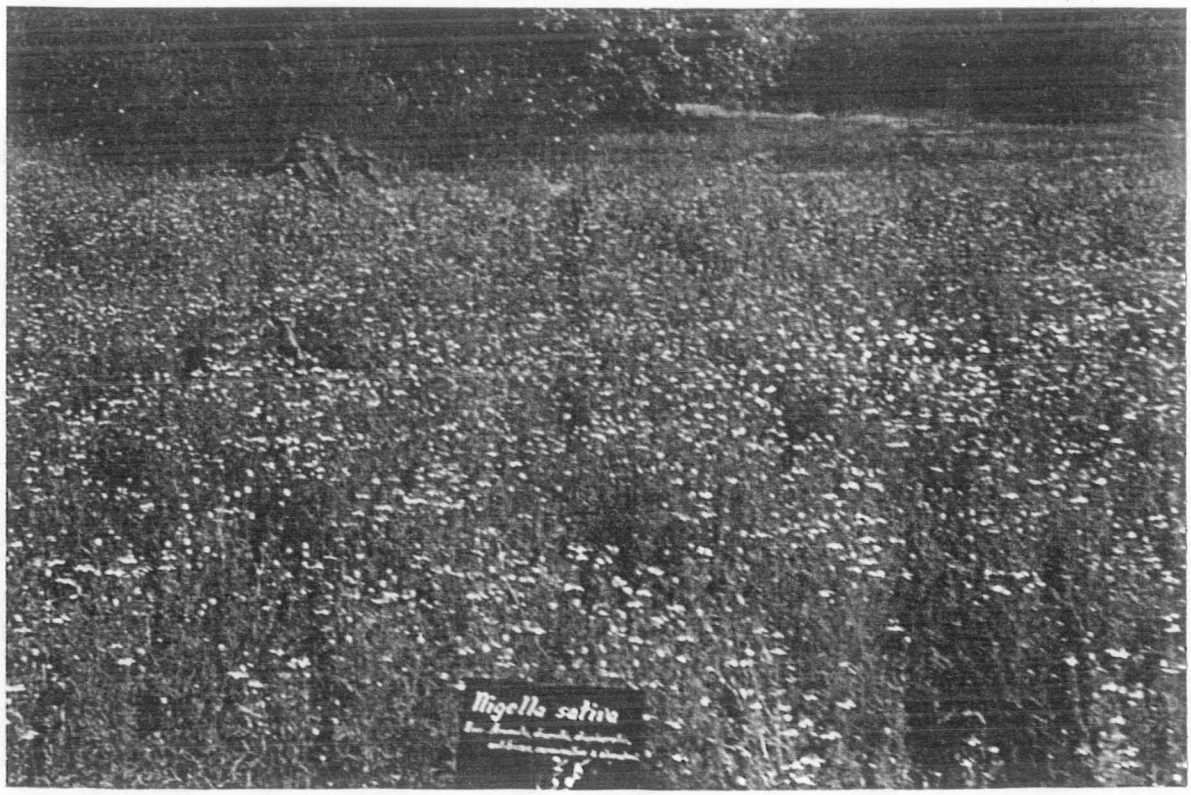


Figure 15: Blooming of *Nigella sativa* crop at Margalla Hills

Chapter – 5
Discussion

5. Discussion

In Pakistan, although adequate data is not available about medicinal plants that requires conservation, there is overwhelming agreement among experts in the country that the most threatened ecosystems are the alpine and temperate Himalayan forest in the north of the country. There is also agreement that almost all the forest of Pakistan has been exploited heavily during the last two decades including the medicinal plants.

In fact previous work of listing threatened species of plants is either fragmentary or out-dated and lying with different agencies, which need to be re-evaluated and updated. The use of these earlier lists as a conservation tool is limited by the fact that the status of many species remains unclear, particularly of threatened species. It is therefore, very important to have a comprehensive survey of the important vegetation zones. It is important to prepare National Red Data Book based on recent IUCN criterion.

To initiate in-situ conservation efforts, Pakistan has established a network of national parks, wildlife sanctuaries and game reserves covering about 10 million hectares (Table 3 & 4). Ex-situ conservation of medicinal and aromatic plants seeds has recently been initiated at the plant Genetic Resource Institute (PGRI) at NARC in Islamabad, where a special corner called the Hakim Said Chamber has been established.

5.1. Documentation of Traditional Knowledge:

Ecological and social changes produced by economic and technological development have laid to a deep transformation of attitudes and values regarding plants (Hynes *et al.*, 1997). Most cultural changes in rural communities are associated with increasing interactions with modern social systems. Consequently, much of the knowledge and use of plant resources, as well as the resources themselves, are disappearing in many regions (Berg, 1994; Boom, 1987). Therefore long term conservation of plant resources and the knowledge associated with them is necessary for the benefit of the local people and for their potential use by communities at large. As a science of documenting traditional knowledge on the use of plants by indigenous people and assessing human interaction with the natural environment, ethnobotany has great potential for contributing to biodiversity conservation in the Himalayas.

