Proceedings of Workshop

High Altitude Medicinal Plants






National Medicinal Plants Board, Ministry of AYUSH
Government of India

Indian Council of Forestry Research and Education
P.O. New Forest, Dehradun - 248 006

Proceedings of Workshop

High Altitude Medicinal Plants

(21-22 March 2016)

Sponsored by:

National Medicinal Plants Board, Ministry of AYUSH
Government of India

Organised by:

Indian Council of Forestry Research and Education
(An Autonomous Body of Ministry of Environment, Forest and Climate Change, Government of India)
P.O. New Forest, Dehradun - 248006

Indian Council of Forestry Research and Education
P. O. New Forest
Dehradun – 248 006 (Uttarakhand)

2016

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सत्यमेव जयते

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उप महानिदेशक (अनुसंधान)
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Deputy Director General (Research)

भारतीय वानिकी अनुसंधान एंव शिक्षा परिषद
(पर्यावरण, वन एंव जलवायु परिवर्तन मंत्रालय, भारत सरकार की एक स्वायत्त संस्था)
पो.ऑ. न्यू फॉरेस्ट, देहरादून–248 006
Indian Council of Forestry Research and Education
(An Autonomous Body of Ministry of Environment, Forest and Climate Change, Government of India)
P.O. New Forest, Dehradun - 248 006

Foreword

High altitude of the Indian Himalayan region houses several unique species of medicinal plants, including many rare and endemic species which are highly valued in the herbal industry for preparation of herbal healthcare formulations and cosmetics. The local communities of these regions are depending on medicinal plants for their health care needs as well as for their livelihoods. Medicinal plants of high altitude regions are facing different categories of threat due to un-scientific collection and over exploitation.

In the aforesaid background, ICFRE organized a two day workshop on "High Altitude Medicinal Plants" on 21 and 22 March 2016 at Dehradun. The aim of workshop was to assess the current status of knowledge of the high altitude medicinal plant resources, to document the conservation and cultivation initiatives across different states in the region, and to highlight the importance and need of cultivation, conservation and sustainable utilization of medicinal plants of high altitude.

The workshop brought together high altitude medicinal plants experts from research organizations, universities, State Forest Departments, industries, Non-Governmental Organisations, traders and cultivators. The recommendations of the workshop are being forwarded to the National Medicinal Plants Board, Ministry of AYUSH, Government of India for speedy implementation. I am optimistic that the recommendations of the workshop and their implementation will facilitate the conservation, cultivation and sustainable utilization of medicinal plants of high altitude regions in the country.

I am thankful to the National Medicinal Plants Board, Ministry of AYUSH, Government of India for providing financial support to organise this very pertinent workshop. I am thankful to the invited speakers and participants of the workshop. I am also thankful to the officers, scientists and staff of Biodiversity and Climate Change Division, Directorate of Research, ICFRE for putting their all efforts in organizing this workshop. Efforts made by the editors and rapporteurs for bringing out the proceedings of workshop in an articulate manner are appreciated.

(Dr. G.S. Goraya)

Contents

Abbreviations

AYUSH	Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy
BSI	Botanical Survey of India
CAMP	Conservation Assessment and Management Prioritization
CSIR	Council of Scientific & Industrial Research
FRI	Forest Research Institute
FRLHT	Foundation for Revitalization of Local Health Traditions
GA	Gibberellic Acid
HAPPRC	High Altitude Plant Physiology Research Center
HFRI	Himalayan Forest Research Institute
HRDI	Herbal Research and Development Institute
HP	Himachal Pradesh
HRG	Himalayan Research Group
ICFRE	Indian Council of Forestry Research and Education
IHBT	Institute of Himalayan Bioresource Technology
IUCN	International Union for Conservation of Nature
Kg	Killogram
MAP	Medicinal and Aromatic Plant
MPCAs	Medicinal Plant Conservation Areas
m	Metre
NBRI	National Botanical Research Institute
NMPB	National Medicinal Plants Board
SFRI	State Forest Research Institute
t	Tonne

EXECUTIVE SUMMARY

A two days workshop on 'High Altitude Medicinal Plants' sponsored by National Medicinal Plants Board, Ministry of AYUSH, Government of India, was organised by Indian Council of Forestry Research and Education (ICFRE) at Dehradun from 21 to 22 March 2016. About fifty delegates/ subject matter specialists from various research organizations, universities, State Forest Departments, industries, Non-Governmental Organisations, traders and cultivators participated in the workshop. The workshop was an endevour to assess the current status of knowledge on medicinal plants of high altitude, to document the conservation and cultivation initiatives across different states in the region, and to highlight the importance and need of cultivation, conservation and sustainable utilization of medicinal plants of high altitude.

The workshop was inaugurated by Dr. Ashwani Kumar, Director General, ICFRE. He highlighted the deep rooted importance of medicinal plants in Indian history and culture in his inaugural address. He spoke about the ancient texts that highlight the use of medicinal plants, especially by Charak, Sushrut and Dhanwantri and how they documented the use of medicinal plants in these texts. Dr. Vimal Kothiyal, Assistant Director General (Research Planning), Directorate of Research, ICFRE highlighted the importance of medicinal plants in income generation for forest dependent communities. He also emphasised on sustainability issues in harvesting and collection of medicinal plants from the forests. Dr. T.P. Singh, Assistant Director General (Biodiversity and Climate Change), Directorate of Research, ICFRE welcomed the participants and apprised the house about the purpose of the workshop.

Four sessions were planned to discuss the various issues of high altitude medicinal plants related to cultivation, conservation, sustainable harvesting and regulatory regimes. In the first technical session titled 'Diversity, utilization and conservation status of high altitude medicinal plants', following three presentations were made:

1. Diversity, utilization and availability of high altitude medicinal plants of Himachal Pradesh by Dr. N. S. Chauhan, Professor and Head (Retd.), Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni (Solan, H.P.) and Former Senior Consultant National Medicinal Plants Board, Government of India
2. Conservation and cultivation of medicinal plants in Himalayas by Dr. M.R. Uniyal, Ex-Director, Ex-Advisor, Medicinal and Aromatic Plants, Uttarakhand Shasan, Dehradun
3. Conservation interventions in respect of red listed medicinal plants in Himachal Pradesh by Dr. Vaneet Jishtu, Scientist, Himalayan Forest Research Institute, Shimla

In the second technical session titled 'Developing strategies for conservation and sustainable utilization of high altitude medicinal plants**',** following seven presentations were made:

1. Status of diversity and population dynamics of key medicinal plant species of Uttarakhand by Dr. H.B. Naithani, Scientist (Retd.), Forest Research Institute, Dehradun

2. Conservation and sustainable utilization strategies for high altitude medicinal plants of Uttarakhand by Sh. M. S. Gosain, Uttarakhand State Medicinal Plant Board, Dehradun
3. Conservation and cultivation of high altitude medicinal plants in cold desert region of the western Himalayas by Dr. Rakesh Kumar, Institute of Himalayan Bioresource Technology, Palampur (H.P.)
4. Rapid mapping of the medicinal plant resources of high altitude by Dr. G. S. Rawat, Dean, Wildlife Institute of India, Dehradun
5. Conservation and cultivation status of medicinal and aromatic plants in Bharsar (Pauri Garhwal) by Dr. Rajendra Singh Chauhan, Officer-In-Charge, Medicinal and Aromatic Plants, Uttarakhand University of Horticulture & Forestry, Bharsar
6. High altitude medicinal plants of Govind Pashu Vihar Wildlife Sanctuary, Western Himalayas by Dr. R. Manikandan, Scientist, Botanical Survey of India, Dehradun
7. Micro propagation of threatened medicinal plants of North-West Himalaya *viz. Lilium polyphyllum, Pittosporum eriocarpum* and *Eremostachys superba* by Dr. Giriraj Singh Panwar, Scientist, Botanical Survey of India, Dehradun

In the third technical session titled 'Cultivation, value addition and marketing of high altitude medicinal plants', following ten presentations were made:

1. Cultivation through cluster approach- a case study of *Swertia* and other species by Dr. Lal Singh, Himalayan Research Group, Shimla
2. Nursery techniques for mass production of important temperate medicinal plants by Dr. Sandeep Sharma, Scientist, Himalayan Forest Research Institute, Shimla
3. Case study of successful cultivation of high altitude medicinal plants of Himachal Pradesh by Dr. Kulwant Rai Sharma, Professor, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni (Solan, H.P.)
4. Cultivation of high altitude medicinal plants through cluster approach in Uttarakhand by Dr. V.P. Bhatt, Scientist, Herbal Research and Development Institute, Mandal (Gopeshwar)
5. Case study of successful cultivation of high altitude medicinal plants in Uttarakhand by Dr. M.C. Nautiyal, High Altitude Plant Physiology Research Centre, Srinagar (Garhwal)
6. Conservation and cultivation of high altitude medicinal plants in Jammu & Kashmir by Sh. S.K. Gupta, Director, State Forest Research Institute, J&K
7. Cultivation and value addition of high altitude medicinal plants of Himachal Pradesh by Sh. Nand Lal Sharma, Nanda Medicinal Plants Exports, Manali, Himachal Pradesh
8. Dabur India Ltd. initiatives in cultivation of high altitude medicinal plants by Dr. Sarvepalli Badari Narayan, Dabur India Ltd., Sahibabad (Ghaziabad, Uttar Pradesh)
9. Cultivation potential and success of high altitude medicinal plants in Uttarakhand by Dr. A.K. Sharma, Scientist, Forest Research Institute, Dehradun
10. Conservation and Cultivation of Medicinal Plants in North-Eastern States of India by Sh. S. Hussain, Vista Agritech, Guwahati (Assam)

The fourth technical session titled 'Regulatory regimes of high altitude medicinal plants' was an open session and this session was chaired by Sh. D.K. Ved, Advisor, Foundation for Revitalization of Local Health Traditions, Bangalore. Other panelists of the session were:

- Dr. S. Farooq, The Himalaya Drug Company, Dehradun
- Dr. M. R. Uniyal, Ex-Director, Ex-Advisor, Medicinal and Aromatic Plants, Uttarakhand Government
- Sh. Arvind Alipuria, Additional Principal Chief Conservator of Forests, Himachal Pradesh Forest Department
- Dr. Lalit Narayan, Dy. Director, National Medicinal Plants Board, New Delhi
- Dr. Lal Singh, Director, Himalayan Research Group, Shimla

All the delegates deliberated on the theme of the session. They also acknowledged the importance of such workshops as they provide a platform for buyers, growers, traders and researchers to interact and put forward their views and concerns about medicinal plants. Chairman concluded the session with the remarks that there are too many issues and too many agencies to deal with or this issue, which is a challenging task.

Recommendations of workshop for conservation and sustainable utilization, cultivation, value addition and marketing, institutional support and capacity building with respect to high altitude medicinal plants were finalized for the consideration and implementation by National Medicinal Plants Board, Ministry of AYUSH, Government of India.

Workshop on

High Altitude Medicinal Plants

(21-22 March 2016)

1. INTRODUCTION

The Indian Himalayan Region (IHR) spreading over 10 states of the country covers a geographical area of approximately 5,00,000 sq km. The high altitude of IHR serves as a rich repository of medicinal plant wealth including many rare and endemic species. High altitude regions have extreme climatic conditions due to which medicinal flora have some special characteristics to develop novel active compounds for adaptation in such climatic conditions. Medicinal plants found in high altitude are unique and useful in curing many diseases. Importance of medicinal plants of high altitude was also available in the Ramayana as Lord Hanuman Jee brought *Sanjivani Booti* (a powerful life restoring herb) form Himalayas to revive wounded Laxman Jee. High altitude regions are rich in medicinal plant diversity and can be considered as hotspot. Medicinal plants of this region are used in Ayurvedic and other alternate systems of medicine. The ethnic communities of the IHR rely, to a large extent, on native plant species for sustenance of their traditional health-care needs and livelihoods. These age-old practices are conservation-oriented and have tremendous potential to uplift the economy of the Himalayan states. Due to increasing market demand, medicinal plants of high altitude are under excessive extraction resulting in ruthless destruction of their natural populations.

One of the priority areas for National Medicinal Plants Board is augmenting the availability of high altitude medicinal plants, which is impacted by a number of factors like lack of domain knowledge about conservation strategies, cultivation practices and regulatory regimes etc. In order to chalk out a road map in the short, medium and long terms for dealing with all these issues, a workshop on High Altitude Medicinal Plants was organized at Dehradun.

The two days workshop was aimed at assessing the current status of knowledge of high altitude medicinal plant resources, documenting the conservation and cultivation initiatives across different states in the region, and highlighting the importance and need of conservation and sustainable utilization of medicinal plants. The workshop also aimed to provide a forum to Policy makers, foresters, scientists, researchers, industrialists, farmers, growers, traders and other stakeholders to interact among themselves as well as to understand the intricacies of this sector and further to improve the enormous potential that high altitude medicinal plants provide.

The workshop covered the following themes:

- Conservation status of high altitude medicinal plants.
- Research and development on high altitude medicinal plants in respect of their cultivation, conservation and sustainable use
- Policy advisories and institutional mechanism for developing high altitude medicinal plants.

This two days workshop on 'High Altitude Medicinal Plants' sponsored by National Medicinal Plants Board, Ministry of AYUSH, Government of India, and organised by Indian Council of Forestry Research and Education (ICFRE) at Dehradun on 21 & 22 March 2016. The

workshop was attended by about 50 delegates from different organizations working on high altitude medicinal plants in the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh. List of participants is placed at Appendix - A.

Schedule of the workshop is given below:

Workshop Schedule	
Day 1: 21 March 2016	
10.00-10.30 AM	• Introduction to workshop by Organising Secretary • Address by Workshop Convener • Address by Chief Guest • Vote of thanks
10.30- 11.00 AM	High Tea
11.00 AM- 01.00 PM	**Technical Session I: Diversity, utilization and conservation status of high altitude medicinal plants** • Diversity, utilization and availability of high altitude medicinal plants in HP by Dr. N.S. Chauhan, HOD (Retd.), UHF, Nauni, Solan • Conservation and cultivation of medicinal plants in Himalayas by Dr. M.R. Uniyal, Ex-Director, Ex-Advisor, Medicinal and Aromatic Plants, Uttarakhand Government • Conservation interventions in respect of red listed medicinal plants in HP. by Dr. Vaneet Jishtu, Scientist, HFRI, Shimla • Discussion
01.00 - 02.00 PM	Lunch
02.00 - 03.15 PM	**Technical Session II: Developing strategies for conservation and sustainable utilization of high altitude medicinal plants** • Status of diversity and population dynamics of key medicinal plant species of Uttarakhand by Dr. H.B. Naithani, Scientist (Retd.), FRI, Dehradun. • Conservation and sustainable utilization strategies for high altitude medicinal plants of Uttarakhand by Shri M.S. Gosain, Uttarakhand State Medicinal Plant Board. • Conservation and cultivation of high altitude medicinal plants in cold desert region of the western Himalayas by Dr. Rakesh Kumar, IHBT, Palampur
03.15 - 03.30 PM	Tea Break
03.30- 05.30 PM	**Technical Session II – continue--** • Rapid survey and assessment of high altitude medicinal plants by Dr. G. S. Rawat, Dean, Wildlife Institute of India, Dehradun • **Case Studies:** ▪ Conservation and cultivation status of medicinal and aromatic plants in Bharsar (Pauri Garhwal) by Dr. Rajendra Singh Chauhan, Officer-In-Charge, MAP, Uttarakhand University of Horticulture & Forestry ▪ High Altitude Medicinal Plants of Govind Pashu Vihar Wildlife Sanctuary, Western Himalayas by Dr. R. Manikandan, Scientist- C, BSI, Dehradun ▪ Micropropagation of threatened medicinal plants of North-West

	Himalaya viz. *Lilium polyphyllum*, *Pittosporum eriocarpum* and *Eremostachys superba* by Dr. Giriraj Singh Panwar, Scientist- C, BSI, Dehradun • Discussion
Day 2: 22 March 2016	
09.30-11.00 AM	**Technical Session III: Cultivation, value addition and marketing of high altitude medicinal plants** • Cultivation through cluster approach- a case study of *Swertia* and other species by Dr. Lal Singh, HRG, Shimla • Nursery techniques for mass production of important temperate medicinal plants by Dr. Sandeep Sharma, Scientist, HFRI, Shimla • Case study of successful cultivation of high altitude medicinal plants of Himachal Pradesh by Dr. Kulwant Rai Sharma, Professor, Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan • Cultivation of high altitude medicinal plants through cluster approach in Uttarakhand by Dr. V.P. Bhatt, Scientist, HRDI, Mandal (Gopeshwar)
11.00- 11.15 AM	Tea Break
11.15 AM- 01.00 PM	**Technical Session III – continue--** • Case study of successful cultivation of high altitude medicinal plants in Uttarakhand by Dr. M.C. Nautiyal, HAPPRC, Srinagar (Garhwal) • Conservation and cultivation of high altitude medicinal plants in Jammu & Kashmir by Shri S.K. Gupta, Director, SFRI, J&K • Cultivation and value addition of high altitude medicinal plants of Himachal Pradesh by Shri Nand Lal Sharma, Nanda Medicinal Plants Traders, H.P. • Dabur India Ltd. initiatives in cultivation of high altitude medicinal plants by Dr. Badri Narayan, Dabur India Ltd.
01.00 - 02.00 PM	Lunch
02.00 - 03.00 PM	• Cultivation potential and success of high altitude medicinal plants in Uttarakhand by Dr. A.K. Sharma, Scientist F, FRI, Dehradun • Conservation and Cultivation of Medicinal Plants in North – Eastern States of India by Shri S. Hussain, Vista Agritech , Guwahati • Discussion
03.00 - 03.30 PM	**Technical Session IV: Regulatory regimes of high altitude medicinal plants**
03.30 -03.45 PM	Tea Break
03.45 - 04.45 PM	**Plenary Session on High Altitude medicinal Plants** **Chair:** Shri D.K. Ved, Advisor, FRLHT, Bangalore **Panelists:** • Dr. S. Farooq, The Himalaya Drug Company, Dehradun • Dr. M. R. Uniyal Ex-Director,Ex-Advisor, MAP, Uttarakhand Govt. • Shri Arvind Alipuria, APCCF, HP Forest Department • Dr. Lalit Narayan, Dy. Director, NMPB, New Delhi • Dr. Lal Singh, Director, HRG, Shimla
04.45 - 05.30 PM	**Concluding Session and Finalisation of Recommendations**

2. INAUGURAL SESSION

Dr. Ashwani Kumar, Director General, Indian Council of Forestry Research and Education inaugurated the workshop and welcomed all the participants. He talked about the deep rooted importance of medicinal plants in Indian history and culture. He spoke about the ancient texts that highlighted use of medicinal plants, especially by *Charak, Sushruta* and *Dhanvantari*. He said that due to loss of interest in medicinal plants in treating patients through ayurvedic system, the allopathic system has seen a rise, which is reported to create problems for environment and human beings. The disappearance of birds, especially vultures due to painkillers such as diclofenac is a testimony to this fact. There is an urgent need of research in the field of medicinal plants as well as development of their databases especially on harvesting, storage, value addition and trade. Due to lack of knowledge of people involved in the collection of medicinal plants from wild leads to loss of their natural population. The new science of bio-prospecting has opened gateways to augment knowledge about the utilization of medicinal plants. In the end, he expressed his gratitude to National Medicinal Plants Board for funding the workshop and lauded the efforts of Biodiversity and Climate Change Division, Directorate of Research, ICFRE for organizing the workshop.

Dr. T. P. Singh, Assistant Director General (Biodiversity and Climate Change), Directorate of Research, ICFRE welcomed the participants and apprised the house about purpose of the workshop. He stressed on need to relook policy framework in medicinal plants sector in order to develop linkages and synergy among various stakeholders like farmers, growers, traders and industries, and also role of research organisations in this sector.

Dr. Vimal Kothiyal, Assistant Director General (Research Planning), Directorate of Research, ICFRE while addressing the gathering stressed on income generation of forest dependent communities through cultivation and sustainable collection of medicinal plants from the forests.

3. TECHNICAL SESSIONS

Session I. Diversity, Utilization and Conservation Status of High Altitude Medicinal Plants

Chairperson**:** Dr. G.S. Rawat, Wildlife Institute of India, Dehradun

Co-Chairperson**:** Dr. Lal Singh, Himalayan Research Group, Shimla

Rapporteurs**:** Shri Raman Nautiyal and Dr. Manish Kumar, Scientists, ICFRE

Presentations: Following three presentations were made in this session:

1. Diversity, utilization and availability of high altitude medicinal plants of Himachal Pradesh by Dr. N.S. Chauhan, Professor and Head (Retd.), Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni (Solan, H.P.) and Former Senior Consultant National Medicinal Plants Board, Government of India
2. Utilization of high altitude medicinal plants by pharmaceutical industries in India by Dr. M.R. Uniyal, Ex-Director, Ex-Advisor, Medicinal and Aromatic Plants, Uttarakhand Government, Dehradun
3. Conservation interventions in respect of red listed medicinal plants in Himachal Pradesh by Dr. Vaneet Jishtu, Scientist, Himalayan Forest Research Institute, Shimla

Dr. N. S. Chauhan gave an overview of the diversity, utilization and availability of high altitude medicinal plants in Himachal Pradesh. He gave zone-wise details of the medicinal plants available and the uses they were being put to. He said that non-timber forest products which were previously used for subsistence purposes and small scale trading by rural communities are now in large demand by various industries. These species are being over exploited and degraded due to lack of knowledge, poverty and increasing market demand etc. The increasing demand of these medicinal plants if not managed effectively may result in irreversible loss of their diversity. Though, a great diversity of medicinal and aromatic plants occurs in the state, yet the pressure is on the traditionally known drugs regularly consumed by pharmacies in the country. In lean season, in the absence of agricultural activities, farmers collect banfsha (*Viola odorata*) and guchhi (*Morchella esculenta)* during March and April; root drugs like atis (*Aconitum heterophyllum*), vatsnabh (*Aconitum ferox*) etc. during September-October and tejpatta (*Cinnamomum tamala*) during December-January, which leads to over exploitation and results in reduction of natural wealth in the state. Himachal Pradesh has taken a lead in producing Kuth (*Saussurea costus*), Kala jeera (*Bunium persicum*), Chicory (*Cichorium intybus*) and Hops (*Humulus lupulus)* in the county through cultivation. Himachal Pradesh is also the largest supplier of Kutki (*Picrorhiza kurroa*), Singli-Mingli (*Dioscorea deltoidea*), Dhoop (*Jurinea dolomiaea*), Tagar (*Tabernaemontana divaricata*), Somlata (*Ephedra* spp.), Atees (*Aconitum heterophyllum*),

Ratanjot (*Arnebia benthamii*) etc. Roughly, 80-85 herbs are collected and marketed annually from the Himachal Pradesh to Khari Baoli (Delhi) and Majith Mandi (Amritsar) to the tune of approximately 10 crore rupees.

Dr. M. R. Uniyal, invoked the ancient chants based on biodiversity and explained the role of Himalayan medicinal plants. He opined that there was a serious problem of conservation of medicinal plants in the high altitude region, which can be solved by establishing nurseries. Development of ayurvedic nomenclature is also essential towards their conservation and utilization, for which, botanists and ayurvedic practitioners should come together. Tackling theft of medicinal plants should be looked into aggressively to prevent their destruction. Unscientific exploitation like uprooting the entire medicinal plant (even if few parts like leaves are of medicinal value) has led to their extinction. Many a times, the plants are uprooted before the seed is set, which is also responsible for their destruction. The collectors and forest personnel should be trained to collect medicinal plants scientifically to ensure their conservation. He also said that the recommendations of workshops need to be implemented rigorously. In case of species that are on the verge of extinction, a complete ban on their harvest for a certain period of time (say 5 years) can help in their conservation.

Replying to a query that the industry does not buy directly from the collectors or farmers but rely on markets (like Khari Baoli, Majith Mandi, etc.), he said this is mainly due to availability of the products in illegal ways. Also, in the mandis, a wide variety of products are available while with the collectors only, one or two species are available. This prompts the industry to buy from the markets. A check on theft and appropriate policy decisions can plug this gap.

Dr. Vaneet Jishtu in his presentation highlighted the efforts of Himachal Pradesh State Forest Department, in conservation of medicinal plants. He presented details of Medicinal Plants Conservation Areas (MPCAs) in the state of Himachal Pradesh, and also highlighted various schemes being implemented by State Government for conservation of high altitude medicinal plants. Replying to queries on the number of MPCAs and criteria adopted for selection of the areas, he informed that there are five MPCAs (1 in alpine zone, and 1 in cold desert and 3 others) with the criterion to incorporate maximum number of species and only in case of two MPCAs the species were site specific.

Shri Arvind Alipuria, Additional Principal Chief Conservator of Forests, Himachal Pradesh State Forest Department said that National Medicinal Plants Board should fund projects for longer duration as in case of high altitude medicinal plants the gestation period is long. Duration of 10 to 15 years is ideal for reaping the benefits of a project. Involvement of communities and dedicated extension workers is also essential and a separate programme for this needs to be developed.

Dr. G.S. Rawat, Chairperson of the session was of the opinion that standardizing the nursery practices of medicinal plant species, and community involvement is necessary to conserve and utilize medicinal plants on a sustainable basis.

The session ended with thanks to the Chair.

Session II. Developing Strategies for Conservation and Sustainable Utilization of High Altitude Medicinal Plants

Chairperson: Dr. N.S. Chauhan, Professor and Head (Retd.) Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni (Solan, H.P.)

Co-Chairperson: Dr. Kulwant Rai Sharma, Professor & Head, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni (Solan, H.P.)

Rapporteurs: Dr. A. N. Singh and Dr. Vishavjit Kumar, Scientists, ICFRE

Presentations: Following seven presentations were made in this session:

1. Status of diversity and population dynamics of key medicinal plant species of Uttarakhand by Dr. H.B. Naithani, Scientist (Retd.), Forest Research Institute, Dehradun
2. Conservation and sustainable utilization strategies for high altitude medicinal plants of Uttarakhand by Shri M.S. Gosain, Uttarakhand State Medicinal Plant Board, Dehradun.
3. Conservation and cultivation of high altitude medicinal plants in cold desert region of the western Himalayas by Dr. Rakesh Kumar, Institute of Himalayan Bioresource Technology, Palampur
4. Rapid mapping of the medicinal plant resources of high altitude by Dr. G. S. Rawat, Dean, Wildlife Institute of India, Dehradun
5. Conservation and cultivation status of medicinal and aromatic plants in Bharsar, Pauri Garhwal by Dr. Rajendra Singh Chauhan, Officer-In-Charge, MAP, Uttarakhand University of Horticulture & Forestry, Bharsar (Pauri Garhwal)
6. High altitude threatened medicinal plants of Govind Pashu Vihar by Dr. R. Manikandan, Scientist- C, Botanical Survey of India, Dehradun
7. Micro propagation of threatened medicinal plants of North-West Himalaya viz. *Lilium polyphyllum*, *Pittosporum eriocarpum* and *Eremostachys superba* by Dr. Giriraj Singh Panwar, Scientist- C, Botanical Survey of India, Dehradun

Dr. H. B. Nathaini spoke on diversity of medicinal plants and other associated vegetation in various Medicinal Plant Conservation Areas (MPCAs) of Uttarakahnd at Mandal (Kedarnath Forest Division), Jhuni (Bageshwar Forest Division), Mohan (Almora Forest Division), Bastia (Champawat Forest Division), Kandara (Uttarkashi Forest Division), Khuliya (Pithoragarh Forest Division).

Dr. G. S. Rawat asked the speaker about locational variation in morphology of the *Nardostachys grandiflora* and status of its availability in different MPCAs. The speaker informed that the species is rare in occurrence. The house raised concern for conservation of *Nardostachys grandiflora, Fritillaria roylei* and *Trillidium govanianum*, which are of rare occurrence.

Shri M. S. Gosain gave the background information on efforts being made by the State of Uttarakhand on the medicinal plant sector. This included organizational structure to deal

with herbal sector, medicinal plants conservation areas, collection of medicinal plants in the state, demand and supply status of medicinal plants and various provisions of the state government in the herbal sector. Dr. N. S. Chauhan, Chairman of the session enquired about the status of cultivation, production and marketing of Kuth (*Saussurea costus*) in the state. It was also asked that cultivation of this species is remunerative and helpful in enhancing the livelihood of the cultivators. Shri Gosian replied that there is no specific market for this species in Uttarakhand and no minimum support price has been declared by State Government till date.

Dr. Rakesh Kumar spoke about the nursery and agro-techniques for cultivation of various medicinal plant species like *Picrorhiza kurrooa, Aconitum heterophyllum, Podophyllum hexandrum, Panax ginseng, Inula reacemosa, Hippophae* spp*., Rosa webbiana, Fagopyrum* spp. in Lahual valley of Himachal Pradesh. He informed the house that active ingredient (picrosides) which is found in the roots (traditionally used plant part) of *Picrorhiza kurrooa* is also present in its leaves. Field intercropping trial of medicinal plants in apple orchards was discussed, where the Chairman of the session and other participants raised concern of use of pesticides in apple orchards and their residual effect on medicinal plants as pesticides are frequently sprayed.

Dr. G. S. Rawat highlighted various approaches of survey and resource assessment of high altitude medicinal plants, *i.e*., social science techniques, economic methods and ecological methods. He also presented case studies on i) Rapid mapping of high value medicinal plants in Forest Divisions of Garhwal, ii) Population surveys of medicinal and aromatic plants in Western Ladakh and iii) Survey of Chinese caterpillar mushroom in Askot Wildlife Sanctuary. His suggestion as way forward on the issue of managing and monitoring high altitude medicinal plants resources included repeat observations and in-depth studies on populations of high value/ globally significant medicinal plants, basic population assessments coupled with yield studies would be must for commercially important medicinal and aromatic plants and use MPCAs for further monitoring and experimental trials on growth and yield.

Dr. Rajendra Singh Chauhan highlighted germplasm bank of medicinal and aromatic plants established at Bharsar (Pauri Garhwal) and agro techniques of some high altitude medicinal plants like *Swertia chirayita, S. ciliiliata, S. cordata, Podophyllum hexandrum*, *Picrorhiza kurroa* and *Valeriana wallichii* etc. developed by Uttarakhand University of Forestry and Horticulture.

Dr. R. Manikandan spoke about the risks associated with threatened and endemic medicinal plant species. He presented the enlisted species of endemic and threatened medicinal plants occurring in different vegetation types within Govind Pashu Vihar Wildlife Sanctuary.

Dr. Giriraj Singh Panwar highlighted the tissue culture protocol developed for the species (*Lilium ploryphyllum, Pittosporum eriocarpum* and *Eremostachys superba*) and response of various media on callus and shoot formation.

The session ended with thanks to the Chair.

Session III: Cultivation, Value Addition and Marketing of High Altitude Medicinal Plants

Part 1

Chairperson: Dr. M.C. Nautiyal, Professor, HAPPRC, Srinagar (G)

Co-Chairperson: Dr. Vaneet Jishtu, Scientist, HFRI, Shimla

Rapporteurs: Dr. Shamila Kalia and Dr. S. S. Jain, ICFRE, Dehradun

Presentations: Following four presentations were made in this session:

1. Cultivation through cluster approach- a case study of *Swertia* and other species by Dr. Lal Singh, Himalayan Research Group, Shimla
2. Nursery techniques for mass production of important temperate medicinal plants by Dr. Sandeep Sharma, Scientist-F, Himalayan Forest Research Institute, Shimla
3. Case study of successful cultivation of high altitude medicinal plants of Himachal Pradesh by Dr. Kulwant Rai Sharma, Professor, Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan
4. Cultivation of high altitude medicinal plants through cluster approach in Uttarakhand by Dr. V.P. Bhatt, Scientist, Herbal Research and Development Institute, Mandal (Gopeshwar, District Chamoli)

Dr. Lal Singh in his presentation discussed in detail about *Swertia cordata* (Wallich ex G. Don) and its health benefits. He talked about agrotechnology and quality of chirayita crop, quality testing and marketing of cultivated chirayita, orientation and seed distribution, seed sowing of chirayita being carried out by his organization. He also informed the house that they have involved more than 1000 women farmers in chirayita cultivation. Comparative quality testing of chirayita species [*Swertia paniculata* (wild), *S. ciliata* (wild), *S. cordata* (cultivated) and *S. chirayita* (Ref. NBRI)] was also presented. He also shared the quality assurance & post harvest management and marketing of chirayita. He also discussed the other (*Picrorrhiza kurrooa*, *Taxus wallichiana*, *Aconitum heterophyllum* and *Lilium polyphyllum, Polygonatum verticillatum, Polygonatum cirrhifolium*) in brief. Further, he highlighted the risks involved in the cultivation of medicinal plants such as long gestation period; volatile herbal market in terms of prices, wild produce is cheap and is preferred over cultivated produce and cultivated produce also covered under Transit Rules of State Forest Department for transport permission and fees.

Dr. Sandeep Sharma spoke about Atish (*Aconitum heterophyllum* Wall ex Royle), Kutki (*Picrorhiza kurooa* Royle ex Benth.) and Chora (*Angelica glauca* Edgew.), the important medicinal plants found in higher altitudes. He said that the underground parts (roots/rhizomes/tubers) of these species have medicinal values and due to overexploitation and unscientific extraction from the natural habitat, the population of these medicinal plants has come down drastically in last three decades. He also informed that the threat status of *Aconitum heterophyllum* and *Picrorhiza kurooa* has been assessed as critically endangered and of *Angelica glauca* as endangered in CAMP workshop, 2010 based on IUCN guidelines. He appraised the house about nursery techniques developed by HFRI for large

scale production of quality planting material for these species and around 7 lakhs nursery stock were produced. He said that *Aconitum heterophyllum* and *Angelica glauca* can be propagated through seeds as well as through root-shoot cuttings. Use of seed for multiplication of these species is more eco-friendly due to non-destructive harvesting of the plants. For mass production of *Aconitum heterophyllum* from seeds in the nursery, temperature and moisture were identified as critical factors influencing the establishment of nursery stock of this species. For *Picrorhiza kurooa*, a simple low cost technique has been developed for vegetative production of nursery stock through macro-proliferation technique. The critical factors identified for the success of this technique were time of separation, portion of shoot/root/rhizome to be retained in each propagule and providing appropriate growing conditions for planting of separated propagules.

Dr. Kulwant Rai Sharma in his presentation discussed the importance of hebal drugs in comarision to modern drugs. He discussed the floral biodiversity of Himachal Pradesh and said that about 900 medicinal plant species are found in the state. He also spoke that the standardization of herbal drugs (herbal formulations and raw drugs) is an important step to ensure the authenticity of these drugs. He discussed in detail the cultivation of *Swertia chirayita*, its importance as well as the adulterants and substitutes. He also informed that a study conducted by Dr. Y.S. Parmar University of Horticulture and Forestry on market samples of drug "Chirayita" procured from markets throughout India revealed that only 40.45 % market samples of drug Chirayita were genuine. He said that unavailability of planting material, long gestation period, delicate field handling and lack of standardized nursery practices are some of the constraints in cultivation of the species. While discussing the cultivation of *Aconitum heterophyllum,* he mentioned that the species is amenable for domestication/cultivation which gives higher tuber yield as compared to wild conditions.

Dr. V. P. Bhatt said that *Aconitum heterophyllum* (Atis), *Angelica glauca* (Choru), *Arnebia benthamii* (Lal Jadi), *Cordyceps sinensis* (Keda Jadi), *Picrorhiza kurrooa* (Kutki), *Saussurea costus* (Kuth), *Nardostachys grandiflora* (Jatamansi), *Paris polyphylla* and *Trillidium govanianum* (Satuwa), *Paeonia emodi* (Chandrayan), *Swertia chirata* (Chirayita), *Podophyllum hexandrum* (Van-Kakdi), *Allium* spp. (Jamboo/Faran), *Carum carvi* (Kala Jeera), *Dactylorhiza hatagirea* (Hattajadi), *Pleurospermum angelicoides* (Gandrayan/Cheepi), *Rheum emodi* (Dolu), *Valeriana jatamansi* (Tagar), *Hippophae* spp. (Amesh) etc. are some important species which have become rare and endangered in natural habitat owing to some natural and many anthropogenic factors like habitat destruction, unscientific and illegal collection and local, national and international trade, which ultimately affected their normal survival, ecological niche and finally their natural regeneration. He informed the house that Herbal Research & Development Institute (HRDI) has developed a cluster based model for promoting cultivation of some important medicinal plant species in high altitude Districts of Uttarakhand, *i.e*., Chamoli, Rudraprayag, Uttarakashi, Tehri, Bageshwar, Pithoragarh and Almora on commercial scale. More than 50 clusters have been developed covering an estimated area of 2000 hectare and benefiting more than 4000 farmers in high altitude areas of Uttarakhand. He said that some incentives to promote cluster based

cultivation are also being given to farmers such as, distribution of free planting material up to 5 *naali* (0.01ha.), free registration and providing exit permit through HRDI on cluster basis, providing 50% subsidy on processing unit, cultivation, nursery establishment and post harvest management and providing training on different subjects related to medicinal plants. Three herbal *Mandis* (Ramnagar, Tanakpur and Rishikesh) have been established by State Forest Development Corporation to ensure marketing of medicinal plants. He concluded that cultivation is one of the easiest alternatives to conserve medicinal plant species *in situ.* Cultivation has an edge over wild collection as cultivation ensures proper botanical identification and the produce is always high in organoleptic properties.

Part 2

Chairperson: Shri Arvind Kumar Alipuria, APCCF, HP Forest Department

Co-Chairperson: Dr. Rakesh Kumar, Scientist, IHBT, Palampur

Presentations: Following four presentations were made in this session:

1. Case study of successful cultivation of high altitude medicinal plants in Uttarakhand by Dr. M.C. Nautiyal, HAPPRC, Srinagar (Garhwal)
2. Case study of successful cultivation of high altitude medicinal plants in J&K by Shri S.K. Gupta, Director, SFRI, J&K
3. Cultivation and value addition of high altitude medicinal plants of Himachal Pradesh by Shri Nand Lal Sharma, Nanda Medicinal Plants Exports, Manali (H.P.)
4. Dabur India Ltd. initiatives in cultivation of high altitude medicinal plants by Dr. Badri Narayan, Dabur India Ltd.

Dr. M. C. Nautiyal presented a case study of successful cultivation of high altitude medicinal plants in Uttarakhand. He stated that in the world, demand for medicinal and aromatic plant products is increasing at the rate of 7% per annum. He said that India has become a centre of attention because of its health care traditions and supply of raw plant meterial and if this trend continues it is expected that by 2020 India's export could reach up to Rs. 20000 crore. He further reported that about 500 medicinal plant species are being traded in the state of Uttarakhand, out of which nearly 160 species have been identified as threatened, and if these are not saved in next five years, nearly 10% reduction in the present turnover can be expected. He stressed that in term of cumulative estimate, Uttarakhand has nearly Rs. 1.5 billion (about US$ 30 million) per annum trade through the hidden market, as most species collected from the wild are protected, and there is no proper trade controlling authority. He stressed on conserving these plants in the wild and to identify means for their sustainable utilisation.

He briefly explained cultivation technologies of medicinal plant species developed for the farmers by HAPPRC. He highlighted that HAPPRC initiated a scheme to promote commercial cultivation of *Picrorhiza kurrooa* (Kutki) in the remote village of Ghese (2500 m) in Chamoli district of Garhwal Himalaya in 2002. He said that tangible impact of Kutki cultivation has

been recorded in comparison to other traditionally growing crops, *i.e*., Potato (*Solanum tuberosum* L.), Chaulaii (Amaranthus spinosus L.), Rajma (*Phaseolus vulgaris* L), Ougal (*Fagopyrum esculentum* L.), Manduwa (*Eleusine coracana* L.), Wheat (*Triticum aestivum* L.) in Gheshe village. He emphasized that the commercial cultivation of *Picrorhiza kurrooa* (Kutki) can create additional source of income for villagers and also helps in the conservation of wild population.

Shri S. K. Gupta delivered a presentation on successful cultivation of high altitude medicinal plants in J&K. He highlighted the medicinal plant species of Lolab Valley, Karnah Valley, Gulmarg, Khilenmarg, Pir Panjal range, Kolhai Mountains and Ladakh Region. He explained the different institutional setups in the state of Jammu and Kashmir in context of conservation of medicinal plants. He further explained the organizational setup and State Forest Research Institute (SFRI) and work done by SFRI in the conservation of medicinal plants. He concluded his presentation by emphasizing that there are certain factors like legal issue, lack of linkage between markets and cultivators and lack of industries utilizing medicinal plants which are playing negative role in the cultivation of medicinal plant species in J&K state.

Shri Nand Lal Sharma delivered a talk on cultivation and value addition of high altitude medicinal plants of Himachal Pradesh. He described the techniques for the cultivation of *Aconitum heterophyllum* in Miyad Valley located in Lahaul Spiti (H.P.). He also shared his experience related to cultivation and harvesting of Kuth, Pushkarmool, Kutki, and Jatamansi. He stressed that the fluctuation in market value of medicinal plants plays positive as well as negative role in cultivation. He further said that farmers motivated if they earns good amount by selling their crops, on the other hand low market value discourages the farmer for cultivation. He also elaborated the uncertainties in the market and the problems faced by the farmers. He concluded his talk by emphasizing that there is lack of technology and hands on training programs for the farmers by which farmers can be motivated towards the cultivation of medicinal plants.