For developing countries like Pakistan, medicinal plants are of great value in the treatment of various kinds of diseases and disorders. They are also more accessible and affordable than allopathic medicines. Thus the systematic documentation of indigenous knowledge about the use of these plant resources by the local people and their chemical and biological examination would be useful for the discovery of new therapeutic agents.

As a part of moist temperate Himalayas, Ayubia National Park is rich in diverse medicinal plants, which are distributed in its sub-tropical, moist temperate and sub-alpine forests. These plants are highly valued since they are used in both traditional medicines and by modern pharmaceutical companies. The ethnobotanical survey also reveals a rich local knowledge of these medicinal plants. About 63% of the respondents reported that they prefer herbal treatment by herbalist (Hakim) or self-treatment with locally available medicinal plants. In remote villages like Lahure Khas, where access to modern medicine is limited, traditional healing systems play an indispensable part in providing healthcare to the people. Among them the Unani medical system is the most highly practiced.

The current ethnobotanical survey shows that out of 129 plants of economic value (Shah, 2001), 117 species (108 indigenous+9 cultivated) were found to be of traditional medicinal value. These medicinal species belongs to 61 families and 108 genera (Chart 1). People use medicinal plants to cure more than 50 ailments. Maximum treatment was found to be given against digestive complaints (c. 77 plants) and skin problems (c. 60 plants) (Graph 4). Their life forms include 15 trees, 20 shrubs, 74 herbs and 8 climbers (Graph 1). About 38% of the plants were used either in the form of roots or whole. This triggers the dire need of conserving such medicinal species through cultivation and regeneration (Graph 2). Maximum medicinal species bloom during April to July (c. 58 plants) while least from November to January (c. 12 plants). So field trips arranged for collection purposes would be beneficial during these months (Graph 3). Similarly maximum harvesting pressure has been noted against fodder utilization (29 per cent i.e., about 34 plants of the total 117) (Graph 5).

5.2. Extraction and Marketing

Moist temperate Himalayas is one of the major ecological zones from which medicinal plants are collected. It provides most of the country's timber requirements. During the last

hundred years, these forests have been subjected to major structural changes leading to a decrease of about 50% of the potential forest areas. The decrease in the forest cover, combined with major changes in community structure have also been responsible for the decline in medicinal plant populations resulting from disturbances of habitats (Siyal, 2003).

During the field investigations twenty three (Table 12) indigenous medicinal plants species have been recorded as being extracted from Ayubia, Kaghan, Murree and Hilkot which are the gateways through which these medicinal plants have been supplied in considerable amount to various national trading centers of Pakistan including Peshawar, Rawalpindi, Quetta, Lahore, Karachi and also abroad.

Analysis of the nearest national market (Rawalpindi and Lahore) survey revealed that 4 species (*Acorus calamus*, *Aconitum heterophyllum*, *Colchicum luteum* and *Rheum australe*-root sap) have maximum price i.e. Rs. 300 to 800 per Kg, followed by *Asparagus adscendens*, *Berberis lycium* and *Smilax aspera* (Rs. 200-300 per Kg) and about 47 species have average price below Rs. 200 per Kg. The data shows that only two species (*Punica granatum* and *Valeriana jatamansi*) have maximum annual consumption i.e more than 100 tonnes per annum followed by *Lavetera kasmeriana, Plantago major* and *Paeonia emodi* i.e. 50 to 100 tonnes per annum and the rest are consumed below 50 tonnes per annum (Table 13).

The post harvesting processing of the material is one of the most important stages in the herbal medicines manufacturing. The collectors can add value to their material and make it more acceptable for the conscious buyers, by adopting scientific procedures. Properly packed, clean and good quality herbal material receives higher price in herbal markets. The price of Pakistani *Podophyllum hexandrum* is Rs. 90/Kg in the national market while the Indian *Podophyllum hexandrum* gain Rs. 190/Kg in the national market of Pakistan; it is due to the effective ways of value addition technology. In case of *Asparagus adscendens,* the price of Pakistani species is Rs. 260/Kg in the national market. While the Indian *Asparagus adscendens* gain Rs. 2200/Kg in the national market of Pakistan due to the effective ways of value addition technology.

In the international market, especially in European herbal markets, there is a growing demand for originally grown medicinal plants. This certified plant material receives 3-4 times higher price in the international market. All the selected species collected from the wild fulfill the requirements of organic produce, if presented in acceptable form with proper certification. The in-situ conservation and rotational harvesting is from the natural areas will ensure organic plant materials.

Crude herbal material realizes little monetary returns in both national and international markets. Often these materials are collected in the developing world and exported to western countries for processing. The manufacturers of finished product in western countries sell them at very high prices worldwide. The major part of this money goes to the processing companies in the west, and not to the collectors in the developing world.

5.3. In Situ Conservation Status

Ayubia National park is heavily exploited for fuelwood and fodder (herbaceous and from broad-leaved trees). The collectors of fuelwood and fodder are women, hundreds of who visit the park daily, except in winter. There is also considerable illegal release of cattle into the park during the summer months. It is reported that there is an official system of fees to allow access to collect fuelwood and fodder and to graze stock. Relatively minor items collected by villagers include medicinal plants, food plants and mushrooms (*Morchella esculenta & M. conica* species etc.) which are dried and exported, fetching a high price in the European market. There is an evidence regarding the extent of collection of medicinal plants. A general survey of the use natural resources by the local people suggests that the use of medicinal plant is on a small scale and declining, but a detailed study revealed a higher prevalence of medicinal plant use and even some commercial collecting in the park.

From the point of view of conservation objectives, the unauthorized collection of plant materials, notably medicinal plants, fuelwood and fodder, in Ayubia National Park is undesirable, as is the unregulated grazing of cattle. About 35.7 per cent cases were registered against fuelwood collection, followed by 22.60 per cent for tree cutting and 16.77 per cent for fodder collection during nine years i.e., 1993-2001. However it is

found that only small fractions of these cases, perhaps not more than 10 per cent of the actual cases have been registered. The rate is more or less constant and perhaps continues by the same offenders (Shah, 2001).

With no link between use and responsibility, and high and probably ever-growing local demands for fuelwood, fodder and grazing land, it can safely be predicted that the quality of the forest will decline unless systems of local resources management are improved. In the long run, there will be no benefits from resource depletion. Fewer resources will be available to the local people, leopards and rare pheasants will be lost, and the quality of the catchment will deteriorate. This will have serious consequences because millions of people in the lowlands rely on the steady flow of rivers from this and other forested area in the Himalayas.

The main threats to the conservation of medicinal plants in the area are unsustainable harvesting by the local people, illegal collection inside the national park, grazing in high pastures, collection of pre mature plants and collection of whole underground parts. Previous ecological studies have also revealed the vulnerability of important medicinal plants to over harvesting and grazing.

Out of 42 indigenous marketable species, 10 medicinal plants have been found endangered, 22 species were found vulnerable and 10 were rare to the area according to the proposed IUCN criteria (Table 14, Graph 6).

The ten endangered species include one tree i.e., *Taxus wallichiana* and a shrub *Berberis lycium*. Due to their long life cycle, these two endangered woody species have been excluded from ex-situ cultivation trials. Rest of the 8 endangered herbaceous species has been selected for ex-situ cultivation trials. These species include *Asparagus adscendens*, *Atropa acuminata*, *Colchicum luteum*, *Dioscorea deltoidea*, *Paeonia emodi*, *Podophyllum hexandrum*, *Saussurea costus* and *Valeriana jatamansi*.

Taxus wallichiana (Burmi) has come into prominence in recent times due to its uncontrolled harvesting from the Himalayan wilds for the extraction of the anticancer drug 'taxol'. This tree has also been reported as endangered from Indian Himalayas. It is found only in some undisturbed locations mixed with fir, spruce and blue pine. It is a very

slow growing tree with poor regeneration and the extent of canopy damage is likely to have serious consequences on biomass yield, plant survival and natural regeneration by affecting seed output (Rikhari *et al.*, 1998). During the last four years about 5920 Kgs needles/twigs along with bark worth Rs. 1,77,600 have been extracted from Kaghan valley alone (Table 12). This tree species have been observed to be a victim of any unknown pathogenic disease. Though it is under pressure due to its use as timber, fuelwood and fodder also. This species has been declared as endangered in the area under the proposed criteria. This tree needs cultivation study. Its propagation and processing needs standardization. The demand of the species is very high and supply is very low in the market. The evaluation of genetic diversity of the sub-species is very important to be found out. It has been reported that significant quantities of taxol have been not only located inside the needles but also on their surface also (Zobel *et al.*, 1996). Use of bark must be substituted with needles to release harvest pressure on bark collection in order to stimulate sustainable utilization of this critical species.

The only medicinal shrub found endangered was *Berberis lycium*. The whole plant was found to be used for different disorders. Its cultivation requires further study. It is usually grown from seed while vegetative propagation needs study. Its fruit was collected by men, women and children for domestic use and often eaten on the spot. The wild fruit was collected by grazers in the forest. Occasionally, small quantities appear on the local market. The demand is high and supply is medium. Study of genetic diversity has been required to be undertaken. Its cultivation can be recommended as live hedges.

Asparagus adscendens cultivation is known but needs standardization. Propagation has been done by seeds and rhizomes but needs refining. Its primary processing methods has been known but needs standardization to avoid color change. Genetic diversity needs to be studied. Further research has been required for improvement of its cultivation techniques. The demand of the plant is high while supply has been found medium.

Atropa acuminata cultivation techniques are known but needs further study. The roots of the plant are used as anti asthmatic and analgesic. The demand of the plant material is high and supply is found low. Its population sample requires evaluation. Cultivation trials

are needed to be done. Roots of *Colchicum luteum* are used for Colchicine. Its cultivation and propagation techniques have not been fully known and needs study. The processing techniques also require study. The demand of the plant material is found very high and supply low. There is a need to evaluate its population diversity. Priority should be given to cultivation and selection of genotype in research.