Dr. Badri Narayan delivered his presentation on initiatives of Dabur India Ltd. in cultivation of high altitude medicinal plants. He elaborated the step wise approach followed by Dabur industry in cultivation and harvesting of various medicinal plants at various cultivation centers developed throughout the country as well as in Nepal.

Part 3

Chairperson : Dr. V.P. Bhatt, Scientist, HRDI, Mandal, Gopeshwar (UK)

Co-Chairperson : Dr. I. D. Bhatt, Scientist, GBPHIED, Almora

Presentations: Following two presentations were made in this session:

1. Cultivation potential and success of high altitude medicinal plants in Uttarakhand by Dr. A.K. Sharma, Scientist F, FRI, Dehradun
2. Conservation and Cultivation of Medicinal Plants in North – Eastern States of India by Shri S. Hussain, Vista Agritech , Guwahati (Assam)

Dr. A.K. Sharma delivered his presentation on cultivation potential and success of high altitude medicinal plants in Uttarakhand. He gave a brief introduction about cultivation efforts made by FRI for various temperate medicinal plants at an experimental scale. He shared his experience regarding cultivation of *Rheum australe* from nursery stage to transplantation in the field at Chakrata. He highlighted the list of successful commercial cultivation of medicinal plant species in Uttarakhand state and medicinal plants species in high trade. He described the species wise achievements in cultivation area for the year 2008-09 to 2012-13 under centrally sponsored scheme of "National Mission on medicinal plant" for the states of J&K, Himachal Pradesh and Uttarakhand. He further concluded his presentation by giving the name of some species which have high scope for promoting cultivation and potential medicinal plants for promoting cultivation in Uttarakhand.

Shri S. Hussain delivered the presentation on conservation and cultivation of medicinal plants in north-eastern states of India. He gave a brief introduction of the area of focus and priority area of Vista Agritech based in Guwahati. While describing the common high altitudinal medicinal plants of north – eastern states of India, he emphasized the need to identify the protected area and to restrict excessive extraction of medicinal plants in North-eastern states. He further elaborated that adjoining forest area outside conservation area should be managed by Joint Forest Management Committees or village communities. He further discussed various approaches for conservation of high altitude medicinal plants in context of harvesting, post harvesting and value addition.

During the discussion various points and concerns were raised and it was concluded that there is a need to focus on regular and hassle free availability of authentic and certified quality planting material and development of standard nursery techniques; since the gestation period of high altitude medicinal plants is 3 to 4 years or more, therefore, there should be proper mechanism for marketing of raw material; farmers' interests should be protected in cultivating high altitude medicinal plants and they should get remunerative price for their produce; Standard agro technological guidelines/protocols should be formulated, and cultivators should have access to such package and practices manuals, booklets, brochures, etc.; post harvest technologies should be developed so as to check unnecessary loss of harvested crop. It was also discussed that there should be lab to land approach and farmers and industry should work in unison and there should be buy back assurance from the industry. There has to be a provision of insurance of crop in case it is damaged or destroyed as a result of natural calamities. Certification of the quality standard of raw material was also emphasized during the discussion. Proper legal framework for cultivation and marketing of medicinal plants should be enacted as there is an urgent need to curb illegal trade in the high altitude medicinal plants.

The session ended with thanks to the Chair.

Session IV: Regulatory Regimes of High Altitude Medicinal Plants and Plenary Session

Chairperson:	Shri D.K. Ved, Advisor, FRLHT, Bangalore
Panelists:	Dr. S. Farooq, The Himalaya Drug Company, Dehradun,
	Dr. M. R. Uniyal Ex-Director, Ex-Advisor, MAP, Uttarakhand Government
	Shri Arvind Alipuria, APCCF, Himachal State Forest Department
	Dr. Lalit Narayan, Dy. Director, NMPB, New Delhi
	Dr. Lal Singh, Director, HRG, Shimla
Rapporteurs:	Dr. Anil Negi and Dr. M. K. Singh**,** Scientists, ICFRE

Shri D.K. Ved initiated the discussion on regulatory regimes of high altitude medicinal plants and plenary session. Shri Arvind Alipuria spoke on market crisis and stressed on need for a regulatory regime. Dr I. D. Bhatt, Scientist, GB Pant Institute of Himalayan Environment and Development, Almora was of the view that there is long gestation period for medicinal plants and markets are not organized. Shri M.S. Gusain, State Medicinal Plants Board Uttarakhand was of the opinion sensitization of the personnel of state forest department are required for conservation of medicinal plants as they are the custodians of the forests. Dr. Vaneet Jishtu, Scientist, Himalayan Forest Research Institute, Shimla said that there is a need to establish medicinal plants nurseries to provide quality planting material. He also stressed that community participation should be encouraged in conservation of medicinal plants. Shri S. Husain, Vista Agritech, Guwahati (Assam) said that major problem faced by medicinal plant growers is how to sell their product. Dr. N.S. Chauhan, Head of Department (Retd.), Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan was skeptical on easy transit of medicinal plants in Himachal Pradesh. Dr. V.P. Bhatt, Scientist, Herbal Research and Development Institute, Mandal (Gopeshwar) explained the simplified model for transit of medicinal plants adopted in Uttarakhand which is completely regulated by HRDI. Dr. M.R Uniyal emphasized that medicinal plants should not be considered as minor forest produce.

It was also proposed that each state may develop complete technology package for 2-3 important medicinal plants. Dr. S. Farooq of Himalayan Drugs Company, Dehradun informed that his company is ready for a buyback kind of programme. He also said that only about 1-2 per cent of the requirement of his company is being met from Uttarakhand. Dr. Badri Narayan, Dabur India Ltd. underscored the issue of section 38 of Biodiversity Act for *Aconitum* spp. even if it is coming from cultivated sources.

The session ended with vote of thanks to the Chair, other panelist and all the delegates of two days workshop.

Articles/ Presentations provided by the resource persons during the workshop are given under Section 5 of the proceedings.

4. RECOMMENDATIONS

Following recommendations were made during the workshop as a road map for conservation, cultivation and sustainable utilisation of high altitude medicinal plants:

S. No.	Recommendation	Suggested Time Frame
Diversity, conservation and sustainable utilization of high altitude medicinal plants		
1	To document high altitude medicinal plants from the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh with special emphasis on their distribution, conservation status, availability in the wild and traditional health care knowledge	2017-2022 (5 years)
2	To assess threat status of high altitude medicinal plants of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh through Conservation Assessment and Management Prioritisation (CAMP) workshops using latest IUCN threat assessment criteria	2017-2018 (2 years)
3	To prioritise high altitude medicinal plants species assessed as Red-Listed in the CAMP Workshops for focused conservation action, including short-listing of species for cultivation	2019-2020 (2 years)
4	To locate viable wild populations of priority Red-Listed medicinal plant species through conducting surveys in high altitudes of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh and to establish Medicinal Plants Conservation Areas for their long-term *in situ* conservation	2017-2022 (5 years)
5	To establish Germplasm Banks of Red-Listed medicinal plants of high altitude in the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh	2017-2022 (5 years)
6	To develop sustainable harvest regimes for high altitude medicinal plants and train wild gatherers in sustainable harvest practices through hands-on training programs	2017-2022 (5 years)
Cultivation, value addition and marketing of high altitude medicinal plants		
7	To promote large scale cultivation of high altitude medicinal plants in the states of Jammu & Kashmir, Himachal Pradesh Sikkim and Arunachal Pradesh as cultivation of medicinal plants are being done in Uttarakhand.	2017-2022 (5 years)
8	To provide quality planting material at reasonable price to the farmers through establishment of nurseries for high altitude medicinal plants	2017-2022 (5 years)
9	To compile and provide technical knowhow on cultivation techniques of high altitude medicinal plants to the farmers/ growers of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh	2017-2019 (2 years)

10	To develop protocols for value addition of medicinal plants	2017-2019 (2 years)
11	To develop a market mechanism (including marketing facilities and buy back agreement with the farmers) for high altitude medicinal plants	2017-2022 (5 years)
12	To develop a certification mechanism for high altitude medicinal plants	2017-2022 (5 years)
13	To establish local herbal mandies in the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh	2017-2022 (5 years)
Institutional and capacity building		
14	To establish raw drug repository of high altitude medicinal plants in the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh	2017-2020 (3 years)
15	To support educational-cum-awareness programs in importance, conservation and strengthening of high altitude medicinal plants for local communities	2017-2022 (5 years)
16	To develop and publish an illustrated compendium of high altitude medicinal plants used by local communities and folk practitioners	2017-2020 (3 years)
17	To provide training to the farmers/ growers on cultivation and post harvest techniques of medicinal plants	2017-2022 (5 years)
18	To initiate collaborative research, development and extension programs/ projects in respect of medicinal plants of high altitude	2017-2027 (10 years)
19	To strengthen the existing institutions working on high altitude medicinal plants in the states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh	2017-2027 (10 years)
Regulatory regimes of high altitude medicinal plants		
20	To revisit Transit Rules of the States of Indian Himalayan Region and build in provisions for checking illegal extraction and illicit trading of medicinal plants	2017-2018 (1 year)
21	To frame a specific policy for dealing in cultivation, conservation and sustainable utilization of high altitude medicinal plants	2017-2020 (3 years)

5. ARTICLES/ PRESENTATIONS OF THE RESOURCE PERSONS

Diversity, utilization and availability of high altitude medicinal plants in Himachal Pradesh

Dr. N.S. Chauhan
Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.)

DIVERSITY, UTILIZATION AND AVAILABILITY OF HIGH ALTITUDE MEDICINAL PLANTS IN HIMACHAL PRADESH

BY

Dr. Narain Singh Chauhan
Professor and Head (Retd.)
Department of Forest Products
Dr. YS Parmar Univercity of Horticulture &Forestry
Nauni, Solan (H.P.)

INTRODUCTION

We live in a world that has been built by our ancestors-ancient and modern and which is continuously maintained by all the things alive today.

Organisms are adapting in a world, whose material state is determined by the activities of their neighbours.

Diversity simply means to be different or unlike. According to UNEP (Anon., 1992) biodiversity is the totality of genes, species and ecosystems.

In simple words, "It is the great variety that exists in living organisms-plants, animals and microbes on this mother earth".

According to US Congress, "Biodiversity is the variety of life and its process in an area, the ecological roles they perform and the genetic diversity they contain". Biological diversity embraces the variability within and between all micro-organisms, plants, animals and the ecological systems, which they inhabit.

- Biodiversity is often used as a measure of the health of biological systems and today consists of many millions of distinct biological species found on earth.
- The year 2010 had been declared as the International Year of Biodiversity. Biodiversity is not distributed evenly on Earth, but is consistently rich in the tropics and in specific localized regions, while it is less rich in polar regions, where fewer species are found.
- Forests constitute some of the richest natural resources of the world.
- 400 million people living in and around forests in India depend on NTFP's for their sustenance or livelihood and often use forest products extensively, both for their own consumption and for income generation.

- Of the 6.2 billion people on the planet, 25 per cent depend to varying degrees on the forest resources for their sustenance and livelihood security.
- Forest helps humanity by different ways, both economically as well as ecologically.
- These contribute to the environment in the moderation of climate, conservation of soil, regulation of water supplies, control of droughts and floods, improvement of landscapes, recreation etc.
- Forests, throughout the world have a tremendous value both in terms of timber and non-timber forest products.
- NTFP's other than "Major Forest Products" (timber, small wood and fuel wood) cover grasses, fruits, leaves, barks, exudates, animal products, medicinal and aromatic plants, soil, minerals, etc.
- The World Health Organization (WHO) estimates that some 80 per cent of the population of the developing world use NTFP's for health and nutritional needs. Globally the forests now cover 3,625 m ha or 22.7 per cent of the total land surface (uncovered with ice) of the world.

It is, thus, rightly said that plants can live without man, but all living beings including man cannot survive without plants.

Medicinal and Aromatic Plants

- **Medicinal and Aromatic plants have recently aroused a phenomenal interest all over the world which is unprecedented in the history of medicines**
- **These not only provide starting material to the traditional systems of medicines, but also to the modern medicines.**
- **In spite of emergence of many wonder drugs from the synthetic field, the problem of senescence and so called civilization diseases like immune deficiency syndromes, arthritic and mental disorders; cancer, AIDs, SARs etc. cannot be tackled**
- **There is a greater demand for natural medicines and "health foods" today than ever before in the world.**
- **Demand for nutraceuticals and cosmeceutical is increasing day by day.**

Comparison Between the Number of Species in India and the World.

Group SI/SW	Number of species in India (SI)	Number of species in the world (SW)	(%)
Mammals	350(1)	4,629(7)	7.6
Birds	1224(2)	9,702(8)	12.6
Reptiles	408(3)	6,550(9)	6.2
Amphibians	197(4)	4,522(10)	4.4
Fishes	2546(5)	21,730(11)	11.7
Flowering Plants	17,000(6)	250,000(12)	6.0

Biodiversity in India

Plants (48,620 spp.)	No. of spp.	Animal (75,000 spp.)/81000	No. of species
Flowering plants	17,000	Insects	50,000
Algae	2,500	Molluscs	4,000
Lichens	1,600	Fish	2,000
Fungi	23,000	Amphibians	140
Bryophytes	2,584	Reptiles	420
Pteridophytes	1,022	Birds	1,200
Gymnosperm	64	Mammals & other vertebrates	340
Bacteria	850		

• It is estimated that 79 species of mammals, 44 of birds, 15 of reptiles, 3 of amphibians and about 3,000 plant species are going to be extinct in the near future .

- India is one of the twelve mega-biodiversity areas of the world
- Having 46,620 species of plants (Flora) and 75,000 species of animal life (Fauna)
- Bestowed with varied climatic conditions and rich biodiversity.
- Indian people have been utilizing plant resources from time immemorial as the main source of food, fodder, fibre, medicine, cosmetics and local crafts etc.
- In India, out of approx. 17,000 species of flowering plants, and around 30,000 non-flowering species, 10,000 species are used by the people in one form or the other:

Plant Diversity of Himachal Pradesh

- Number of flowering plants in HP = ± 3,500
- Angiosperms = 3,120
- Gymnosperms = 23
- Pteridophytes = 124
- Orchids = 64
- Timber yielding species = 87
- Fuel Wood species = 172
- Fodder (Leaf fodder only) = 125
- Fibres and Flosses = 36

Cont...

- Wild fruits = 98
- Bee Flora = 63
- Oil seeds = 35
- Tans and Dyes = 59
- Gums and Oleo-resins = 18
- Soil Conservation species = 35
- Medicinal plants = >500
- Aromatic plants = >150
- Plants of Ethnobotanical Importance = > 250

Cont...

- Medicinal and Aromatic Plants which Can be cultivated in different agro-climatic zones in Himachal Pradesh = 375
- Plant species harnessed for trade and industry = 85-100
- Commercial Medicinal and Aromatic Plants available for trade and industry = 150-200
- Threatened/endangered species of plants in Himachal Pradesh = >100

Diversity of medicinal and aromatic plants in H.P (some case studies)

Area	Medicinal and Aromatic Plants	Ethno-botanical Plants
Nauni (Solan)	260	85
Shilly Willife Sanctuary (Solan)	121	41
Pabbar Valley (Shimla)	392	85
Sangla Valley (Kinnaur)	193	45
Spiti (Lahaul & Spiti)	74	104
Nahan (Sirmour)	95	119
Kangra Valley	81	67
Parvati Valley (Kullu)	157	100
Kunihar (Solan)	121	197

Area	Medicinal and Aromatic Plants	Ethno-botanical Plants
Shikari Devi (Mandi)	33	49
Rohtang area (Kullu)	93	46
Churdhar area (Sirmour)	108	39
Kullu Valley Kullu	55	261
Chopal Forest Division (Shimla)	223	24
Pangi area of Chamba	193	45
Kamlah Range (Jogindernagar F.D., Mandi)	155	89
Dodra Kawar Range (Shimla)	186	55
Daranghati Wild life Sanctuary (Distt. Shimla)	89	46
Lippa Asrang Wild Life Sanctuary 247spp.	94	74

MEDICINAL PLANTS DIVERSITY IN HIMACHAL PRADESH

1. SHIWALIK HILLS
(Below 1500 m)

Habitat for:

- Drugs of Dashmool- Shalparni, Prishniparni, Gokhru, Chhoti Kantkari, Badi Kantkari, Bilve, Shiyonak, Agnimanth, Gambhari and Padhal etc.
- 3 Myrobalans, Brahmi, Ashwagandha, Shatavari, Shivlingi, Kutaj, Safed Musli etc.

2. MID HILLS
(1500-2500 m)

Habitat for:

- Drugs of Ashtavarga group: Meda, Mahameda, Ridhi, Vridhi, Jeevak, Rishbhak, Kakoli, Kshir-Kakoli etc.
- Chora, Talispatra, Kastoori patra, Biranjsif, Lodhra, Singli-Mingli, Tagar, Banajwain, Sugandhbala, Vanaksha, Daru Haldi, Pashanbhed, Kapurkachri, Guchhi, Chirayata etc.

3. TEMPERATE & ALPINE

Habitat for:

- Ateesh, Vatsnabh, Vankakri, Jatamasi, Kutki, Dhoop, Revandchini, Ratanjot, Salampanja, Chora, Bhutkesi Nagchhatri, Satua etc.

Atropa acuminata (Indian Belladona)

PONKAR

Aconitum heterophyllum (Atish, Patish))

Gentiana kurroo

Podophyllums hexandrum (Bankakri)

Pyracantha crenulata

Rheum australe (Revandchini)

Rhododendron campanulatum

Saussurea costus (Kuth)

Saussurea obovallata (Brahmakamal)


Saussurea gossypiphora
(Ghugi Badshah)
Pleurospermum candollii
(Baan)


Selinum tenuifolium (Bhutkesi)


Swertia chirayita (Chirayata)


Taxus wallichiana (Talispatra)


Valeriana jatamansi (Nihani, Mushkbala)


Viola odorata

4. COLD DESERT AREAS

Habitat for:

- Somlata (Chhedang), Amritdhara ghas, Laot, Koche, Pharna, Khamet (Ratanjot), Sainski-Nurcha, Kabra, Shingu-Zeera (Caraway), Panja, Tikta, Chharma, Thuklang (Khurasani ajwain), Tengu (Juffa), Shukpa, Tukshu, Leechu, Aachak (Dandelion), Padumba (Banajwain)

Arnebia guttata (Ratanjot)

Arctium lappa (Jangli kuth)

Bergenia stracheyi (Pashanbhed)

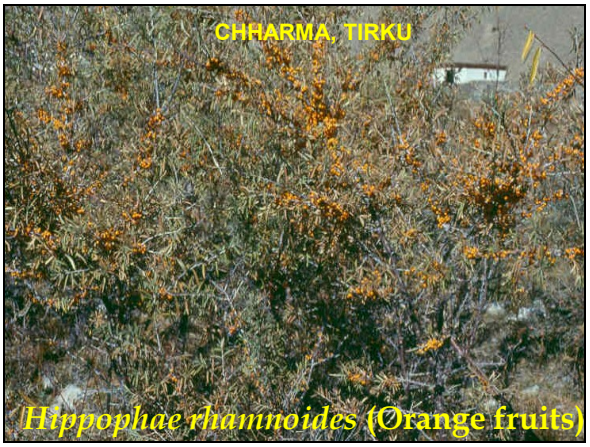
Capparis spinosa (Rutokpa Kabra)

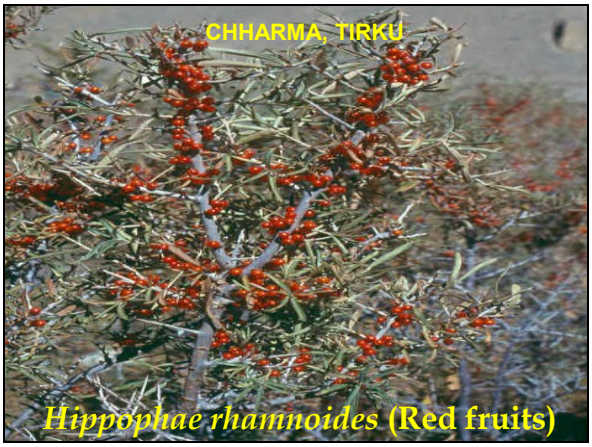

CHINGTI, TONGSIL
Corydalis govaniana


Ephedra gerardiana (Somlata)


Ferula jaeschkeana (Jangli hing)


Heracleum candicans (Heypomo, Chogot)


CHHARMA, TIRKU
Hippophae rhamnoides (Orange fruits)


CHHARMA, TIRKU
Hippophae rhamnoides (Red fruits)


Hyoscyamus niger (Khurasani Ajwain, Tukhlang)


Inula racemosa (Manu)


Picrorrhiza kurrooa (Hangland, Honglen)


Meconopsis aculeata (Himalyan Blue Poppy)


Rheum australe (Revandchini)


Rheum moorcroftianum (Leechu, Chukri)

Conclusion

- **Biodiversity in plants is attracting increasing attention of National Governments, development planners as well as Environmentalists due to their multiple functions and contributions.**
- **NTFP's previously used for subsistence purposes and small scale trading by rural communities are increasingly in demand for large scale industries.**
- **Certain NTFP's/M&AP's species are being over exploited and degraded due to lack of knowledge and local control over these species; rural poverty, increasing external market demand, lack of capacities, market information, processing and value addition technologies.**
- **The different end users of NTFP's/M&AP's create competing demands which if not managed effectively with appropriate institutions and processes, can result in causing irreversible loss of biodiversity and adversely affect the livelihoods of rural and tribal people.**

Contd...