Dioscorea deltoidea has also been described among threatened plants of economic value from India (Jain, 1997). Cultivation of *D. deltoidea* has been known but needs further standardization. The propagation of the plant has been done by pieces of rhizomes. The local demand of the plant material is high while supply is low. Processing technique are known. Evaluation of the population is needed to be done. While conducting research on this plant, priority should be given to its cultivation based on its regional trials.

Paeonia emodi is being used in the treatment of rheumatic pain and backache. Its demand is high while supply is low. The germplasm evolution is reported to be crucial, especially in relation to rhizome production and time of harvest. Cultivation of the plant as crop under shade is needed. This species prefers to grow in sandy loam and loamy silt soil having slightly acidic properties (Sher, 2002).

The population of *Podophyllum hexandrum* is small in size. It is also over exploited in high altitude Himalayas at its natural stands (Choudhary, *et al.*, 1998). The natural populations of *P. hexandrum* have also been decreasing since 1982 in Garhwal Himalaya (Bhadula *et al.,* 1996). It has been propagated from seeds and rhizome parts. There is an urgent need for sampling evaluation. Demand of the plant is high and supply is low. In research priority should be given to its germplasm exploration, cultivation, regional trials, harvest time reduction.

Saussurea costus roots being aromatic used in respiratory problems. It has also been reported among Indian threatened plants of economic value (Jain, 1995). Its cultivation, propagation and processing techniques are known. Demand of the plant material is high and supply is found to be low. It is very important to evaluate for shelter growth cycle. Genetic diversity is needed to be done as it has two forms, one from Kashmir and other from Ayubia.

Valeriana jatamansi rhizomes and roots are found to be used as mild sedative, in leprosy and as a tonic. The same has also been reported as endangered from Nepal (Bhattarai, 1996). Cultivation and propagation's known but requires further study. Its demand is very high and supply is low. Germplasm evaluation is crucial, especially in relation to rhizome production and time of harvest.

Carum copticum seeds are used as stomachic and carminative. Cultivation techniques are known but need to be developed. Propagation is by seed while selection is needed. The demand of the species is very high and supply is low. Genetic diversity is needed to be tested. In research priority should be given to its cultivation as field crop reduction of natural seed shedding. Same is the case with *Nigella sativa*.

5.4. Ex Situ Conservation Trials

5.4.1. Seed Germination Tests of Selected Species:

Seeds of three selected species were collected from various forest areas of Kaghan, Dungagali, and Kuzagali and seed germination trials were conducted to determine the germination percentage and to enhance the germination ability of seeds by various chemical and mechanical means. The experimentation resulted in reducing the germination period, enhancement of germination percentage and breaking seed dormancy period of *Atropa acuminata*, *Colchicum luteum* and *Saussurea costus* with the application of 200ppm Gibbrellic acid and other treatment. The germination tests of *Atropa acuminata* revealed that seeds when treated with 200ppm gibbrellic acid for 30 minutes reduced the time of initiation of germination by about 20 days as compared to untreated seeds which took 40 days for initiation of germination. Similarly less number were taken for complete germination (100 days) by the treated seeds as compared to untreated seeds (140 days). Higher germination percentage (93%) was obtained with gibbrellic acid treatment as compared to untreated seeds (53%).

Seed germination of *Colchicum luteum* in various treatments under field condition showed higher germination (47%) with chilling treatment (29%) and 200ppm gibbrellic acid (11%) against control (9%). Chilling treatment also reduced initiation time by 20 days as compared to control, which took 75 days.

In case of *Saussurea costus*, the maximum germination (97%) was obtained with 200ppm gibbrellic acid treatment followed by 100ppm treatment (91%) and chilling treatment (89%) against controlled (60%). The gibbrellic acid treatment also reduced the germination initiation time to 14 days as compared to controlled which took 35 days. Similarly chilling treatment also reduced initiation time to 21 days.

5.4.2. Ex-situ Cultivation Trials on Selected Species:

For cultivation trials at Burban Research station, Murree, a patch of land was selected and fenced with barbed wire for protection against cattle stray. Seedling raised from germplasm of three species discussed above and propagated material of five other selected species such as *Asparagus adscendens*, *Dioscorea deltoidea*, *Paeonia emodi*, *Podophyllum hexandrum* and *Valeriana jatamansi* were planted in replicated small plots for observation of propagation regeneration behavior (Table 17).

The over all performance of these species has been encouraging and attracted herbal practitioners and students for identification of genuine plant material to avoid adulteration and as reference. This regeneration area looked as it could serve as a model for training and motivation of local community to involve them in conservation of medicinal plants through its demonstration effects. Secondly it is also proved that such areas can be used as seed source for supplying quality seed and propagating material to community activists for planting on their land for additional income generation. The propagation and regeneration behavior of all the 8 selected endangered medicinal herbs were as follows:

The over all survival percentage after first and a half year observations was found maximum in *Dioscorea deltoidea* (97%) followed by *Valeriana jatamansi* (96%) and *Saussurea costus* (95%). The survival percentage of *Asparagus adscendens* (92%), and *Atropa acuminata* was also encouraging. However, *Paeonia emodi* (45%), *Podophyllum hexandrum* (45%) and *Colchicum luteum* (40%) showed very poor survival ratio.

Asparagus adscendens shows satisfactory growth potential in the experimental plots however needs atleast 3-5 years to get rhizome of commercial size. Seedling of *Atropa acuminata* raised in polythene tubes were most suitable for planting in the field while the method of planting root shoot cutting is not economical and practicable. Fresh leaves

yield was low during first year but it increased with the duration of time from second year. It has been estimated that root took 3 years growth period to attain commercial size for harvesting and utilization (Khan *et al.*, 1992).

Regeneration of the *Colchicum luteum* plant is found more successful from seed though the plant takes more time to develop from the corm. Propagation by planting daughter corm is wasteful and uneconomical due to large number of corm required for planting. It has been also reported that seed collection of *Colchicum luteum* is more sustainable and beneficial as the seed contains more Colchicine contents as compared to the corms (Khan *et al.,* 1992). The extraction of corms should be prohibited to give sufficient time for the development of corms, its seed dispersal and regeneration.

Dioscorea deltoidea is a slow growing plant and takes 5-6 years for attaining commercial size for harvesting. The plant is also responsive to artificial fertilizer and a dose of 300Kg nitrophos per hectare when thoroughly mixed at the time of planting was found beneficial in the establishment of the plant. The propagating material collected from Kuzagali showed better regeneration percentage and higher yield of rhizomes as compared to other sources and may be suitable for planting for regeneration purposes. A spacing of 60 x 30 cm was found suitable for planting as it utilized 25 % less planting material (rhizomes) and also gave higher yield of rhizomes and ease in cultural operations and the average regeneration percentage of rhizomes as observed in various experiments ranged from 46-55% (Khan *et al.,* 1992).

One of the previous attempt to cultivate *Paeonia emodi* has failed in agriculture land at Swat (Sher, 2002). Similarly, during the present study the cultivation trail results are also not very encouraging i.e, only 45% seedlings could survive (Table.17).

The seed germination trials of *Podophyllum hexandrum* has also been reported as unsuccessful (Khan *et al.,* 1992). An attempt to cultivate *Podophyllum hexandrum* in agriculture land had also been failed in Swat (Sher, 2002). However, an information about the successful regeneration of this plant from seed has been obtained from the indigenous people of the study area at Kuzagali and Kaghan during ethnobotanical surveys. It has been told that the fruit of *Podophyllum hexandrum* is eaten by the

indigenous Rhesus monkey of the area and the partially digested seeds in excreta show rapid and high rate of germination. Hence the breakage of the seed dormancy of *Podophyllum hexandrum* seed is associated with the digestion process of the Rhesus monkey. *Podophyllum* rhizomes are reported to be slow growing and take 8-10 years for attaining commercial size for harvesting, therefore a rotational period of 10 years is required for exploitation of rhizomes. Since the seed germination is difficult, therefore propagation may be done by planting 2 budded portions of rhizomes for obtaining more number of plants for artificial regeneration in the area.

Saussurea costus being a perennial plant requires at least five years growth period for development of good size roots for commercial exploitation, therefore a rotation period of five years may be fixed for its harvesting and better regeneration. A spacing of 60 x 30 cm is found suitable for artificial planting. The optimum growth period required by *Valeriana jatamansi* is 3-5 years therefore a rotation period of five years be adopted for harvesting the rhizome to provide sufficient time for regeneration .

Cultivation of medicinal plant is usually viewed not only as a means for meeting current and future demands for large volume production of plant based drugs and herbal remedies, but also as a means for relieving harvest pressure on wild populations (Palevich, 1991; WHO, IUCN & WWF, 1993; FAO, 1995). Domestication and cultivation provide numerous advantages over wild harvest for production of plant-based medicines, including reliable botanical identification; steady source of raw materials; standardized or improved genotype; and controlled post harvest handling.

5.4.3. Limitations in Cultivation:

There are certain limitations in cultivation of medicinal plants. In terms of economic feasibility the first step is to conduct cultivation trials of medicinal plant if they would provide reasonable and additional income to the growers. Drug crops cannot compete in income with major food or cash crops. Planting, cultivation or harvesting of medicinal plant crops requires a relatively large investment in human labor and therefore growing them is often not economically feasible. However, some specialty crops like cardamom,

clove, cinnamon etc., come to the markets from regions where climatic conditions are favorable for their growth and cost of production is also low.

Moreover, medicinal plants may require, in addition to their cultural requirement, special processing, for drying, distilling apparatus or other equipment for some other processes in their preparation as drugs. These conditions and requirements may limit production of crude drugs. Drug plants are also subject to law of supply and demand, just as most other farm products. Few drug crops are in great enough demand to make their cultivation general. A relatively small increase in supply of any of them may cause a corresponding decrease in the market value.

Diseases and pests that effect drug crops are as diverse as those that effect other crops. Viruses, wilts, leaf spots, root diseases and others as well insect pests are common among drug and condiment plants. Diseases and pests must be recognized and method of control worked out. Marketing of medicinal plant crude products is another problem, which restrict their cultivation on large scale. There are only a few drug dealers who monopolize the market and there are genuine difficulties faced by the farmers in disposing off their products at reasonable rates.