- Though, a great diversity of medicinal and aromatic plants occurs in the state, yet the pressure is on the traditionally known drugs regularly consumed by the pharmacies in the country.
- In lean season, in the absence of agriculture activities, farmers collect Banaksha and Guchhi during March and April; root drugs like Atis, Vatanabh etc. during Sep.-Oct. and Tejpatra during Dec.-Jan., which leads to over exploitation and results in reduction of natural wealth in the state. Himachal Pradesh had given a lead in producing Kuth, Kalazeera, Chicory and Hops in the county through cultivation and had been the largest supplier of Kutki, Dioscorea, Dhoop, Tagar, Ephedra, Atees, Ratanjot etc. collected from the wild.
- Roughly, 80-85 herbs are collected and marketed annually from the state to Khari Bawli (Delhi) and Majith Mandi (Amritsar) to the tune of approx. 10 crore rupees.

Conservation and cultivation of medicinal plants in Himalayas

हिमालय में जड़ी–बूटियों का संरक्षण एंव पुनरोत्पादन

डॉ0 मायाराम उनियाल
(से0नि0) निदेशक आयुर्वेद आयुष विभाग, भारत सरकार
पूर्व सलाहकार जड़ी–बूटी उत्तराखण्ड

हिमालय प्राचीन काल से ही जड़ी–बूटियों का भण्डार रहा है। जड़ी–बूटियों की गुणवत्त में हिमालय को चरक ने श्रेष्ठ बतलाया है। यथा : हिमवान् औषध–भूमिनां श्रेष्ठम् । पिछले 3–4 दशकों से हिमालय क्षेत्र में वनों का अत्यधिक अनियमित दोहन होने के कारण जीवनदायनी अमूल्य जड़ी–बूटियाँ लुप्तप्रायः की अवस्था में पहुँच गई है। समस्त हिमालय क्षेत्र जम्मू–कश्मीर से लेकर उत्तराखण्ड, हिमालय प्रदेश, सिक्किम, अरूणाचल प्रदेश, मणिपुर आदि हिमशैलों की घाटियों में प्राकृतिक रूप से उगने वाले औषधीय पौधों का अवैज्ञानिक तरीके से आवश्यकता से ज्यादा रू‍प से दोहन किया जाता रहा है। परन्तु इन पौधों के पुनः विकसित करने के लिए योजनावद्ध रूप से कोई ध्यान नहीं दिया गया। परिणाम स्वरूप अतीस, कुटकी, त्रायमाण, सालमपंज्जा, जटामाँसी, अष्ठवर्ग जैसी कतिपय आयुर्वेदिक चिकित्सा में उपयोगी वनौषधीयाँ लुप्तप्रायः हो गई हैं। इस विलुप्तिकरण क्रिया को ध्यान में रखते हुए भारत सरकार ने अपने शासकीय पत्र संख्या 349/14–1947 दिनांक 20–5–74 के अनुसार कुटकी, अतीस, जटामाँसी, सालममिश्री, सालमपंज्जा, आर्चा, चिरायता, पत्थरलोंग, सिंगली–मिंगली (डायस्कोरिया), वन्यकर्कटी (पोडोफिल्म) आदि कतिपय औषधीय पादपों को लुप्तप्राय की श्रेणी में घोषित किया है।

यदि अभी भी समय रहते इन बहुउपयोगी जड़ी–बूटियों के संरक्षण एंव खेती की तरफ ध्यान नही दिया गया तो उपरोक्त लुप्तप्रायः घोषित औषधीय पादयों की तरह अन्य कतिपय उपयोगी जड़ी–बूटिया भी सदा–सदा के लिए लुप्तप्रायः की श्रेणी में आ जायेंगी और हिमालय जो कि जीवनदायिनी वनौषधियों का भण्डार कहा जाता है, उससे विहीन हो जायेगा।

इन जड़ी–बूटियों के विलुप्तीकरण का मुख्य कारण यह भी रहा है कि अवैज्ञानिक ढंग से एकवर्षायु, द्विवर्षायु एंव बहुवषायु जड़ी–बूटियों को बिना बीज पके समूल उखाड़ना, आवश्यकता से अधिक संग्रह करना, जानवरों जैसे भैंस, घोड़े व भेड़–बकरियों द्वारा बुग्यालों को रौंदना तथा वनो का अवैध कटान आदि कतिपय मुख्य कारण हैं। एक ओर कारण भी है कि कई अनवाश्यक पौधों का खरपतवार के रूप में अत्यधिक फैलाब होना जिसके कारण भी प्राकृतिक रूप से उगने वाली जड़ी–बूटियों पर तीव्र प्रहार हो रहा है।

यदि हम आयुर्वेद के प्राचीन साहित्य का अध्ययन करते हैं तो यह देखा गया है कि प्रकृति में इन औषधीय द्रव्यों का अपार भंडार रहा है परन्तु उपराक्त कारणों से धीरे–धीरे ये अमूल्य वनस्पतियाँ विलुप्त होती जा रही है। इन वनस्पतियों की कमी के कारण प्रकृति का सन्तुलन बिगड़ने एंव पर्यावरण प्रदूषण की भी समस्या उत्पन्न हो गई है। आज समस्त विश्व समुदाय का विश्वास इन वनौषधि द्रव्यों की ओर आकृष्ट हो रहा है। आज देश–विदेशों में आयुर्वेदिक औषध द्रव्यों की मांग बढ़ती जा रही है, परन्तु प्रामाणिक एंव सही द्रव्य समुचित मात्रा में सुलभ नहीं हो पाया हैं। जिसके कारण औषधि निर्माणशालाओं में निर्मित औषधियाँ भी महंगी होती जा रही है। इसलिए वर्तमान में जड़ो–बूटियों की खपत को देखते हुए तथा आयुर्वेदिक निरापद चिकित्सा का ध्यान में रखते हुए इन जड़ी–बूटियों की जलवायु एंव भौगोलिक परिस्थितियों के अनुसार पूरे भारत में व्यापक तौर पर वैज्ञानिक विधि से कृषि (खेती) की जाए। इन वनौषधि पादपों की उपज बढ़ने से जहां की खेती करने वालों को भी आर्थिक लाभ होगा।

जड़ी–बूटियों का संरक्षण एंव वैज्ञानिक विदोहन

पहले हिमालय क्षेत्र में जड़ी–बूटियों का विदोहन ठेकेदारी प्रथा से किया जाता था जिसमें ठेकेदार निर्धारित अवधि के लिये रौयल्टी के रूप में एकमुश्त धनराशि वनविभाग को भुगतान करता था। इस पद्धति में ठेकेदार श्रमिकों से जड़ी–बूटी एकत्र करवा कर उनकी निकासी करता था। इस पद्धति में ठेकेदार द्वारा एकत्र करायी गयी जड़ी–बूटियों की प्रजातियों एवं मात्रा पर वन विभाग का कोई प्रभावी नियन्त्रण नही था। वर्ष 1973–74 से यह प्रथा बन्द कर दी गई व उसके बाद स्थानीय लोग स्वंय जड़ी–बूटी एकत्र कर स्थानीय व्यापारियो को बेच देते थे, जो कुमाऊँ क्षेत्र से इन्हे बाहर ले जाने के पूर्व वन विभाग को निर्धारित रॉयल्टी का भुगतान करते थे।

वर्ष 1979 में जड़ी–बूटियों के विदोहन का कार्य जड़ी–बूटियों के विकास, क्रय–विक्रय एंव मूल्य (रौयल्टी) निर्धारण हेतु गठित समिति द्वारा लिये गये निर्णय के अनुसार सहकारिता विभाग को सौंपा गया, परन्तु उन्होंने यह कार्य केवल पिथौरागढ़ जनपद में ही किया। सिविल एंव पंचायती वनों की जड़ी–बूटियों के समुपयोजन व निकासी का एकाधिकार कुमाऊ मण्डल विकास निगम के इस प्रतिबंध के साथ दिया गया कि हक, हकधारियों के अधिकारों पर इसका कुप्रभाव न पड़े तथा उनको कोई आपत्ति न हो। कुमाऊ मण्डल विकास निगम ने कार्य प्रारम्भ किये व उन्हें 1985–86 तक एकाधिकार प्राप्त था इस अवधि में भेषज सहकारो विकास एंव क्रय–विक्रय संघ, कुमाऊ मण्डल विकास निगम को जड़ी–बूटियों के समुपयोजन तथा निकासी का एकाधिकार दिया गया था परन्तु निगम द्वारा किया जा रहा समुपयोजन श्रेष्ठ सिद्ध नहीं हुआ है। ग्रामवासी जड़ी–बूटियाँ एकत्र करते थे व निगम के प्रतिनिधि (भेषज संघ) उनसे खरीद लेते थे। यह उल्लेखनीय है कि चमोली, गढ़वाल, नैनीताल एंव अल्मोड़ा जनपदों के प्रत्येक स्थानीय निवासी का अपने निजी उपयोग हेतु निःशुल्क जड़ी–बूटी निकालने का अधिकार प्राप्त है।

हिमालय में जड़ी–बूटियों का संरक्षण एंव पुनरोत्पादन

कुमाऊ मण्डल विकास निगम को स्वतन्त्र रूप से पृथक–पृथक अपने प्रशिक्षित संग्रहणकर्त्ताओं के माध्यम से जड़ी–बूटियों के संग्रहण एंव विपणन हेतु अधिकृत किया गया। दोनों संस्थायें वन विभाग को निधारित वन चोकियों पर राजस्व अदायगो के उपरान्त रवन्ना तथा निकासी प्रपत्र अपने–अपने संग्रहणकर्त्ताआ को जारी करने में सक्षम हैं। इस शासनादेश के परिप्रेक्ष्यों में अब जिला भेषज सहकारी विकास संघ एंव कुमाऊ मण्डल विकास निगम द्वारा स्वतंत्र रूप से जड़ी–बूटियों के संग्रह एंव वितरण का कार्य किया जा रहा है।

शासनादेश के अनुसार वन विभाग को दिये जानेवाले अधिकार शुल्क (रौयल्टी) की दर का निर्धारण इस शासनादेश के साथ संलग्न कार्य वृत्त के प्रस्तर 5(3) में गठित दर निर्धारण समिति द्वारा निर्धारित प्रक्रिया के अधीन किया जाना है। शासनादेश के अनुसार संग्रहण व निर्यात की जाने वाली जड़ी–बूटियों के नाम, स्थान, अवधि व मात्रा का निर्धारण शासनादेश के साथ संलग्न कार्य वृत्त के प्रस्तर 4(2) में गठित समिति द्वारा कार्यवृत्त में उल्लेखित निर्देशों के अधीन किया जाना है।

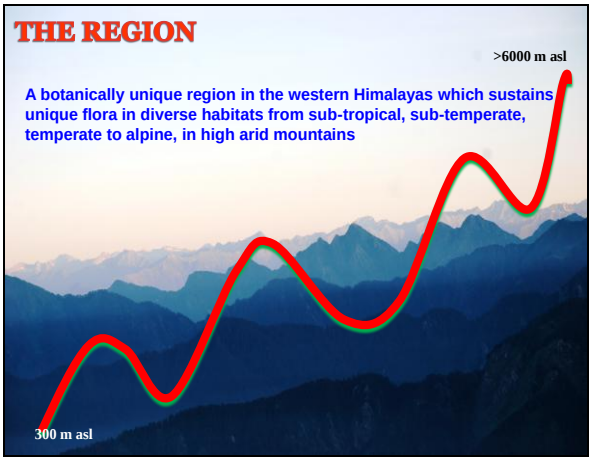
जड़ी–बूटि संग्रहण कार्य प्रशिक्षित श्रमिकों द्वारा किया जाना चाहिये। इन श्रमिकों को जड़ी–बूटियों की समुचित पहचान, विदोहन को वैज्ञानिक विधि तथा पौधे के किस भाग का विदोहन करना है, आदि का ज्ञान अनिवार्यतः होना चाहिये। इसके लिये संग्रह दर्शिका तैयार की जाय।

वैज्ञानिक विदोहन के सम्बंध में प्रमुख ध्यान देने योग्य बाते

1. वन विभाग के कर्मचारियों को भी उपरोक्त प्रशिक्षण इकाई के माध्यम से जड़ी–बूटियो की पहचान, वैज्ञानिक विदोहन की नीति उनके कृत्रिम पुनरोत्पादन के सम्बन्ध में प्रशिक्षण दिया जाना चाहिये।
2. कुमाऊं मण्डल विकास निगम तथा जिला सहकारी भेषज विकास एवं क्रय–विक्रय संघ, दोनों के द्वारा रानीखेत स्थित कोपरेटिव ड्रग फैक्ट्री की प्रशिक्षण इकाई के माध्यम से अपने–अपने संग्रहण कत्ताओं को, जो जड़ी–बूटियों का संग्रहण करते है, जड़ी–बूटियों की पहचान, वैज्ञानिक विदोहन की नीति, सफाई, वर्गीकरण, भण्डारण आदि के सम्बन्ध में प्रशिक्षण दिलाया जाना चाहिये। वर्तमान में इस प्रशिक्षण इकाई में सहकारिता व कृषि विभाग के फील्ड स्तर के कर्मचारियों को प्रशिक्षण दिया जाता है।
3. केवल प्रशिक्षित व्यक्तियों को ही, जिनके पास निर्धारित प्रमाणपत्र हो, जड़ी–बूटियो का विदोहन करने की अनुमति दी जानी चाहिए। आरक्षित वन में प्रवेश हेतु रेंज अधिकारी का हस्ताक्षरयुक्त परिचय–पत्र होना चाहिये तथा संग्रहकर्त्ताओं को प्रतिबन्धित जड़ी–बूटियों की सूची दी जानी चाहिए।
4. जड़ी–बूटी के उसी भाग को निकाला जाना चाहिये जो औषधि बनाने में प्रयुक्त होता हो व अनावश्यक रूप से पूरे पौधे को न उखाड़ा जाय।
5. प्रतिबन्धित प्रजातियों का विदोहन नहीं किया जाना चाहिये।

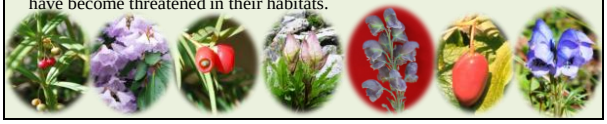
Conservation interventions in respect of threatened medicinal plants in Himachal Pradesh

Dr. Vaneet Jishtu
Himalayan Forest Research Institute, Shimla



Background:

- HP is considered a veritable emporium of MAPs in the Western Himalayan region.
- Forest settlements and local forest use: (1855 – 1934): Settlements, completed almost a century ago, are still the legal documents that provide rights to local people for forest resource use.
- Local people/right holders have extensive user rights to graze cattle and collect fuelwood, poles, and most NT products for their personal use. Rights also to collect, sell medicinal herbs, roots, flowers, fruits and aromatic plants from forests.
- Due to increased demand and competition among the harvesters, the populations of the majority of the species have dwindled manifold and have become threatened in their habitats.



Plant Conservation Efforts:

The state, through the Forest Dept., has made some efforts towards conservation and development of NTFPs under various centrally sponsored schemes.

Joint Forest Management (JFM)

- National program through which communities have been involved in FM since the 1990s.
- Initially supported through projects/initiatives of individual officers/ NGOs, it was subsequently institutionalized through the National Afforestation Programme (NAP), a flagship scheme of the National Afforestation and Eco-Development Board (NAEB), MoEF&CC, GoI.
- Under NAP, a 3-tier institutional structure has been developed with JFMCs (or Eco-development Committees (EDCs)) at the village level, Forest Development Agencies (FDAs) at the Territorial Forest/Wildlife Division level, and State Forest Development Agencies (SFDAs).

SANJHI VAN YOJNA SCHEME (2001)

Involvement of grass root level institutions: Gram Panchayats, Mahila Mandals, Yuvak Mandals, exservicemen's bodies, schools, Village Forest Development Societies (VFDSs), User groups, other Community Based Organisations (CBOs) and NGOs in sustainable management of forest resources.

To tackle the over exploitation and to provide genuine raw material for Drug Industry, the Ministry of Health & Family Welfare, Department of ISM & H started a centrally aided scheme for development and conservation of Medicinal Plants under 'Vanaspati Van Scheme'. 2001

OBJECTIVES

- Conservation and development of Medicinal Plants in their natural habitat for sustainable use.
- *Ex-situ* conservation of endangered species to save them from extinction
- Development and extension of technologies for species difficult to raise through artificial means.
- Employment generation to people living in and around forests to minimize the exploitation of Medicinal Plants through illegal means.

- GoHP has notified a list of 58 MPs for which export fee has been levied under the Forest Produce (Land Routes) Rules, 1978.
- SFD has also adopted a norm of integrating all plantations with a minimum of 30% MPs
- State has no formal system of herbal Mandis or trade through any estd. Markets.
- Trading Yards: NMPB-HPSFDC (Shamshi) and Bhadroya (Kangra).

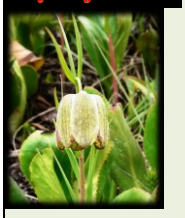
- Traditionally remained subservient to the management of commercially important tree species.
- System of rotational closure of forests for extraction of NTFPs has been in vogue in the state for long.
- However, its regulation has not received due attention -resulting in almost unregulated removals from the wild.
- State realised potential of this resource/ attention to its management.
- first step – Comprehensive MPP (2006).
- Special purpose instrument (HPMPS) – to provide greater autonomy for implementation of projects related to cons. of MP sector in the state.

Conservation, Development and Sustainable Management of Priority Wild Medicinal Plant Species

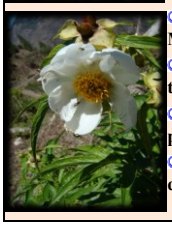
A comprehensive project aimed at *in situ* conservation of priority medicinal plants in the state through a network of MPCAs, augmenting populations of these species in the wild and putting in practice strategies for their sustainable management.

Project funded by the NMPB and steered by the PCCF (Res. & Mgt.) HPSFD

Key Objectives:



- Identification of sites to lay out MPCA's for long term *in situ* conservation of threatened medicinal plant species.
- Prepare a set of herbarium specimens and plant photographs of threatened medicinal plant species for record and reference.
- Analytical report incorporating the species wise and location wise detail of wild populations of the medicinal plants assessed as threatened in the CAMP Workshops; their major plant associations; ecological and habitat status; threats and recommended remedial measures.
- **Larger goal a LTE to conserve the biodiversity of NW Himalaya *in situ*.**



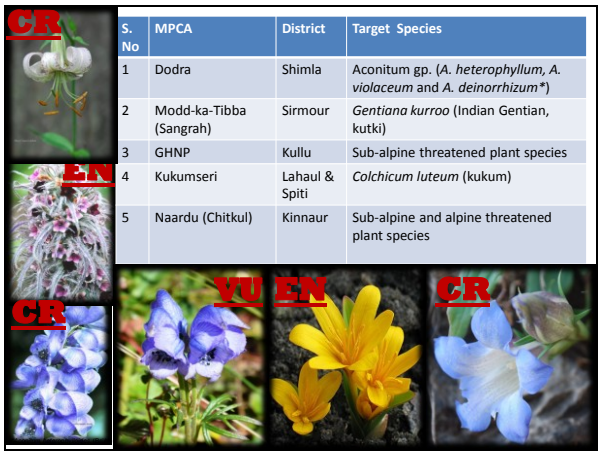
METHODOLOGY ADOPTED

- **Preparation of a comprehensive list of Medicinal Plants in HP.**
- **Assessment of Threat Status IUCN guidelines.**
- **Prioritisation of species for conservation action.**
- **Rapid Mapping of Priority Medicinal Plant species.**
- **Establishment of MPCA's and their Botanical Profiles.**
- **Capacity building programmes/stakeholders.**
- **Herbarium Methods/Photographic documentation.**

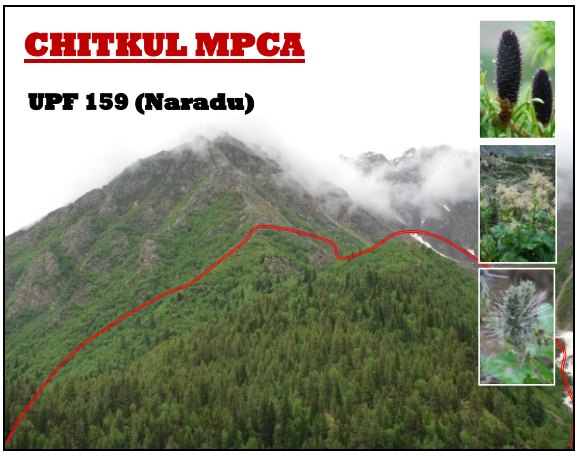
In an effort to understand the threat status of medicinal plants of the region, three successive Conservation Assessment and Management Prioritisation (CAMP) exercises have been organised within the state.