In addition to loss of markets, benefits and other conservation incentives for local collectors, cultivation of threatened medicinal plant as a conservation measure also has some other disadvantages, such as the limited range of genotypes selected for cultivation. Separate measures to protect wild populations and wild relatives for evolution and adaptation might be required. The higher cost of research, development and production make it likely that all abut a few of the more valuable medicinal plant species will continue to be collected from wild. All wild plant species can not be cultivated. Hence cultivation does not necessarily reduce harvest pressure on all wild populations (Leamaan, 1998).

However, it has been recommended that small scale cultivation by local collectors combined with the research on plant ecology required to determine sustainable wild harvest levels and methods for a targeted species will be a better approach for conservation (Pinhiero, 1997)

5.5. Conservation through Community Participation

Building on local knowledge and involving local people in conservation and development schemes is a new paradigm which has brought many changes in development and conservation approaches over the last decade (Aumeeruddy, 1997). Among all other forest products, medicinal plants from Himalayan regions are most threatened in this context. The yield of community base approaches for conservation and use of medicinal plants in the Himalayan region is new and requires even more attention today as trade has increased dramatically. This issue is of major importance not only from a global view point but also in term of the livelihood of people living in the areas where these plants originate.

Giving growing consumer interest plant -based medicines, this threat is likely to increase. Most medicinal plant species are harvested from wild populations; it is unlikely that more than a few economically valuable species will be cultivated on a commercial scale or supplied through biotechnology.

The priority actions identified for conservation of medicinal plants are; conductance of basic studies to identify medicinal plants and traditional knowledge of their uses; sustainable utilization through cultivation, controlled wild harvest and reduction of waste; conservation trials both in-situ and in natural habitats, and ex situ -in botanical gardens a, kitchen gardens and seed banks; and to stimulate increased public support for conservation of medicinal plants through communication and cooperation.

For an effective resource base management through community participation it is important that the resource must have some social and economic value to the community. Communities must also be aware that the resource is in short supply and vulnerable to over exploitation. It is important to ensure that the benefits of the resources are equitably shared with the communities; the sense of ownership can only be generated when the community at large sees the benefits coming from the resource. Appealing to the communities' social conscience regarding the proper use of their natural resources will not be very effective. If monetary value of the species can be identified and developed as

a managed enterprise for local communities this will create the desired awareness into which interest can be built for the wider enhancement of conservation.

Forest management through participatory approach recently gained popularity among rural communities in the country. It is spreading its roots gradually in the hilly areas of the country. The management efforts are directed to increase the productivity of degraded forest and forest products through active involvement of local communities in harvesting, marketing and benefit sharing etc. The inhabitants of hilly areas are poor and depend on non-profitable agriculture and forestry operations.

Promotion of community level enterprise through cultivation of medicinal plants and familiarization of scientific post harvest processing techniques like drying, cleaning, storage for value addition to produce and marketing will provide an important support to livelihood for income generation activities in the hamlets. Due to large demography and food security needs of the country, there is no alternative way in which agricultural land reserved for food crops can be utilized for growing medicinal plants. For this purpose, farmers of small holdings are needed to be motivated in an organized manner to grow medicinal plants along with traditional crops in their kitchen garden, wasteland and bunds of cultivated field rather than promoting big farmers with plans for large plantations. This effort will be useful in poverty alleviation through community participation of rural communities. Such activities will boost up the growth and development of herbal and allied industries. The attempt made by establishment of demonstration plots of Kotla Village, Margalla Hills have been succeeded. It attracted many other farmers of the village and showed keen interest in the cultivation of the medicinal crops sown.

Interim yield results indicated that *Nigella sativa* gave higher income followed by *Carum copticum* respectively (Table 18). These specialized crops gave better economic return than traditional crop of the area. Such crops had a better chance of succeeding than any other minor crop. This has built up confidence among farmers in the study area and has also motivated others who were keen but conservative in their initiations.

5.6. Conservation through Sustainable Utilization

It is general rule that the effectiveness of herbal medicines depends on chemical constituents present in plant parts. These active constituents are often thermally prone to air and light induced degradation. Microbial and insect infestation of a crude material not only degrades the chemical ingredients but also introduce toxin into the materials. Wrong time and season of collection, adulteration, garbling and poor drying and storage also adversely affect the active constituents. Preserving the optimal quantities of active chemical ingredients in the herbal medicines is one of the major requirements of end users, including herbal pharmaceutical companies and exporters.

Limiting the harvest to a sustainable level is complicated by the conflict of interests between use and protection. It requires an effective management system and sound scientific information. Development of a management strategy should include; the assessment of population abundance and distribution; biological studies (growth and regeneration rates, pollination system, seed dispersal, etc); assessment of tenure and access; potential for confusion with similar species; local knowledge and harvest practices; impact of harvest on viability of individuals; yield and market studies; and assessment of regional and global threat based on all available knowledge and expertise (Schippmann, 1997; FAO, 1995).

The management system should include annual harvest quotas; seasonal restrictions; geographical restrictions; restricted harvest of particular plant part or size classes; and continuos monitoring and evaluation of conservation status.