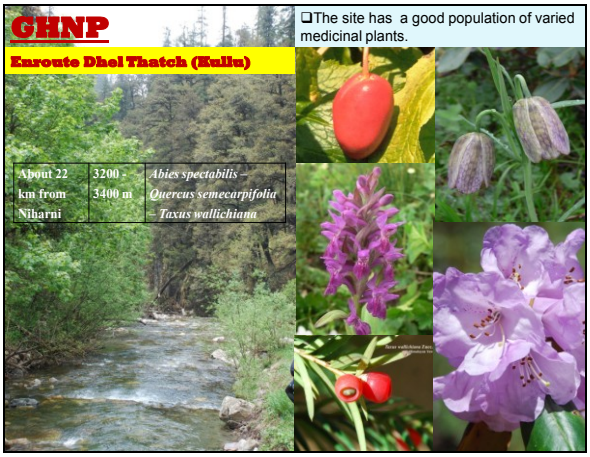
CAMP	Org/ Partners	Reviewed Taxa	*Threatened Taxa					TOTAL	Red List" Criteria adopted by IUCN
			NT	VU	EN	CR	DD/NE/LC		
KULLU (1998)	FRLHT	42	4	21	11	2	1/2	34	2.3: IUCN (1994)
SHIMLA (2003)	FRLHT & HFRI	68	0	27	21	12	3/2	60	3.1: IUCN (2000)
SHIMLA (2010)	HPMPS & NMPB	80	5	17	19	11	1/4	57	3.1: IUCN (2001)

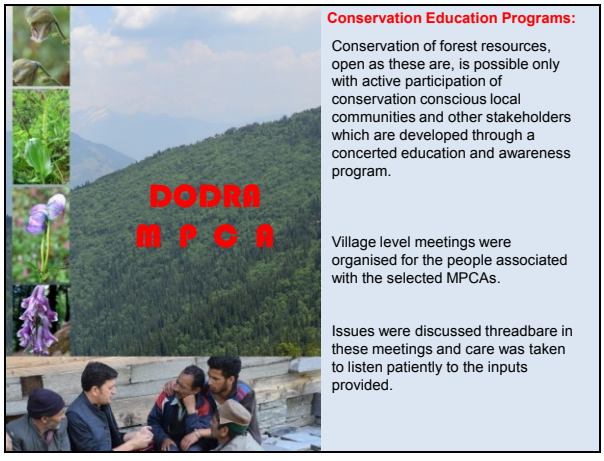
*Assessments based on the IUCN's Red List Categories and Criteria



S. No	MPCA	District	Target Species
1	Dodra	Shimla	Aconitum gp. (*A. heterophyllum, A. violaceum* and *A. deinorrhizum**)
2	Modd-ka-Tibba (Sangrah)	Sirmour	*Gentiana kurroo* (Indian Gentian, kutki)
3	GHNP	Kullu	Sub-alpine threatened plant species
4	Kukumseri	Lahaul & Spiti	*Colchicum luteum* (kukum)
5	Naardu (Chitkul)	Kinnaur	Sub-alpine and alpine threatened plant species







Conservation Education Programs:

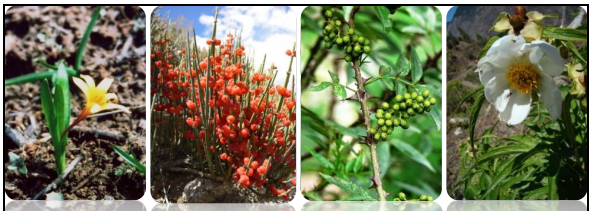
Conservation of forest resources, open as these are, is possible only with active participation of conservation conscious local communities and other stakeholders which are developed through a concerted education and awareness program.

Village level meetings were organised for the people associated with the selected MPCAs.

Issues were discussed threadbare in these meetings and care was taken to listen patiently to the inputs provided.

The Project proposes to strengthen the diminishing wild populations of priority medicinal plants in the state through augmentation plantations of these species in their natural zone of occurrence by involving local communities.

1. Estd. MPCAs
2. Augmentation plantations
3. Community orientation in wild harvests, post-harvest handling and sustainable management of forests for MPs.



Medicinal plants have been assessed as endangered based on perceptions of changes of species parameters, although quantitative data are lacking, and surveying and research is recommended to collect such information . (Tandon & Ved, 1998; Ved et al., 2003; Goraya et al., 2010).

Moroever, this conservation effort is an initiation on long term *in situ* conservation actions in the state of priority MPs through a network of MPCAs.

Community involvement emerged as a new paradigm in forest management during the 1980s. Policies/projects began incorporating a social component.

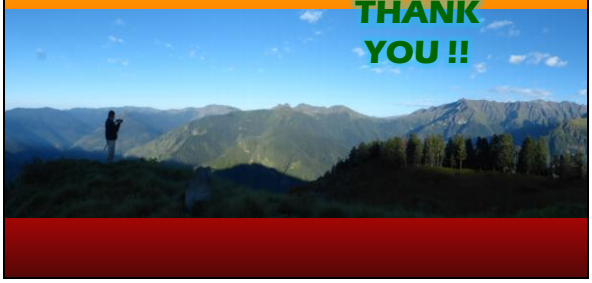
NFP (1988) envisages peoples involvement in the D&P of forests.

Most experts agree that that cooperation of local communities is essential for the sustainable management of forests

While the overall initiative to involve LC in forest management/cons., in HP is laudable, the actual practices/actions leave much to be desired.

Today, the situation of threatened plants calls for an immediate and focussed conservation action.

It is hoped that such initiatives will also create conservation consciousness amongst the local people and help them in harnessing the MPs in a sustainable basis.



Status of diversity and population dynamics of key medicinal plant species of Uttarakhand

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Forest Research Institute, Dehradun

Introduction

The State of Uttarakhand consists of 13 districts with total geographic area of 53,483 sq.km. Uttarakhand has extensive forest cover (about 66% of its geographical area). The state has nearly 700 species of medicinal plants used in traditional system of medicine. The state also has a wealth of traditional knowledge associated with the use of these plants. The State Forest Department manages approximately 70% of the forest area in the state. These forests are managed as per Working Plans that provide guidelines for ecological and sustainable exploitation. Some forests areas are also managed by local communities through *Van Panchayats*. Functioning of the *Van Panchayats* in Uttarakhand is guided by Uttaranchal Panchayati Forest Rules, 2001 as amended in 2005. Presently, there are 12,089 *Van Panchayats* managing 5,241 sq. km. of forests in Uttarakhand.

Methodology

The present study for the medicinal/ floral diveristy was conducted in sub – tropical, temperate and one alpine area of Uttarakhand, viz. Mandal, Jhuni, Mohan, Bastia, Kandara and Khulia. At each location 10 quadrats were laid along with GPS data. Sampling was done in the year 2010 post mansoon. A nested quadrates technique was used for sampling the medicinal plant. The size and number of quadrates needed were determined using the species area curve (Mishra, 1968) and the running mean method (Kershaw, 1973). Summarization of previously used methods and recommendations led to the use of more than ten (10x10 m) randaomly placed quadrats for sampling the tree and sapling stratum and 1x1 m quadrats for herbs and grasses. However, for examining the shrub and climber species 3x3 m sample plots were laid out. The enumeration of the vegetation in each of the quadrat was done by measuring dbh (diameter at breast height, *i.e.*, 1.37 m above the ground) individually in case of woody vegetation and collar diameter in case of herbs and grasses, with the help of tree caliper and electronic digital caliper, respectively. In case of grasses and sedges, each shoot is considered to a plant tiller and the enumeration was done by lying 1x1 m quadrats at random, further subdivided into 10x10 cm segments. Four such segments selected at random were analysed from each quadrate by counting the tillers individually as per the method used was that of Singh and Yadava (1974). The vegetation data were quantitatively analysed for density, frequency and abundance following Curtis and Mc Intosh (1950). The relative values of frequency, density and dominance were determined as per Phillips (1959). Name of important medicinal plant names are given in bold letters.

Results

Mandal Beat Compartment No. 20 – a- (i), [N 30^0 27' 99.2'' E 79^0 15' 77.9'' (altitude 1525 m)] Kedarnath Forest Division: Twelve tree species have been recorded from the site with highest density for *Daphniphyllum himalense* and *Symplocos racemosa* (240 trees ha^{-1} each, and with 66.99 and 48.97 IVI respectively) with 100% and 60% frequencies followed by *Neolitsea umbrosa* (160 trees ha^{-1}, IVI 44.71) with 60% frequency, and *Betula alnoides* (120 trees ha^{-1}, IVI 58.53) with 60% frequency. Eighteen shrub species have been recorded in this site with highest density for *Piper mullesua* (3333 shrub ha^{-1}, IVI 34.12) with 80% frequency followed by *Sarcococca saligna* (3111 shrub ha^{-1}, IVI 30.44) with 60% frequency, and *Symplocos racemosa* (2000 shrub ha^{-1}, IVI 16.31) with 20% frequency. One bamboo species i.e. *Sinarundinaria falcata* have been found from the site with a density of 222 individuals ha^{-1} (IVI 9.69) and 20% frequency. Twenty one herb species have been recorded in this site (out of them two belongs to climbers and two belongs to grasses) with highest density of *Oplismenus compositus* (96000 herb ha^{-1}, IVI 44.05) with 60% Frequency followed by *Ainsliaea latifolia* (32000 herb ha^{-1}, IVI 24.04) with 20% frequency, *Eupatorium adenophorum* (30000 herb ha^{-1}, IVI 26.61) with 40% frequency, *Achyranthus bidentata* (20000 herb ha^{-1} IVI 17.68) with 60% frequency and *Hydrocotyle javanica* (16000 herb ha^{-1} IVI 15.41) with 60% frequency.

Mandal Beat Compartment No. 20 c -(II), Kedarnath Forest Division: Sixteen tree species have been recorded from the site with highest density for *Neolistea umbrosa* (150 trees ha^{-1} IVI 50.37) with 80% frequency followed *by Rhododendron arboreum* and *Quercus leucotrichophora* (90 trees ha^{-1}, IVI 65.87 and 40.84) with 50% and 70% frequency, and *Persea odoratissima* (80 trees ha^{-1}, IVI 28.34) with 50% frequency. Fourteen shrub species have been recorded in this site with highest density for *Hedychium acuminatum* (9222 shrub ha^{1}, IVI 84.51) with 70% frequency followed by *Sarcococca saligna* (2889 shrub ha^{-1}, IVI 36.05) with 40% frequency, and *Elsholtzia flava* (1778 shrub ha^{-1}, IVI 23.99) with 30% frequency. One bamboo species i.e. *Thamnocalamum*

falconeri have been found from the site with a density of 889 individuals ha^{-1} (IVI 10.65) and 10% frequency. Fourty herb species have been recorded in this site (out of them five belongs to climbers and three belongs to grasses) with highest density of *Oplismenus compositus* (126000 herb ha^{-1}, IVI 28.36) with 80% Frequency followed by *Strobilanthus atropurpurens* (81000 herb ha^{-1}, IVI 21.54) with 80% frequency, *Pileia umbrosa* (68000 herb ha^{-1}, IVI 19.53) with 80% frequency, *Carex cruciata* (65000 herb ha^{-1} IVI 13.14) with 20% frequency and *Polygonum nepalense* (52000 herb ha^{-1} IVI 13.61) with 50% frequency. One pterdophyte species i.e. *Diplazium maximum* have been found from the site with a density of 3000 individuals ha^{-1} (IVI 6.60) and 10% frequency.

Medicinal Trees: *Cinnamomum tamala* (Dalcheni, Tejpat) and *Rhododendron arboreum* (Burans).
Medicinal Shrubs: *Berberis asiatica* (Kingor), *Berberis lycium* (Kingor), *Prinsepia utilis* (Bhikal) and *Sarcococca saligna.*
Medicinal Climbers: *Piper mellesua* (Pahari piper, Pahari pan) and *Rubia manjith (Rubia cordifolia*) (Manjith).
Medicinal Herbs: *Achyranthes aspera* (Apamarga), *Ainsliaea latifolia* and *A. aptera* (Karui), *Ajuga parviflora* (Neelkanthi), *Bergenia cilita* (Silphora, Pashanved), *Boenninghausenia albiflora* (Pissumar), *Drymaria cordata, Houtynea cordata, Hydrocotyle javanica, Hedychium acuminatum* (Kapoorkachri, Jangli haldi), *Paris polyphylla, Potentilla fulgens* (Bajrdanti), *Solanum viarum, Swertia chirayita, Thalictrum foliolosum* (Mamira) and *Viola pilosa* (Banafsa).

Bageshwar Jhuni (Pagua) [N 30^0 07' 15.7'' E 79^0 58' 27.5'' (altitude 3285 to 3380 m)]: Seven tree species have been recorded from the site with highest density for *Rhododendron campanulatum* (282 trees ha^{-1} IVI 100.03) with 50% frequency followed by *Rhododendron arboreum* (155 trees ha^{-1}, IVI 77.20) with 40% frequency, and *Quercus semecarpifolia* (82 trees ha^{-1}, IVI 57.94) with 30% frequency. Six shrub species have been recorded in this site with highest density for *Rhododendron campanulatum* (1411 shrub ha^{-1}, IVI 73.84) with 50% frequency followed by *Berberis umbellata* (1011 shrub ha^{-1}, IVI 47.84) with 30% frequency, and *Cotoneaster acuminatus* (611 shrub ha^{-1}, IVI 28.70) with 20% frequency. One bamboo species, *i.e*., *Sinarundinaria anceps* have been found from the site with a density of 400 individuals ha^{-1} (IVI 1.49) and 10% frequency. Fourty three herb species have been recorded in this site (out of them two belongs to climbers and one belongs to grasses) with highest density of *Gaultheria trichophylla* (1118000 herb ha^{-1}, IVI 17.33) with 40% Frequency followed by *Fragaria nubicola* (100000 herb ha^{-1}, IVI 17.73) with 50% frequency, *Polygonum amplexicaule* (91800 herb ha^{1}, IVI 19.87) with 70% frequency, *Potentilla fulgens* (89100 herb ha^{-1} IVI 17.91) with 40% frequency and *Anaphalis busua* (63600 herb ha^{-1} IVI 29.06) with 60% frequency. One orchid i.e. *Poneorchis chusua* have been found from the site with a density of 4500 individuals ha^{-1} (IVI 1.64) and 10% frequency.

Medicinal Trees: *Abies pindrow* (Talispatra), *Betula utilis* (Bojpatra), *Rhododendron arboreum* (Burans) *Rhododendron campanulatum* and *Taxus baccata* (Thuner)
Medicinal Shrubs: *Berberis umbellata* (Kingor) and *Skimmia laureola* (Kedarpati)
Medicinal Herbs: *Ainsliaea latifolia* (Karu), *Hydrocotyle javanica, Gaultheria trichophylla*, *Malaxis mucifera* (Jeevak), *Podophylum hexandrum* (Bankakri), *Picrorhiza kurrooa* (Kutki), *Polygonatum verticillatum, P. multiflorum* (Maida), *Potentilla fulgens* (Bajradanti), *Selinum wallichianum* (Bhoot kashi), *Swertia ciliata* (Chiryata), *Vallerina hardwickii* (Tagar) and *Vallerina jatamansi* (Somaya)

Almorah Compartment Komaria No. 100 (1-C)- (I) [N 29^0 33' 245'' E 79^0 03' 092'' (altitude 530 m)]: Fourteen tree species have been recorded from the site with highest density for *Tectona grandis* (133 trees ha^{-1} IVI 41.82) with 60% frequency followed by *Syzygium cumini* (117 trees ha^{-1}, IVI 47.76) with 60% frequency. Sixteen shrub species have been recorded in this site with highest density for *Glycosmis pentaphylla* (11667 shrub ha^{-1}, IVI 56.58) with 80% frequency followed by *Pogestemon benghalensis* (5367 shrub ha^{-1}, IVI 30.99) with 70% frequency, and *Clerodendrum viscosum* (3333 shrub ha^{-1}, IVI 21.45) with 70% frequency. Twenty seven herb species have been recorded in this site (out of them four belongs to climbers,one bryophyte, one orchid and one belongs to grasses) with highest density of *Pogostemon benghalensis* (33300 herb ha^{-1}, IVI 36.59) with 30% Frequency followed by *Oplismenus burmannii* (25000 herb ha^{-1}, IVI 27.86) with 50% frequency, *Cynotis cristata* and *Dioscorea belophylla* (11700 herb ha^{-1}, IVI 17.89 & 13.84) with 30 & 20% frequencies. One pteridophyte *i.e*. *Adiantum incisum* have been found from the site with a density of 6700 individuals ha^{-1} (IVI 10.53) and 20% frequency. *Curculago orchioids* have been found from the site with a density of 5000 individuals ha^{-1} (IVI 22.39) and 20% frequency.

Medicinal Herbs: *Achyranthes aspera* (Apamarga, Latjira), *Canscora decussate* (Sankhapushpi), *Curculago orchioides* (Kalimusli), *Gloriosa superba* (Kalhari), *Desmodium gangeticum*(Salparni), *Elephantopus scaber* (Gabhi), *Lygodium japonicum, Phyllanthus amarus* (*P. niruri*) (Bhumyamala) and *Vernonia cinirea* (Sehadevi),

Mohan, Compartment Kumaria No. 4 -(II): Twenty five tree species have been recorded from the site with highest density for *Shorea robusta* (155 trees ha^{-1} IVI 77.09) with 80% frequency followed by *Mallotus philippensis* (64 trees ha^{-1}, IVI 20.46) with 50% frequency and *Ougenia oojeinensis* (55 trees ha^{-1}, IVI 18.72) with 40% frequency. Thirty three shrub species have been recorded in this site with highest density for *Clerodendrum viscosum* (9899shrub ha^{-1}, IVI 32.18) with 80% frequency followed by *Pogestemon benghalensis* (7277 shrub ha^{-1}, IVI 27.29) with 60% frequency, *Mallotus philippensis* (3433 shrub ha^{-1}, IVI 15.52) with 50% frequency and *Schleichera oleosa* (3233 shrub ha^{-1}, IVI 15.28) with 60% frequency. One bamboo i.e. *Dendrocalamus strictus* have been found from the site with a density of 99 individuals ha^{-1} (IVI 1.25) and 10% frequency. Thirteen climber species have been recorded in this site with highest density of *Millettia extensa* (2522 herb ha^{-1}, IVI 9.68) with 10% Frequency followed by *Peuraria tuberosa* (399 herb ha^{-1}, IVI 5.35) with 40% frequency. Thirty nine herb species have been recorded in this site with highest density of *Rungia pectinata* (46400 herb ha^{-1}, IVI 24.40) with 90% Frequency followed by *Achyranthus aspera* (24500 herb ha^{-1}, IVI 12.95) with 50% frequency. Nine grasses species including with three sedges have been recorded in this site with highest density of *Arundinella nepalensis* (13600 herb ha^{-1}, IVI 7.79) with 30% Frequency followed by *Oplismenus compositus* (8200 herb ha^{-1}, IVI 5.38) with 30% frequency, *Capillipedium assimile* (4500 herb ha^{-1}, IVI 96.58) with 10% frequency and *Carex pectinata* (2700 herb ha^{-1}, IVI 2.62) with 20% frequency. Three pteredophyte species have been found from the site with highest density of *Adiantum incisum* (10900 fern ha^{-1}, IVI 6.94) with 30% Frequency followed by *Cheilanthus farinosa* (1800 fern ha^{-1}, IVI 1.68) with 10% frequency. Two orchids have been found from the site with highest density of *Nervilia plicata* (2700 orchids ha^{-1}, IVI 1.78) with 10% Frequency followed by *Habenaria plantaginea* (900 orchids ha^{-1}, IVI 1.16) with 10% frequency.