5.6.1. Harvesting Techniques:

There is an optimal time for the collection of plants depending upon their phenology. Optimal timings have a direct link with the part of plant used. There exists a clear relationship between the time of harvesting and impact on plant regeneration and the amount and nature of active chemical constituents present in the plants, which are not constant throughout the year and throughout their lifecycle. Each part of a plant contains different chemical components; therefore the collection of the incorrect part for a specific purpose will result in a wrong outcome.

The rhizomatous plants like; *Paeonia emodi*, *Podophyllum hexandrum*, *Valeriana jatamansi*, *Bistorta amplexicaule*, *Polygonatum multiflorum*, *Colchicum luteum*, *Dioscorea deltoidea* and *Saussurea costus* are harvested by the local people in summer and during this period the plant utilizes the root chemistry and nutrition for the development of aerial parts especially to produce better reproductive growth (i.e., to give fruits and seeds). This wrong time of collection results in the depletion of active chemical constituents and also affect the potential of their sustainability. Biologically speaking the rhizomes of all these species should be collected / harvested when the plant become dormant i.e. in winter or before sprouting i.e. early spring (November to April). During this period the plant converts the nutritional chemistry of aerial parts (leaves, stem) into alkaloidal contents and store in roots. Therefore, the plant contains maximum percentage of active ingredients in their roots/ rhizomes.

Poor harvesting techniques often exacerbate the threat to medicinal plant species by causing unnecessary levels of damage. For example, uprooting of a plant to use only the aerial parts can cause severe depletion of population levels of the species. Similarly, collection of large portions of the bark of a tree may lead to plant death.

5.6.2. Post Harvest or Processing Techniques:

After collection, drying is the net technical step as part of processing. Incorrect drying may lead to loss of valuable constituents. Proper drying helps in the preservation and fixation of the active constituents. Presently the inhabitants of the valleys dry all the plant material in sunlight. The local no proper place for drying and they spread the plant material on open floor, where these are contaminated by dust particles and some pathogenic agents. This incorrect drying of the plant material may also lead to loss of valuable constituents.

As a general rule, plants, whose active constituents are not affected by sunlight should be sun dried for instance *Colchicum luteum* for Colchicine (Trease & Evans, 1985). Plant containing volatile constituents and oil should be dried in the shad for example *Valeriana jatamansi*, *Viola serpens* and all other target species should be shade dried. Both sun and

shade dried plants need to be in suspended wooden trays, to get circulate air freely. Turning 3-4 times a day is also required.

It is important to understand that the real wealth lies in the scientific processing (extraction, standardization, quality control and proper packing) and marketing of herbal material, and not just in the collection and cultivation. It is therefore important that the small-centralized processing units should be established in the areas where medicinal plant resources are abundant.

Chapter – 6
Conclusion

6. Conclusion

Medicinal plants are a valuable global resource, increasingly threatened by loss of habitats and over exploitation. The principal cause of over exploitation includes; lack of knowledge about sustainable harvest rates and practices; poverty and breakdown of traditional controls. It is, however, imperative that all of us, as users of biological resources in all its diversity, understand and practice the principle of conservation. This is the only way that any one can be sure of reaping the maximum benefits from these resources in our time without putting in jeopardy the existence of future generations since they must also depend on these same biological resources.

Given the importance of medicinal plants for sustaining livelihoods in Ayubia and the pressure over these resources due to trade, the conservation status of medicinal plant is endangered inside the national park. There is evidence that people living outside the national park are already collecting medicinal plants within the boundary of the park. The national park lacks sufficient manpower to efficiently monitor all illegal activities. On the other hand, communities living inside the park have been traditionally managing their pastures and other resources according to customary systems. Knowledge about distribution, abundance, harvesting and management techniques of medicinal plants is thus community based, while National Park staff has little precise knowledge about these subjects. It ensues from this that local communities are in the best position to protect and manage medicinal plants if an agreement, which confers appropriate, right on them is reached with the park authorities. In order to reach this agreement, a precise management plan needs to be established which each community which includes conservation and sustainable management systems. This community management plan can then be submitted to the park authorities for further considerations and ultimately integration in the park management plans for buffer zones situated inside the park.

Tentative guidelines for work to improve local systems of management for medicinal and other plant resources, emerging from the Ayubia experience, include:

1. Local medicinal plant issues should be placed within wider local contexts e.g., consider all plant resources used, and all land use and resource ownership categories, including the roles that the latter might play in conservation efforts.
2. Good management depends partly on making it worthwhile for people to be good managers. The system of land tenure and resource ownership, and decision-making processes within communities (including between the genders) are key considerations.
3. Those who actually harvest and locally use wild plant resources must be included within management systems. Often, harvesters of wild medicinal plants are among the most disadvantaged members of communities' e.g., women and the land less.
4. Valuable alliances can be forged local people and conservationist each bringing their particular perspective and knowledge to the identification and resolution of conservation and development problems (subject areas include identification of plants; knowledge of plant use; values assigned to plants and their products; perspectives on rarity and threatened status; methods of management; perspectives on marketing).