Medicinal Trees: *Aegle marmelos* (Bel), *Buchnania lanzan* (Cheronjee), *Cassia fistula* (Amaltash), *Emblica officinalis, Holarrhena pubescens* (Kura), *Madhuca longifolia*(Mauha), *Mallotus philippensis* (Rohini), *Syzygium cumini (Jamun), Terminalia bellerica* (Behera) and *Terminalia chebula* (Harar)
Medicinal Shrubs: *Adhatoda zeylanica* (*A. vasica*) (Basinga), *Baliospermum montanum*(Danti), *Embelia tsjeriam – cottam* (*E. robusta*) (Vaivarang), *Flacourtia indica* (Kenel, Bilangra), *Glycosmis pentaphylla* (Ban-nimbu), *Helictris isora* (Marorphal), *Murraya koengii* (Karipatta), and *Randia spinosa* (Madana)
Medicinal Climbers: *Abrus practeorus* (Ratti), *Cissampelos parieira* (Parhi, Pahari), *Dioscorea belophylla* (Turar), *Pueraria tuberosa* (Vidarkand, Sirala, Biralu), *Smilax ovalifolia* (*S. macrophylla*) (Ramdatun) and *Tinospora sinensis* (Giloi)

Champawat, Bastia Compartment No. 4 [N 29º 07' 872" E79^0 05' 551" (altitude 490 m)]: Thirty two tree species have been recorded from the site with highest density for *Mallotus philippensis* (119 trees ha^{-1} IVI 35.78) with 70% frequency followed by *Shorea robusta* (50 trees ha^{-1}, IVI 30.09) with 40% frequency and *Holarrhena pubescens* (44 trees ha^{-1}, IVI 16.23) with 40% frequency. Thirty four shrub species have been recorded in this site with highest density for *Clerodendrum viscosum* (6733 shrub ha^{-1}, IVI 27.03) with 80% frequency followed by *Shorea robusta* (5899 shrub ha^{-1}, IVI 23.21) with 50% frequency, *Pogostemon benghalensis* (4788 shrub ha^{-1}, IVI 19.68) with 60% frequency and *Coffea benghalensis* (3755 shrub ha^{-1}, IVI 17.51) with 60% frequency. Eighteen climber species have been recorded in this site with highest density of *Dalbergia volubilis* (1811 herb ha^{-1}, IVI 10.30) with 40% Frequency followed by *Ichnocarpus frutescens* (1044 herb ha^{-1}, IVI 8.25) with 40% frequency and *Millettia extensa* (977 shrub ha^{-1}, IVI 9.20) with 40% frequency.
Thirty nine herb species have been recorded in this site with highest density of *Rungia pectinata* (31900 herb ha^{-1}, IVI 30.46) with 40% Frequency followed by *Curculago orchioids* (28800 herb ha^{-1}, IVI 18.59) with 60% frequency and *Peperomia pellucida* (13800shrub ha^{-1}, IVI 6.87) with 10% frequency. Five grasses species have been recorded in this site with highest density of *Oplismenus burmannii* (13100 herb ha^{-1}, IVI 9.01) with 20% Frequency. Three bryophyte species have been found from the site with highest density of *Cheilanthus farinosa* (5600 fern ha^{-1}, IVI 3.67) with 10% Frequency followed by *Adiantum incisum* (5000 fern ha^{-1}, IVI 3.82) with 10% frequency. Two orchids have been found from the site with highest density of *Nervilia plicata* (1900 orchids ha^{-1}, IVI 2.75) with 10% Frequency followed by *Habenaria plantaginea* (1300 orchids ha^{-1}, IVI 2.01) with 10% frequency.

Medicinal Trees: *Aegle marmelos* (Bel), *Buchnania lanzan* (Cheronjee), *Cassia fistula*(Amaltash), *Emblica officinalis,Ficus racemosa* (Gular), *Mallotus philippensis* (Rohini), *Moringa olifera, Murraya paniculata* (Kamni), *Pterocarpus marsupium* (Bijasal), *Terminalia bellirica* (Behera) and *Terminalia chebula* (Harar) and *Holorrhena pubescens.*

Medicinal Shrubs: *Adhatoda zeylanica* (*A. vasica*) (Basinga), *Asparagus adscendens, Baliospermum montanum* (Danti), *Embelia tsjeriam – cottam* (*E. robusta*) (Vaivarang), *Flacourtia indica* (Kenel, Bilangra), *Glycosmis pentaphylla* (Ban-nimbu), *Helictris isora* (Marorphal), *Murraya koengii* (Karipatta), and *Catunaregam spinosa,* (Madana), *Thespesia lampas, Urena lobata.*
Medicinal Climbers: *Abrus precatorius* (Ratti), *Cissampelos parieira*(Parhi, Pahari), *Celastrus paniculatus* (Malkangni), *Dioscorea belophylla* (Turar), *Pueraria tuberosa*(Vidarkand, Sirala, Biralu), *Smilax ovalifolia* (*S. macrophylla*) (Ramdatun) and *Tinospora sinensis* (Giloi),
Medicinal Herbs: *Achyranthes aspera* (Apamarga, Latjira), *Gloriosa superba, Canscora decussata* (Sankhapushpi), *Curculago orchioides* (Kalimusli), *Desmodium gangeticum*(Salparni), *Elephantopus scaber* (Gabhi), *Lygodium japonicum, Phyllanthus amarus* (*P. niruri*) (Bhumyamala) and *Vernonia cinirea* (Sehadevi),

Uttarkashi, Kandara (i) [N 30^0 94' 9.5" E 78^0 67' 43" (altitude 3530 m)]: Twenty six herb species have been recorded in this site with highest density of *Cyananthus lobatus* (35000 herb ha^{-1}, IVI 25.06) with 70% Frequency followed by *Potentilla cuneifolia* (24000 herb ha^{-1}, IVI 13.61) with 30% frequency and *Tanacetum dolichophyllum* and *Anaphalis royleana* (22000 shrub ha^{-1} each, IVI 35.00 & 13.49) with 80% & 30% frequencies.

Medicinal Herbs: *Aconitum heterophyllum, Arnebia benthamii, Jurinea dolomiea, Origanum vulgare, Polygonatum multiflorum, Swertia ciliata, Tanacetum dolichophyllum*

Kandara (ii) [N. 30^0 94 ' 9.5" E. 78^0 67' 43" (altitude 3530 m)]: Twenty six herb species have been recorded in this site with highest density of *Nardostachys grandiflora* (28000 herb ha^{-1}, IVI 18.58) with 30% Frequency followed by *Cyananthus lobatus* (26000 herb ha^{-1}, IVI 18.72) with 40% frequency and *Osmunda calyteniana* and *Picrorhiza kurrooa* (12000 shrub ha^{-1} each, IVI 11.76 & 16,43) with 10% & 20% frequencies.

Medicinal Herbs: *Aconitum heterophyllum, Alluim wallichianum, Arnebia benthamii, Heracleum candicans, Jurinea dolomiaea, Malaxis mucifera, Nardostachys grandiflora, Origanum vulgare, Picrorhiza kurrooa, Polygonatum multiflorum, Rheum australe, Swertia ciliata, Tanacetum dolichophyllum.*

Khulia, Munshyari Pithoragarh [N 30^0 44' E80^0 11.5' (altitude 3467 m)]: Three tree species have been recorded from the site with highest density for *Sorbus ursina* (20 trees ha^{-1} IVI 127.99) with 20% frequency followed by *Betula utilis* (10 trees ha^{-1}, IVI 116.07) with 10% frequency and *Rhododendron campanulatum* (10 trees ha^{-1}, IVI 55.94) with 10% frequency. One shrub species i.e. *Cotoneaster microphyllus* have been recorded in this site with a density of 10 shrub ha^{-1}, IVI 27.03, with 300%. Thirty four herb species have been recorded in this site with highest density of *Fragaria indica* and *Gaultheria trichophylla* (30000 herb ha^{-1}, IVI 9.42 & 7.64) with 20% & 10% Frequencies followed by *Picrorhiza kurrooa* (23000 herb ha^{-1}, IVI 110.69) with 70% frequency.

Medicinal Herbs: *Betula utilis, Fritillaria roylei, Gaultheria trichophylla, , Heracleum candicans, Nardostachys grandiflora, Pichrorhiza kurrooa, Polygonatum multiflorum, Potentilla fulgens, Selinum wallichianum, Swertia ciliata, Tanacetum dolichophyllum.*

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Status of diversity and population dynamics of key medicinal plant species of Uttarakhand

By
H.B.Naithani

Year 2010-2011, Qualitative and Quantitative Survey was conducted in six Medicinal Plant Conservation Areas of Uttarakhand

- Maximum diversity of medicinal plants in the given region
- The area traditionally known for medicinal plant richness, especially for endemic species
- The area should be representative of forest/ vegetation type, they are relatively undisturbed and accessible, have reasonably large block of 200-500 ha size easily distinguishable of vegetation with viable population of prioritized medicinal plant species
- The area enjoy a minimum level of protection or protected area network or reserve forest

KEDARNATH FOREST DIVISION
MANDAL -COMPARTMENT No. 20 – A
N 30^0 27' 99.2'' – E 079^0 15' 77.9'' (Alt. 1525 m)

i) Location:
- **Beat:** Mandal
- **Compartment:** 20a, 20c
- **Range:** Gopeshwar
- **Division**: Kedarnath Wildlife Division

ii) **Legal Status of land**: Reserve Forest
iii) **Management Status**: Forest Department

- *Symplocos racemosa* **(240 trees ha^{-1} each, and with 66.99 and 48.97 IVI respectively) with 100%**
- *Neolitsea umbrosa* **(160 trees ha^{-1}, IVI 44.71) with 60% frequency**
- *Betula alnoides* **(120 trees ha^{-1}, IVI 58.53) with 60% frequency.**

Floristic attributes of vegetation IInd

Neolistea umbrosa (150 trees ha^{-1} IVI 50.37) with 80% frequency

Rhododendron arboretum

Quercus leucotrichophora (90 trees ha^{-1}, IVI 65.87 and 40.84) with 50% and 70% frequency

Persea odoratissima (80 trees ha^{-1}, IVI 28.34) with 50% frequency.

Medicinal Trees

Cinnamomum tamala (Dalcheni, Tejpat) and *Rhododendron arboreum* (Burans).

Medicinal Shrubs

Berberis asiatica (Kingor), *Berberis lycium* (Kingor) *Prinsepia utilis* (Bhikal) and *Sarcococca saligna.*

Medicinal Climbers

Piper mellesua (Pahari piper, Pahari pan) and *Rubia manjith* (*Rubia cordifolia*) (Manjith).

KeyK Medicinal Herbs

Achyranthes aspera (Apamarga), *Ainsliaea latifolia* (Karui), *Ajuga parviflora* (Neelkanthi), *Bergenia ciliata* (Silphora, Pashanved), *Boenninghausenia albiflora* (Pissumar), *Drymaria cordata, Houtynea cordata, Hedychium spicatum* (Kapoorkachri, Jangli haldi), *Paris polyphylla*(Satwa), *Potentilla fulgens* (Bajrdanti), *Solanum viarum, Swertia chirayita* (Chiriata), *Thalictrum foliolosum* (Mamira) and *Viola pilosa* (Banafsa).

Table : Compartment No. 20 A TREES

Tree	Freq.	Density	Trees/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Neolitsea umbrosa	60.00	1.60	160	2.67	13.04	16.33	15.34	44.71
Betula alnoides	60.00	1.20	120	2.00	13.04	12.24	33.25	58.53
Daphniphyllum himalense	100.00	2.40	240	2.40	21.74	24.49	20.76	66.99
Euonymus pendulus	20.00	0.20	20	1.00	4.35	2.04	0.39	6.78
Cupressus torulosa	20.00	0.20	20	1.00	4.35	2.04	6.07	12.46
Symplocos racemosa	60.00	2.40	240	4.00	13.04	24.49	11.44	48.97
Alnus nepalensis	20.00	0.20	20	1.00	4.35	2.04	3.84	10.23
Persea odoratissma	20.00	0.20	20	1.00	4.35	2.04	0.41	6.80
Caesalpinia decaptala	40.00	0.40	40	1.00	8.70	4.08	0.44	13.21
Ilex dipyrena	20.00	0.40	40	2.00	4.35	4.08	1.04	9.47
Cinnamomum tamala	20.00	0.40	40	2.00	4.35	4.08	0.39	8.82
Lynonia ovalifolia	20.00	0.20	20	1.00	4.35	2.04	6.63	13.02

SHRUBS

Shrubs	Freq.	Density	Shrubs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Berberis asiatica	20.00	0.40	444	2.00	3.33	2.60	4.50	10.43
Euonymous pendulus	20.00	0.20	222	1.00	3.33	1.30	2.63	7.26
Boehmeria platyphylla	20.00	0.40	444	2.00	3.33	2.60	1.34	7.27
Hedyechium spicatum	40.00	0.80	889	2.00	6.67	5.19	0.80	12.66
Randia tetrasperma	20.00	0.40	444	2.00	3.33	2.60	2.51	8.44
Neolitsea umbrosa	80.00	1.20	1333	1.50	13.33	7.79	8.38	29.50
Quercus leucotrichphora	40.00	0.60	667	1.50	6.67	3.90	3.72	14.28
Piper mullesua	80.00	3.00	3333	3.75	13.33	19.48	1.31	34.12
Smilax perfoliata	20.00	0.20	222	1.00	3.33	1.30	0.04	4.68

SHRUBS

Shrubs	Freq.	Density	Shrubs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Reinwardtia indica	20.00	0.40	444	2.00	3.33	2.60	0.29	6.22
Sarcococca saligna	60.00	2.80	3111	4.67	10.00	18.18	2.26	30.44
Craniotome furcata	20.00	0.20	222	1.00	3.33	1.30	0.59	5.22
Symplocos racemosa	20.00	1.80	2000	9.00	3.33	11.69	1.29	16.31
Hydrangea anomala	40.00	0.60	667	1.50	6.67	3.90	25.25	35.82
Dioscorea bulbifera	20.00	0.20	222	1.00	3.33	1.30	0.17	4.80
Cinnamomum tamala	20.00	0.60	667	3.00	3.33	3.90	37.38	44.61
Rosa burnonii	20.00	0.20	222	1.00	3.33	1.30	1.62	6.25
Caesalpinia decaptala	20.00	1.20	1333	6.00	3.33	7.79	0.86	11.99

BAMBOO

Bamboo	Freq.	Density	Bamboo/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Sinarundinaria falcata	20.00	0.20	222	1.00	3.33	1.30	5.06	**9.69**

CLIMBERS

Climbers	Freq.	Density	Climbers/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Hedera nepalensis	40.00	0.40	444	1.00	6.45	1.42	0.05	**7.92**
Dioscorea bulbifera	40.00	0.60	667	1.50	6.45	2.13	0.14	**8.72**

HERBS

Herbs	Freq.	Density	Herbs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Fragaria indica	20.00	1.40	14000	7.00	3.23	4.96	0.64	**8.83**
Drymaria diandra	20.00	1.00	10000	5.00	3.23	3.55	0.46	**7.23**
Achyranthus bidentata	60.00	2.00	20000	3.33	9.68	7.09	0.91	**17.68**
Eupatorium adenophorum	40.00	3.00	30000	7.50	6.45	10.64	9.52	**26.61**
Scutellaria scandens	20.00	0.60	6000	3.00	3.23	2.13	0.33	**5.68**
Boenninghausenia albiflora	20.00	0.40	4000	2.00	3.23	1.42	0.67	**5.31**
Hydrocotyle javanica	60.00	1.60	16000	2.67	9.68	5.67	0.05	**15.41**

HERBS

Herbs	Freq.	Density	Herbs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Ainsliaea latifolia	20.00	3.20	32000	16.00	3.23	11.35	9.47	**24.04**
Stephenia elegans	20.00	0.40	4000	2.00	3.23	1.42	0.07	**4.72**
Ophiopogon intermedius	20.00	0.20	2000	1.00	3.23	0.71	0.27	**4.21**
Piper mullesua	20.00	0.40	4000	2.00	3.23	1.42	1.64	**6.29**
Elatostema sessile	20.00	0.60	6000	3.00	3.23	2.13	6.60	**11.95**
Rubia cordifolia	20.00	0.20	2000	1.00	3.23	0.71	0.22	**4.15**
Solanum viarum	40.00	0.60	6000	1.50	6.45	2.13	0.38	**8.96**
Bergenia ciliata	20.00	0.40	4000	2.00	3.23	1.42	32.17	**36.81**
Stellaria latifolia	20.00	0.40	4000	2.00	3.23	1.42	0.73	**5.37**
Zingiber roseum	20.00	0.60	6000	3.00	3.23	2.13	34.25	**39.60**

FERN

Fern	Freq.	Density	Fern/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Diplazium maximum	10.00	0.30	3000	3.00	2.22	1.57	2.80	**6.60**

GRASS

Grass	Freq.	Density	Grass/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Oplismenus compositus	80.00	12.60	126000	15.75	8.99	19.33	0.05	**28.36**
Microstegium ciliatum	20.00	3.20	32000	16.00	2.25	4.91	0.20	**7.36**
Artharoxon lancifolius	10.00	1.70	17000	17.00	1.12	2.61	0.11	**3.84**

JHUNI (PAGUA)
N 30^0 07' 15.7'' E 079^0 58' 27.5''(Alt. 3285 to 3380 m)
BAGESHWAR

i) Location:

- **Van Panchayat** : Jhuni & Khati
- **Compartment** : NA
- **Range** : Kapkot
- **Division** : Bageshwar Forest Division

ii) Legal Status of land : Community land
iii) Management Status : Van Panchayat

Floristic attributes of vegetation

Rhododendron campanulatum (282 trees ha^{-1} IVI 100.03) with 50% frequency

Rhododendron arboreum (155 trees ha^{-1}, IVI 77.20) with 40% frequency,

Quercus semecarpifolia (82 trees ha^{-1}, IVI 57.94) with 30% frequency.

Medicinal Trees

Abies pindrow (Talispatra), *Betula utilis* (Bojpatra), *Rhododendron arboreum* (Burans) and *Taxus baccata* (Thuner).

Medicinal Shrubs

Berberis umbellata (Kingor) and *Skimmia laureola* (Kedarpati),

Medicinal Herbs

Ainsliaea latifolia (Karu), *Anglica glauca* (Chora), *Delphinium denudatum* (Nirbasi), *Gaultheria trichophylla*, *Maharanga emodi* (Balchar), *Malaxis mucifera* (Jeevak), *Podophylum hexandrum* (Bankakri), *Picrorhiza kurrooa* (Kutki), *Polygonatum verticillatum* (Maida), *Potentilla fulgens* (Bajradanti), *Selinum tenuifolium* (Bhoot kashi), *Swertia ciliata* (Chiryata), *Vallerina hardwickii* (Tagar) and *Vallerina wallichii* (Somaya).