Where there are protected areas, agreements are necessary between local people and agencies specifying rights and responsibilities. Medicinal plants can be significant components of such agreements, since they are often culturally valued, vital for local healthcare and sometimes-important sources of income.

Natural regeneration of medicinal plants is adversely affected also by a number of climatic and edaphic factors. The period of growth at higher elevation is generally very short i.e., (April, May to October), any change or disturbance in the climatic factors i.e., prolonged drought in the initial stages of growth (April to June) or excessive rains resulting in low temperature during the month of July and August may result in the poor regeneration and growth of the plants during that year.

Disturbance in the regeneration patterns is also caused due to heavy grazing and intensive felling of trees in particular area. Due to increase in population and simultaneously of animals the grazing pressure has increased tremendously and thus unpalatable or even

poisonous plants though not eaten but are trampled so heavily that regeneration and survival of the plants become extremely difficult.

Moreover the extraction of important medicinal plants is being continued ruthlessly by the grazers, collectors and concerned drug dealers without any consideration of age and size of the plants which result in the depletion of this natural resource. Generally the plants occurring at higher elevation acquire perennial nature and require a prolonged period of growth i.e. 6-8 years depending upon the plant species concerned. Some of the plant requires at least three to four years to reach the flowering stage. Most of the time, it is extracted by the collectors before reaching the flowering and fruiting stage and thus minimizing its regeneration possibilities. Further where the roots of the plants are to be collected, the plant has to be destroyed in the process of extraction. Being long duration plants these important medicinal plants are at the verge of extinction in some of the accessible areas, while in the far-flung areas, the plants are found sparsely and widely scattered.

Collection of medicinal plants carried out by the collectors may be streamlined in such a manner to provide ample regeneration time to the plants keeping their optimum period of growth in view. The area once used for collection may be declared as protected area and no more extraction may be allowed for a period of six to eight years.

Seeds of important medicinal plant may be collected according to their time of maturity and after proper cleaning, drying and garbling be stored in glass-jars for regeneration in the next season.

It is suggested that reseeding of important medicinal plants in their natural habitats may be carried out during rainy season in the depleted areas where these plants had become scarce. The regeneration area later on may be closed for 6 year by imposing ban on the extraction of herbal drugs. This practice would help to conserve germplasm resources and ensure future sustained supply of this renewable resource from the forest area.

Introduction, modes of propagation, regeneration, cultural and agronomical studies carried out in the moist temperate Himalayan region indicated that endangered plants like *Asparagus adscendens*, *Atropa acuminata*, *Colchicum luteum*, *Dioscorea deltoidea*,

Paeonia emodi, *Podophyllum hexandrum*, *Saussurea costus* and *Valeriana jatamansi* could be successfully regenerated and propagated in the depleted areas where the population of these species have become scarce. While short-term annual plants like *Carum copticum* and *Nigella sativa* can be introduced as crop substitute in low land Himalayas.

In the light of observations and experience of the present study the following recommendations have been formulated for future considerations:

1. Local communities can take more responsibilities for sustainable harvest of medicinal plants only if they have the choices afforded by adequate income, control over the resource, and the knowledge and skill required.
2. A medicinal plant conservation strategy should be designed at government level that includes land-use planning, habitat protection and species-specific in-situ and ex-situ conservation measures.
3. Industry and consumers should assume greater responsibility for the conservation of medicinal plant and should bear a greater share of the cost of conservation directly.
4. Medicinal plants produce is governed by the law of supply and demand and therefore only those plants may be cultivated which have a constant demand in the market and could provide a reasonable cash return to the farmer.
5. Plants requiring long period of growth and specific ecological conditions and elevations may be regenerated in their natural habitats in case of their scarcity, otherwise the demand may be met from natural resources by adopting a systematic rotation for exploitation on sustained yield basis.
6. Pharmaceutical concerns interested in the cultivation of specific plants should take up their cultivation on large scale by developing their own research and development facilities.
7. To preserve the medicinal plant species, gene pools may be created in the natural habitats of various plants.
8. A procedure may be evolved to stream line the marketing of medicinal plants. Unstable market, fluctuation in prices is the main cause of low production of medicinal plant produce.

9. Research needs to be undertaken on the selection of fast growing, high active ingredients yielding cultivars of the commercially important species.
10. It is economically viable that small holder farmers should play a greater role in medicinal plant cultivation, by introducing home yard gardens or kitchen garden concept.
11. Core conservation areas should be recognized as control sites for comparison with the forest where exploitation of wild population of medicinal plants continues to take place. Disturbed sites should be used to monitor recovery and regeneration.
12. Provenance collection in secure field banks should be established for medicinal plant genotypes.
13. Sustainable limits of harvesting from wild population should be set over a period until enriched plantings are established.
14. To raise awareness, campaigns like "plants for health" or "plants are wealth" should be designed. Understanding of the importance of habitat and medicinal plant conservation should be promoted in the area.
15. Fresh quantitative survey should also be conducted in this area and to monitor the effectiveness of the recommendations, as well as the status and recovery of populations, permanent plots or transect lines need to be set up outside and within core conservation areas.

Chapter - 7
References

7. References

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