Table : vegetative species of Jhuni (Pagua)- II

TREES

Tree	Freq.	Density	Trees/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Taxus baccata	20	0.18	18	1.00	12.50	3.08	4.85	**20.43**
Abies pindrow	10	0.18	18	2.00	6.25	3.08	9.25	**18.58**
Betula utilis	10	0.18	18	2.00	6.25	3.08	2.43	**11.75**
Rhododendron campanulatum	50	2.82	282	6.20	31.25	47.69	21.08	**100.03**
Acer caesium	10	0.18	18	2.00	6.25	3.08	4.74	**14.07**
Quercus semecarpifolia	30	0.82	82	3.00	18.75	13.85	25.35	**57.94**
Rhododendron arboreum	40	1.55	155	5.67	18.75	26.15	32.30	**77.20**

SHRUBS

Shrubs	Freq.	Density	Shrubs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Rhododendron campanulatum	50	1.27	1411	2.80	33.33	31.82	8.69	**73.84**
Rosa macrophylla	20	0.36	400	2.00	13.33	9.09	67.34	**89.77**
Cotoneaster acuminatus	20	0.55	611	3.00	13.33	13.64	1.73	**28.70**
Quercus semecarpifolia	20	0.18	200	1.00	13.33	4.55	0.65	**18.53**
Berberis umbellata	30	0.91	1011	5.00	13.33	22.73	11.78	**47.84**
Sinarundinaria anceps	10	0.18	200	2.00	6.67	4.55	0.70	**11.91**

BAMBOO

Bamboo	Freq.	Density	Bamboo/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Sinarundinaria anceps	10	0.36	400	4.00	1.05	0.42	0.02	**1.49**

CLIMBERS

Climbers	Freq.	Density	Climbers/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Clematis montana	10	0.55	611	6.00	6.67	13.64	9.11	**29.41**
Smilax aspera	30	0.45	500	1.67	3.16	0.52	0.01	**3.69**

HERBS

Herbs	Freq.	Density	Herbs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Plygonum amplexicaule	70	9.18	91800	12.63	8.42	10.55	0.89	**19.87**
Fragaria nubicola	50	10.00	100000	22.00	5.26	11.49	0.97	**17.73**
Geranium wallichianum	60	1.73	17300	3.17	6.32	1.99	7.63	**15.94**
Clinpodium umbrosum	10	0.18	1800	2.00	1.05	0.21	0.22	**1.48**
Selinium tenuifolium	20	0.27	2700	1.50	2.11	0.31	8.81	**11.23**
Viola biflora	20	2.55	25500	14.00	2.11	2.93	0.14	**5.17**
Arisaema tortuosum	20	0.36	3600	2.00	2.11	0.42	0.00	**2.52**
Padophyllum hexandrum	10	0.09	900	1.00	1.05	0.10	0.01	**1.17**
Swertia ciliata	10	0.09	900	1.00	1.05	0.10	1.73	**2.89**
Berberis umbellate	10	0.18	1800	2.00	1.05	0.21	1.13	**2.39**
Impatiens amplexicaule	30	0.82	8200	3.00	3.16	0.94	0.02	**4.12**
Myricatis wallichii	10	0.36	3600	4.00	1.05	0.42	1.73	**3.20**
Valleriana wallichii	20	1.91	19100	10.50	2.11	2.19	0.05	**4.35**
Anaphalis busua	60	6.36	63600	11.67	6.32	7.31	15.43	**29.06**
Aguilegia pubiflora	10	0.18	1800	2.00	1.05	0.21	0.05	**1.32**
Rubus nepalensis	20	0.73	7300	4.00	2.11	0.84	0.28	**3.22**

HERBS

Herbs	Freq.	Density	Herbs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Rumex nepalensis	10	0.18	1800	2.00	1.05	0.21	0.16	**1.42**
Parochetus communis	40	3.18	31800	8.75	4.21	3.66	18.54	**26.41**
Rosa macrophylla	10	0.18	1800	2.00	1.05	0.21	0.00	**1.27**
Gaultheria trichophylla	40	11.18	111800	30.75	4.21	12.85	0.27	**17.33**
Epilobium latifolium	10	0.18	1800	2.00	1.05	0.21	0.01	**1.27**
Bupleurum himalayense	20	1.73	17300	9.50	2.11	1.99	2.36	**6.45**
Anemone obtusifolia	10	0.36	3600	4.00	1.05	0.42	1.27	**2.74**
Hydrocotyle javanica	10	1.64	16400	18.00	1.05	1.88	10.16	**13.09**
Meharanga emodi	10	0.18	1800	2.00	1.05	0.21	7.05	**8.32**
Primula denticulata	30	2.09	20900	7.67	3.16	2.40	5.59	**11.15**
Potentilla fulgens	40	8.91	89100	24.50	4.21	10.24	3.46	**17.91**
Halenia elliptica	10	0.36	3600	4.00	1.05	0.42	0.02	**1.49**
Sexifraga flagellaris	30	2.91	29100	10.67	3.16	3.34	4.52	**11.02**
Pedicularis pectinata	30	3.27	32700	12.00	3.16	3.76	0.08	**7.00**
Malaxis mucifera	10	0.09	900	1.00	1.05	0.10	0.00	**1.16**
Euphorbia pilosa	10	0.18	1800	2.00	1.05	0.21	0.16	**1.42**
Picrorhiza kurrooa	40	5.45	54500	15.00	4.21	6.27	4.00	**14.48**
Stachys sericea	10	0.09	900	1.00	1.05	0.10	0.03	**1.18**

HERBS

Herbs	Freq.	Density	Herbs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Skimmia loureana	10	0.55	5500	6.00	1.05	0.63	0.96	**2.64**
Ansliaea latifolia	10	1.09	10900	12.00	1.05	1.25	1.12	**3.42**
Polygonatum verticillatum	10	0.55	5500	6.00	1.05	0.63	0.48	**2.16**
Hypericum japonicum	10	1.45	14500	16.00	1.05	1.67	0.32	**3.04**
Polygonatum multiflorum	30	1.18	11800	4.33	3.16	1.36	0.18	**4.70**

GRASS

Grass	Freq.	Density	Grass/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Agrostis pilosa	20	3.73	37300	20.50	2.11	4.28	0.09	**6.48**

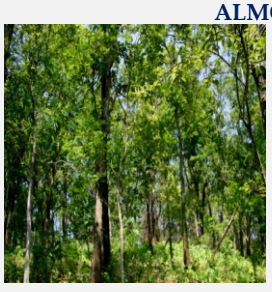
ORCHID

Orchid	Freq.	Density	Orchid/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Poneorchis chusua	**10**	0.45	4500	5.00	1.05	0.52	0.07	**1.64**

MOHAN COMPARTMENT KOMARIA NO. 100(1-C)

N 29^0 33' 245'' – E 79^0 03' 092'' (Alt. 530 m)

ALMORAH



i) Location:

- **Beat:** Kath Ki Naw/ Kumeria
- **Compartment**: 2
- **Range**: Mohan
- **Division**: Almora Forest Division

ii) **Legal Status of land**: Reserve Forest

iii) **Management Status**:Forest Department

Floristic attributes of vegetation

Tectona grandis (133 trees ha^{-1} IVI 41.82) with 60% frequency

Syzygium cumini (117 trees ha^{-1}, IVI 47.76) with 60% frequency.

Glycosmis pentaphylla (11667 shrub ha^{-1}, IVI 56.58) with 80% frequency

Medicinal Trees

Aegle marmelos (Bel)
Buchnania lanzan (Cheronjee)
Cassia fistula (Amaltash)
Emblica officinalis
Holarrhena pubescens (Kura)
Madhuca longifolia(Mauha)
Mallotus philippensis (Rohini)
Syzygium cumini (Jamun)
Terminalia bellerica (Behera)
Terminalia chebula (Harar).

Medicinal Shrubs

Adhatoda zeylanica (*A. vasica*) (Basinga), *Baliospermum montanum*(Danti), *Embelia tsjeriam – cottam* (*E. robusta*) (Vaivarang), *Flacourtia indica* (Kenel, Bilangra), *Glycosmis pentaphylla* (Ban-nimbu), *Helictris isora* (Marorphal), *Murraya koengii* (Karipatta), and *Randia spinosa* (Madana).

Medicinal Climbers

Abrus practeorus (Ratti)
Cissampelos parieira (Parhi,Pahari)
Dioscorea belophylla (Turar)
Gloriosa superba(Kalhari)
Pueraria tuberosa(Vidarkand, Sirala, Biralu) *Smilax ovalifolia* (*S. macrophylla*) (Ramdatun) *Tinospora sinensis* (Giloi)

Medicinal Herbs

Achyranthes aspera (Apamarga, Latjira) *Canscora decussata* (Sankhapushpi), *Curculago orchioides* (Kalimusli), *Desmodium gangeticum*(Salparni), *Elephantopus scaber* (Gabhi), *Lygodium japonicum, Phyllanthus amarus* (*P. niruri*) (Bhumyamala) and *Vernonia cinirea* (Sehadevi)

Table : vegetative species of Mohan Compartment Komaria No. 100(1-C)

TREES

Tree	Freq	Density	Tree/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Terminalia chebula	**50**	**0.50**	50	**1.00**	**11.54**	**8.82**	**25.75**	**46.12**
Shorea robusta	30	0.33	33	1.00	7.69	5.88	7.73	**21.31**
Adina cordifolia	50	0.50	50	1.00	11.54	8.82	27.84	**48.21**
Mallotus philippensis	30	0.50	50	1.50	7.69	8.82	0.85	**17.37**
Syzygium cumini	60	1.17	117	1.75	15.38	20.59	11.79	**47.76**
Tectona grandis	60	1.33	133	2.00	15.38	23.53	2.90	**41.82**
Ehretia laevis	20	0.17	17	1.00	3.85	2.94	0.22	**7.01**
Holoptelia integrifolia	20	0.17	17	1.00	3.85	2.94	13.23	**20.02**
Cassia fistula	20	0.17	17	1.00	3.85	2.94	1.28	**8.07**
Careya arborea	20	0.17	17	1.00	3.85	2.94	1.55	**8.33**
Terminaria ballerica	20	**0.17**	17	**1.00**	**3.85**	**2.94**	**4.63**	**11.42**
Schleichera oleosa	20	0.17	17	1.00	3.85	2.94	0.69	**7.47**
Lagerstroemia parviflora	20	0.17	17	1.00	3.85	2.94	0.91	**7.70**
Casearea tomentosa	20	0.17	17	1.00	3.85	2.94	0.62	**7.40**

SHRUBS

Shrubs	Freq.	Density	Shrubs/ ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Mallotus philippensis	80	1.50	1667	1.80	11.90	5.36	0.27	**17.53**
Schleichera oleosa	30	0.67	744	2.00	4.76	2.38	2.82	**9.96**
Glycosmis pentaphylla	80	10.50	11667	12.60	11.90	37.50	7.18	**56.58**
Peuraria tuberosa	20	0.17	189	1.00	2.38	0.60	1.49	**4.46**
Pogestemon benghalensis	70	4.83	5367	7.25	9.52	17.26	4.20	**30.99**
Adhatoda zeylanica	70	2.67	2967	4.00	9.52	9.52	43.25	**62.30**
Clerodendrum viscosum	70	3.00	3333	4.50	9.52	10.71	1.21	**21.45**
Cassia fistula	30	0.50	555	1.50	4.76	1.79	2.97	**9.52**
Tectona grandis	20	0.17	189	1.00	2.38	0.60	3.00	**5.97**
Murraya koenigii	30	0.67	744	2.00	4.76	2.38	30.29	**37.43**
Holarrhena pubescens	20	0.17	189	1.00	2.38	0.60	0.08	**3.05**
Randia spinosa	20	0.17	189	1.00	2.38	0.60	0.37	**3.34**
Coffea benghalensis	30	1.00	1111	3.00	4.76	3.57	0.40	**8.74**
Lantana camara	30	0.33	367	1.00	4.76	1.19	1.38	**7.33**
Colebrookia oppositifolia	20	0.50	555	3.00	2.38	1.79	0.12	**4.29**
Baleospermum montanum	20	0.50	555	3.00	2.38	1.79	0.56	**4.73**

CLIMBERS

Climbers	Freq.	Density	Climbers/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Tinospora sinensis	20	**0.17**	189	**1.00**	**2.38**	**0.60**	**0.30**	**3.27**
Millettia extensa	20	0.17	189	1.00	2.38	0.60	0.10	**3.07**
Smilax ovalifolia	30	0.33	367	1.00	4.76	1.19	0.01	**5.97**
Cissus repanda	20	0.33	367	2.00	3.45	2.33	1.22	**6.99**

HERBS

Herbs	Freq.	Density	Herbs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Syzygium cumini	20	0.33	3300	2.00	3.45	2.33	0.25	**6.03**
Achyrathes aspera	20	**0.33**	3300	**2.00**	**3.45**	**2.33**	**6.29**	**12.06**
Cynotis cristata	30	1.17	11700	3.50	6.90	8.14	2.85	**17.89**
Pogostemon benghalensis	30	3.33	33300	10.00	6.90	23.26	6.44	**36.59**
Clerodendrum viscosum	20	0.17	1700	1.00	3.45	1.16	0.02	**4.63**
Elatostemma surculosum	20	0.33	3300	2.00	3.45	2.33	2.91	**8.68**
Adenostema laeviana	20	0.17	1700	1.00	3.45	1.16	2.90	**7.51**
Cassia tora	20	0.33	3300	2.00	3.45	2.33	31.54	**37.32**
Wrightia arborea	20	0.17	1700	1.00	3.45	1.16	5.15	**9.76**
Commelina benghalensis	20	0.33	3300	2.00	3.45	2.33	4.87	**10.64**
Nervilia plicata	20	0.33	3300	2.00	3.45	2.33	0.49	**6.27**
Mallotus philippensis	20	0.33	3300	2.00	3.45	2.33	0.04	**5.81**
Garuga pinnata	20	0.17	1700	1.00	3.45	1.16	1.13	**5.74**
Shorea robusta	20	0.17	1700	1.00	3.45	1.16	1.13	**5.74**

HERBS

Herbs	Freq.	Density	Herbs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Dioscorea belophylla	20	**1.17**	11700	**7.00**	**3.45**	**8.14**	**2.25**	**13.84**
Flacourtia indica	20	0.17	1700	1.00	3.45	1.16	0.99	**5.60**
Elephantopus scaber	20	**0.33**	3300	**2.00**	**3.45**	**2.33**	**5.79**	**11.57**
Desmodium triflorum	20	0.17	1700	1.00	3.45	1.16	0.85	**5.46**
Cissampelos pariera	20	**0.33**	3300	**2.00**	**3.45**	**2.33**	**4.87**	**10.64**
Biophytum reinwardtii	20	0.33	3300	2.00	3.45	2.33	0.04	**5.81**
Curculago orchides	20	0.50	5000	3.00	3.45	3.49	15.45	**22.39**

GRASS

Grass	Freq.	Density	Grass/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Oplismenus burmannii	50.00	2.50	25000	5.00	10.34	17.44	0.08	**27.86**

FERN

Fern	Freq.	Density	Fern/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Adiantum incisum	20	0.67	6700	4.00	3.45	4.65	2.43	**10.53**

BASTIA COMPARTMENT NO. 4
N 29° 07' 872 " 05' 551" (Alt. 490 m)
CHAMPAWAT

i) Location:

- **Beat:** Bastiya
- **Compartment:** 4 & 6
- **Range:** Boom
- **Division:** Champawat Forest Division

ii) Legal Status of land: Reserve Forest

iii) Management Status: Forest Department

Floristic attributes of vegetation

Mallotus philippensis **(119 trees ha^{-1} IVI 35.78) with 70% frequency**

Shorea robusta **(50 trees ha^{-1}, IVI 30.09) with 40% frequency**

Holarrhena pubescens **(44 trees ha^{-1}, IVI 16.23) with 40% frequency.**

Medicinal Trees

Aegle marmelos **(Bel),** ***Anogeissus latifolia*** **(Bakli),** ***Buchnania lanzan*** **(Cheronjee),** ***Cassia fistula*****(Amaltash),** ***Emblica officinalis,Ficus racemosa*** **(Gular),** ***Mallotus philippensis*** **(Rohini),** ***Moringa olifera, Murraya paniculata*** **(Kamni),** ***Pterocarpus marsupium*** **(Bijasal),** ***Terminalia bellerica*** **(Behera) and** ***Terminalia chebula*** **(Harar).** ***Holorrhena pubescens.***

Medicinal Shrubs

Adhatoda zeylanica **(*A. vasica*) (Basinga),** ***Asparagus adscendens, Baliospermum montanum*****(Danti),** ***Embelia tsjeriam – cottam*** **(*E. robusta*) (Vaivarang),** ***Flacourtia indica*** **(Kenel, Bilangra),** ***Glycosmis pentaphylla*** **(Ban-nimbu),** ***Helictris isora*** **(Marorphal),** ***Murraya koengii*** **(Karipatta), and** ***Randia spinosa*** **(Madana),** ***Thespesia lampas.***

Medicinal Climbers

Abrus precatorius **(Ratti),**
Cissampelos parieira**(Parhi, Pahari),**
Celastrus paniculatus **(Malkangni)**
Dioscorea belophylla **(Turar)**
Gloriosa superba**(Kalhari)**
Pueraria tuberosa**(Vidarkand, Sirala, Biralu),**
Smilax ovalifolia **(*S. macrophylla*) (Ramdatun)**
Tinospora sinensis **(Giloi)**

Medicinal Herbs

Achyranthes aspera **(Apamarga, Latjira)** ***Canscora decussata*** **(Sankhapushpi)**
Curculago orchioides **(Kalimusli)**
Desmodium gangeticum**(Salparni)**
Elephantopus scaber **(Gabhi)**
Lygodium japonicum
Phyllanthus amarus **(*P. niruri*) (Bhumyamala)**
Vernonia cinirea **(Sehadevi)**

Table: Vegatative species of Champawat, Bastia Compartment No.4

TREES

Tree	Freq.	Density	Trees/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Adina cordifolia	40	0.38	38	1.00	7.32	5.88	14.02	**27.22**
Mallotus philippensis	70	1.19	119	1.73	13.41	18.63	3.74	**35.78**
Terminalia chebula	**20**	**0.19**	19	**1.00**	**3.66**	**2.94**	**5.90**	**12.50**
Schleichera oleosa	20	0.38	38	2.00	3.66	5.88	5.86	**15.41**
Cassia fistula	30	0.38	38	1.20	6.10	5.88	1.29	**13.27**
Holarrhena pubescens	40	0.44	44	1.00	8.54	6.86	0.83	**16.23**
Stereospermum chelonoides	**10**	**0.06**	6	**1.00**	**1.22**	**0.98**	**0.79**	**2.99**
Ficus rumphii	**10**	0.06	6	1.00	1.22	0.98	0.19	**2.39**
Terminalia ballirica	**20**	**0.19**	19	**1.00**	**3.66**	**2.94**	**9.66**	**16.26**
Lannea coromandelica	20	0.19	19	1.00	3.66	2.94	2.21	**8.81**
Shorea robusta	40	0.50	50	1.33	7.32	7.84	14.93	**30.09**
Syzygium cumini	**10**	0.13	13	1.00	2.44	1.96	1.29	**5.69**
Cordia dichotoma	**10**	0.25	25	2.00	2.44	3.92	3.85	**10.21**
Emblica officinalis	20	0.19	19	1.00	3.66	2.94	1.64	**8.24**
Trichilia connorioides	**10**	0.13	13	1.00	2.44	1.96	0.13	**4.53**

Table: Vegatative species of Champawat, Bastia Compartment No.4

TREES

Tree	Freq.	Density	Trees/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Ficus racemosa	**10**	0.06	6	1.00	1.22	0.98	0.49	**2.69**
Casearia tomentosa	20	0.19	19	1.00	3.66	2.94	0.37	**6.97**
Holoptelia integrifolia	**10**	0.06	6	1.00	1.22	0.98	0.55	**2.75**
Mangifera indica	**10**	0.06	6	1.00	1.22	0.98	1.16	**3.36**
Terminalia alata	**10**	**0.13**	13	**1.00**	**2.44**	**1.96**	**1.38**	**5.78**
Semicarpus anacardium	**10**	0.06	6	1.00	1.22	0.98	0.36	**2.56**
Flacourtia indica	**10**	0.06	6	1.00	1.22	0.98	0.49	**2.69**
Buchnania lanzan	**10**	**0.06**	6	**1.00**	**1.22**	**0.98**	**0.22**	**2.42**
Albizia procera	**10**	0.06	6	1.00	1.22	0.98	1.12	**3.32**
Moringa oleifera	20	0.31	31	1.67	3.66	4.90	3.90	**12.46**
Cassine glauca	**10**	0.06	6	1.00	1.22	0.98	0.55	**2.75**
Diospyros	**10**	0.06	6	1.00	1.22	0.98	0.17	**2.37**
Alstonia scholaris	**10**	0.06	6	1.00	1.22	0.98	2.54	**4.74**
Garuga pinnata	**10**	0.19	19	1.50	2.44	2.94	3.69	**9.07**
Careya arborea	**10**	0.06	6	1.00	1.22	0.98	1.84	**4.04**
Anogiessus latifolia	**10**	0.19	19	1.50	2.44	2.94	4.87	**10.25**
Pterocarpus marsupium	**10**	**0.06**	6	**1.00**	**1.22**	**0.98**	**9.96**	**12.16**

SHRUBS

Shrubs	Freq.	Density	Shrubs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Adhatoda zeylanica	**40**	**3.06**	3399	**8.17**	**4.44**	**9.14**	**62.01**	**75.60**
Holarrhena pubescens	60	1.38	1533	2.20	7.41	4.10	0.39	**11.90**
Mallotus philippensis	60	1.44	1599	2.56	6.67	4.29	0.27	**11.23**
Coffea benghalensis	60	3.38	3755	5.40	7.41	10.07	0.03	**17.51**
Murraya koenigii	50	1.56	1733	3.13	5.93	4.66	4.95	**15.54**
Cassia fistula	30	0.63	699	2.00	3.70	1.87	0.43	**6.00**
Pogostemon benghalensis	60	4.31	4788	7.67	6.67	12.87	0.14	**19.68**
Clerodendrumn viscosum	70	6.06	6733	8.08	8.89	18.10	0.04	**27.03**
Colebrookia oppositifolia	**10**	0.19	211	1.50	1.48	0.56	0.02	**2.07**
Shorea robusta	50	5.31	5899	10.63	5.93	15.86	1.42	**23.21**
Trichilia connaroides	30	0.38	422	1.50	2.96	1.12	1.17	**5.26**
Syzygium cumini	**10**	0.19	211	3.00	0.74	0.56	0.13	**1.43**
Phlogacanthus thyrsiformis	**10**	0.06	66	1.00	0.74	0.19	0.40	**1.33**

SHRUBS

Shrubs	Freq.	Density	Shrubs/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Lagrestroemia parviflora	**10**	0.13	144	2.00	0.74	0.37	3.52	**4.63**
Thespesia lampas	**10**	0.06	66	1.00	0.74	0.19	0.14	**1.06**
Dalbergia sericea	**10**	0.06	66	1.00	0.74	0.19	0.34	**1.27**
Casearia tomentosa	**10**	0.13	144	1.00	1.48	0.37	0.08	**1.93**
Maesa indica	**10**	0.06	66	1.00	0.74	0.19	0.31	**1.24**
Emblica officinalis	**10**	0.19	211	1.50	1.48	0.56	6.46	**8.51**
Boehmeria platyphylla	**10**	0.25	277	2.00	1.48	0.75	0.09	**2.31**
Litsea glutinosa	**10**	**0.19**	211	**3.00**	**0.74**	**0.56**	**1.47**	**2.77**
Casearia graveolens	**10**	0.13	144	1.00	1.48	0.37	0.21	**2.07**
Leea aspera	**10**	0.06	66	1.00	0.74	0.19	0.29	**1.22**
Semicarpus anacardium	**10**	0.13	144	2.00	0.74	0.37	4.47	**5.58**
Urena lobata	**10**	0.06	66	1.00	0.74	0.19	0.04	**0.97**
Inula cappa	**10**	0.13	144	2.00	0.74	0.37	0.12	**1.24**
Grewia asiatica	**10**	0.19	211	1.00	2.22	0.56	0.23	**3.01**
Glochidion velutinum	**10**	0.06	66	1.00	0.74	0.19	0.22	**1.15**
Schleichera oleosa	**10**	0.06	66	1.00	0.74	0.19	0.02	**0.95**
Streblus asper	**10**	0.06	66	1.00	0.74	0.19	0.10	**1.03**
Murraya paniculata	**10**	0.06	66	1.00	0.74	0.19	0.07	**1.00**
Asparagus adscendens	**10**	0.06	66	1.00	0.74	0.19	1.24	**2.17**
Randia spinosa	**10**	0.06	66	1.00	0.74	0.19	0.42	**1.35**
Aegle marmelos	**10**	0.06	66	1.00	0.74	0.19	0.30	**1.23**

CLIMBERS

Climbers	Freq.	Density	Climbers/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Cryptolepis buchananii	**10**	0.06	66	1.00	0.74	0.19	2.03	**2.96**
Capparis zeylanica	**10**	0.06	66	1.00	0.74	0.19	0.03	**0.96**
Millettia extensa	40	0.88	977	2.33	4.44	2.61	2.14	**9.20**
Dalbergia volubilis	40	1.63	1811	3.71	5.19	4.85	0.36	**10.39**
Gaunea laptostachya	**10**	0.06	66	1.00	0.74	0.19	0.16	**1.09**
Peuraria tuberosa	**10**	**0.13**	144	**1.00**	**1.48**	**0.37**	**0.09**	**1.95**
Cissus repanda	**10**	0.13	144	2.00	0.74	0.37	3.25	**4.37**
Celastrus paniculatus	**10**	0.06	66	1.00	0.74	0.19	0.05	**0.97**
Bauhinia vahlii	**10**	0.19	211	3.00	0.74	0.56	0.02	**1.32**
Abrus precaterius	**10**	**0.13**	144	**2.00**	**0.74**	**0.37**	**0.00**	**1.12**
Tinospra sinensis	**10**	0.06	66	1.00	0.74	0.19	0.29	**1.21**
Cissampelos pariera	**30**	**0.38**	422	**1.20**	**3.85**	**1.40**	**0.10**	**5.34**
Ichnocarpus frutescens	40	0.94	1044	2.50	4.62	3.49	0.14	**8.25**
Discorea belophylla	**40**	**0.69**	766	**1.57**	**5.38**	**2.56**	**0.01**	**7.95**
Smilax ovalifolia	**10**	0.06	66	1.00	0.77	0.23	1.80	**2.80**
Ventilago denticulate	**10**	**0.13**	144	**2.00**	**0.77**	**0.47**	**0.48**	**1.72**
Abrus prectorius	**10**	**0.13**	144	**2.00**	**0.77**	**0.47**	**0.05**	**1.29**

HERBS

Herbs	Freq.	Density	Herb/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Shorea robusta	30	0.56	5600	2.25	3.08	2.09	2.47	**7.64**
Curculago orchids	60	**2.88**	28800	**4.60**	**7.69**	**10.70**	**0.20**	**18.59**
Adhatoda zeylanica	**10**	**0.50**	5000	**4.00**	**1.54**	**1.86**	**1.45**	**4.85**
Rungia pectinata	40	3.19	31900	8.50	4.62	11.86	13.98	**30.46**
Lapidagathis incurva	**10**	0.50	5000	4.00	1.54	1.86	4.15	**7.55**
Sida rhombifolia	**10**	0.06	600	1.00	0.77	0.23	0.07	**1.07**
Coffea benghalensis	30	0.81	8100	3.25	3.08	3.02	2.35	**8.45**
Desmodium gangeticum	40	0.88	8800	2.33	4.62	3.26	0.37	**8.25**
Triumfetta rhomboidea	**10**	0.06	600	1.00	0.77	0.23	0.01	**1.01**
Mudrannia nudiflora	**10**	0.19	1900	3.00	0.77	0.70	0.01	**1.48**
Elephantopus scaber	**40**	**1.00**	10000	**2.67**	**4.62**	**3.72**	**0.62**	**8.95**
Phyllanthus amarus	**30**	**1.13**	11300	**4.50**	**3.08**	**4.19**	**0.02**	**7.28**

HERBS

Herbs	Freq.	Density	Herb/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Schleichera oleosa	**10**	0.06	600	1.00	0.77	0.23	0.00	**1.01**
Evolvulus nummularius	**10**	1.44	14400	11.50	1.54	5.35	0.02	**6.91**
Flacourtia indica	**10**	0.06	600	1.00	0.77	0.23	0.09	**1.09**
Borreria stricta	**10**	0.13	1300	1.00	1.54	0.47	1.56	**3.56**
Achyranthus aspera	**30**	**0.75**	7500	**2.40**	**3.85**	**2.79**	**1.85**	**8.49**
Houttuynia cordata	**10**	**0.69**	6900	**5.50**	**1.54**	**2.56**	**0.75**	**4.85**
Syzygium cumini	**10**	0.13	1300	2.00	0.77	0.47	0.62	**1.85**
Cassia fistula	**10**	0.19	1900	1.50	1.54	0.70	0.05	**2.29**
Zingiber roseum	**10**	0.13	1300	1.00	1.54	0.47	0.08	**2.08**
Mallotus philippensis	**10**	0.19	1900	1.50	1.54	0.70	0.05	**2.29**
Emblica officinalis	**10**	**0.06**	600	**1.00**	**0.77**	**0.23**	**0.35**	**1.35**
Desmodium triflorum	**10**	0.06	600	1.00	0.77	0.23	0.02	**1.02**
Flemingia bracteata	**10**	0.06	600	1.00	0.77	0.23	0.00	**1.00**
Sida acuta	**10**	0.13	1300	2.00	0.77	0.47	3.78	**5.01**

HERBS

Herbs	Freq.	Density	Herb/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Ageratum conyzoides	**10**	0.19	1900	3.00	0.77	0.70	3.09	**4.55**
Costos speciosus	**10**	0.13	1300	2.00	0.77	0.47	6.72	**7.95**
Boerhavia diffusa	**10**	**0.13**	1300	**2.00**	**0.77**	**0.47**	**0.86**	**2.09**
Streblus asper	**10**	0.06	600	1.00	0.77	0.23	0.21	**1.21**
Vernonia cinerea	**10**	0.13	1300	2.00	0.77	0.47	0.31	**1.54**
Acrocephales indicus	**10**	0.06	600	1.00	0.77	0.23	0.62	**1.62**
Peperomia pellucida	**10**	1.38	13800	11.00	1.54	5.12	0.21	**6.87**
Globba racemosa	**10**	0.13	1300	2.00	0.77	0.47	1.23	**2.47**
Gauga pinnata	**10**	0.06	600	1.00	0.77	0.23	0.05	**1.05**
Biophytum reinwardtii	**10**	0.13	1300	2.00	0.77	0.47	0.17	**1.41**
Desmodium muflorum	**10**	0.88	8800	14.00	0.77	3.26	0.13	**4.16**
Sida cordata	30	1.19	11900	3.80	3.85	4.42	19.55	**27.82**
Cynotis cristata	20	0.38	3800	2.00	2.31	1.40	0.16	**3.86**

GRASS

Grass	Freq.	Density	Grass/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Oplismenus burmannii	20	1.31	13100	7.00	2.31	4.88	1.82	**9.01**
Oplismenus compositus	20	0.44	4400	2.33	2.31	1.63	4.69	**8.62**
Arundinella pumila	**10**	0.13	1300	2.00	0.77	0.47	0.08	**1.31**
Microstegium ciliatum	**10**	0.13	1300	2.00	0.77	0.47	0.00	**1.24**
Capillpedium assimile	**10**	0.44	4400	7.00	0.77	1.63	20.27	**22.67**

FERN

Fern	Freq.	Density	Fern/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Cheilanthus farinosa	**10**	0.56	5600	4.50	1.54	2.09	0.04	**3.67**
Lygogium flexusoum	**10**	0.06	600	1.00	0.77	0.23	0.00	**1.00**
Adinatum incisum	**10**	0.50	5000	4.00	1.54	1.86	0.42	**3.82**

ORCHID

Orchid	Freq.	Density	Orchid/ha	Abund.	Rel Freq	Rel Den	Rel Dom	IVI
Nervillia plicata	**10**	0.19	1900	3.00	0.77	0.70	1.29	**2.75**
Habenaria plantaginea	**10**	0.13	1300	1.00	1.54	0.47	0.00	**2.01**

KANDARA- N. 300 94 ' 9.5 "- E. 780 67 ' 43 " Alt. 3530 m

UTTARKASHI

[redacted]

i) Location:

- **Beat :** Sukhi
- **Compartment** : 3b
- **Range** : Gangotri
- **Division** : Uttarkashi Forest Division

ii) Legal Status : Reserve Forest

iii) Management Status : Forest Department

Floristic attributes of vegetation

Cyananthus lobatus (35000 herb ha^{-1}, IVI 25.06) with 70% Frequency

Potentilla cuneifolia (24000 herb ha^{-1}, IVI 13.61) with 30% frequency

Tanacetum dolichophyllum and *Anaphalis royleana* (22000 shrub ha^{-1} each, IVI 35.00 & 13.49) with 80% & 30% frequencies.

Medicinal Herbs Ist site

Aconitum heterophyllum
Arnebia benthamii
Jurinea dolomica
Origanum vulgare
Polygonatum heterophyllum
Swertia ciliata
Tanacetum dolichophyllum

Medicinal Herbs IInd site

Alluim wallichianum
Heracleum candicans
Malaxis mucifera
Nardostachys grandiflora
Picrorhiza kurrooa
Polygonatum multiflorum
Rheum australe

Table : vegetative species of KANDARA- N. 300 94 ' 9.5 "- E. 780 67 ' 43 " Alt. 3530 m

HERBS

Herb	density(P/m2.)	Plants/ha	Frequency %	TBA (cm2/m2)	IVI
Arnebia benthamii	0.40	4000	30.00	0.01	6.45
Jurinea dolomiaea	0.50	5000	40.00	0.08	11.98
Anemone obtusiloba	1.10	11000	30.00	0.02	9.47
Tanacetum dolichophyllum	2.20	22000	80.00	0.30	35.00
Cremanthodium arnicoides	0.30	3000	20.00	0.10	9.00
Cyananthus lobatus	3.50	35000	70.00	0.04	25.06
Thermopsis barbata	0.90	9000	20.00	0.18	15.45
Anaphalis royleana	2.20	22000	30.00	0.02	13.49
Morina langifolia	0.40	4000	10.00	0.15	10.84
Potentilla atrisanguinea	0.30	3000	10.00	0.02	3.73
Senecio leatus	0.50	5000	20.00	0.02	5.86
Parnassia nubicola	1.90	19000	60.00	0.03	17.03
Saxifraga paranassifolia	0.20	2000	10.00	0.00	2.26
Aconitum heterophyllum	0.80	8000	40.00	0.05	11.51
Origanum vulgare	1.00	10000	10.00	0.04	7.04
Berberis jaeschkeana	1.00	10000	10.00	0.68	40.05
Potentilla cuneifolia	2.40	24000	30.00	0.01	13.61
Swertia ciliata	0.70	7000	40.00	0.01	8.98
Anaphalis nubigenia	1.90	19000	40.00	0.05	15.56
Aster falconeri	0.20	2000	10.00	0.01	2.51
Geranium wallichianum	1.30	13000	20.00	0.01	8.00
Polygonatum multiflorum	0.30	3000	10.00	0.02	3.73
Cyananthus integer	0.60	6000	10.00	0.01	3.95
Epilobium cylindricum	0.20	2000	10.00	0.02	2.97

GRASS

Grass	density(P/m2.)	Plants/ha	Frequency %	TBA (cm2/m2)	IVI
Danthonia schneideri	2.00	20000	10.00	0.01	9.26

FERN

Fern	density(P/m2.)	Plants/ha	Frequency %	TBA (cm2/m2)	IVI
Osmunda calyteniana	0.70	7000	10.00	0.06	7.21

Khulia, Munshyari N. 300 044 ' E. 80 ' 11.5 ' Alt. 3467 m

PITHORAGARH

i) Location:

- **Beat:** Khuliya
- **Compartment:** 8
- **Range:** Munsyari
- **Division:** Pithoragarh Forest Division

ii) **Legal Status of land**: Reserve Forest

iii) **Management Status**: Forest Department

Floristic attributes of vegetation

Sorbus ursina **(20 trees ha^{-1} IVI 127.99) with 20% frequency**

Betula utilis **(10 trees ha^{-1}, IVI 116.07) with 10% frequency**

Betula utilis **(10 trees ha^{-1}, IVI 116.07) with 10% frequency**

Medicinal Herbs

Betula utilis
Fritillaria roylei
Gaultheria trichophylla
Heracleum candicans
Nardostachys grandiflora
Pichrorhiza kurrooa
Polygonatum multiflorum
Potentilla fulgens,
Selinum wallichianum,
Swertia ciliata,
Tanacetum dolichophyllum

Table : vegetative species of Khulia, Munshyari Pithoragarh

TREES

Tree	density(T/ha.)	Frequency %	TBA (m^2/Ha)	IVI
Sorbus ursina	20	20.00	1.480	127.99
Betula utilis	10	10.00	3.492	116.07
Rhododendron campanulatum	10	10.00	0.314	55.94
	40	40.00	5.286	300.00

SHRUBS

Shrub	density(P/ha.)	Frequency %	TBA (cm^2/9m2)	IVI
Cotoneaster microphyllus	10	10.00	0.216	300.00

HERBS

Herb	density(P/ha.)	Frequency %	TBA (cm2/m2)	IVI
Picrorhiza kurrooa	23000	70.00	1.518	110.69
Danthonia schneideri	2000	20.00	0.004	3.44
Geum elatum	2000	20.00	0.010	3.65
Clematis barbellata	2000	10.00	0.004	1.98
Selinum wallichianum	22000	50.00	0.504	29.78
Polygonum amplexicaule	21000	30.00	0.053	10.46
Primula denticulata	8000	10.00	0.042	4.57
Anaphalis nubigena	17000	20.00	0.019	6.98
Parnassia nubicola	9000	20.00	0.020	5.43
Epilobium cylindricum	9000	20.00	0.023	5.52
Fragaria indica	30000	20.00	0.015	9.42
Thalictrum elegans	3000	20.00	0.018	4.16
Carex nothа	10000	10.00	0.002	3.51
Potentilla fulgens	11000	20.00	0.031	6.21
Geranium wallichianum	18000	40.00	0.075	12.08
Tanacetum dolichophyllum	3000	20.00	0.036	4.79
Delphinium vestitum	3000	20.00	0.023	4.31
Swertia speciosa	2000	10.00	0.119	6.13
Cyananthus lobatus	4000	20.00	0.004	3.83
Saxifraga diversifolia	8000	30.00	0.009	6.27
Halenia elliptica	5000	20.00	0.011	4.30
Polygonatum multiflorum	2000	10.00	0.004	1.99
Senecio laetus	6000	20.00	0.009	4.43

HERBS

Herb	density(P/ha.)	Frequency %	TBA (cm2/m2)	IVI
Fritillaria roylei	6000	20.00	0.015	4.64
Nardostachys jatamansii	4000	30.00	0.005	5.31
Polygonum vaccinifolium	3000	10.00	0.066	4.43
Haracleum candicans	1000	10.00	0.013	2.12
Swertia ciliata	13000	20.00	0.086	8.58
Anaphalis royleana	4000	10.00	0.005	2.41
Potentilla fragariodes	5000	10.00	0.013	2.90
Agrostis pilosula	6000	20.00	0.002	4.18
Gaultheria trichophylla	30000	10.00	0.006	7.64
Sedum crenulatum	1000	10.00	0.005	1.81
Lactuca macrortiza	2000	10.00	0.006	2.05
	502000	690.00	2.774	300.00

Conservation and sustainable utilization strategies for high altitude medicinal plants of Uttarakhand

M.S. Gusain
State Medicinal Plants Board Uttarakhand, Dehradun

Developing strategy for conservation and sustainable utilization of high altitude medicinal plants

State Medicinal Plants Board
Uttarakhand, Dehradun

Uttarakhand-Background

- 27th state of the Republic of India
- Total Geographical area – 53,483 Sq.km.
- Forest Cover – 24,240 Sq.km (45.32 % of geographical area).
- Medicinal plant wealth- 1608

Department/organization/Board

- Horticulture Department
- State Forest Department
- Forest Development Corporation
- State Biodiversity Board
- State Medicinal Plants Board
  - Herbal Research and Development Institute
  - Center for Aromatic Plants
  - Bhesaj Development Unit (Bhesaj Vikas Ikai)
- Garhwal and Kumaon Mandal Vikas Ltd.

Herbal Sector in the state

- State Medicinal Plants Board was restructured as Nodal Agency for MAPs.
- Cultivation and Collection of MAPs
- Registration of MAP cultivators
- Transit pass issued for the produce
- Training to cultivators and collectors
- Subside for cultivation of prioritized medicinal plants
- Cluster cultivation of MAPs in the state
- A task force established in the state (2015) to conserve and promote cultivation of threatened and high value medicinal plants as *Delphinium denudatum, Picrorhiza kurrooa, Aconitum heterophyllum* etc.

Contd..

- Medicinal plants identified that are restricted / open for collection
- Marketing of collected MAPs is done through established Herbal Mandis.
- Concept of Conservation, Development and Harvesting (CDH), MPCA and sustainable harvesting of medicinal plants being enclosed within the Working Plan of forest department.

MPCAs IN UTTARAKHAND

Name of MPCA	District	Agro-climatic Zone	Forest Divisions	Altd. (m) approx	Remarks
Kandara	Uttarkashi	Alpine	Uttarkashi	3000-3600	Developed in UNDP-GEF Project 2011-14
Gangi	Tehri	Temperate	Tehri	2200-3000	
Jhuni	Bageshwar	Dry Temperate	Bageshwar	2500-3200	
Mandal	Chamoli	Moist Temperate	Kedarnath Wildlife Division	1700-2800	
Khuliya	Pithoragarh	Sub-Alpine	Pithoragarh	2700-3200	
Mohan	Almora	Sub-tropical	Almora	400-900	
Bastiya	Champawat	Sub-tropical	Champawat	600- 1000	
Mundali	Dehradun	Alpine	Chakrata	> 2000	Developed under Vanaspati Van Yojna, 2004
Kunain	-do-	-do-	-do-	-do-	
Devban	-do-	-do-	-do-	-do-	

Collection of MAPs in Uttarakhand

Year	Collection (Qtls)	Amount (Lakhs)
2010-11	15,897.72	1211.08
2011-12	18,023.154	1801.60
2012-13	29,287.10	2326.17
2013-14	19,823.25	180.83
2014-15	16,659.0	1642.69

**Source: UFDC, Dehradun*

Demand of high altitude medicinal plants

Medicinal Plant	Botanical name	Annual Demand (in Tons)
Kuth	*Saussurea costus*	250
Kutki	*Picrorhiza kurrooa*	70
Chiriyta	*Swertia chirayata*	27
Atis	*Aconitum heterophyllum*	10
Jadwar	*Delphinium denudatum*	6.5
Kapur kachri	*Hedychium spicatum*	13
Salampanja	*Dactylorhiza hatagirea*	5
Puskar mool	*Inula racemosa*	4
Tagar	*Valeriana wallichii*	3

**Source: Task Force on medicinal plants*

Species Restricted for collection

S/No	Botanical Name	S/No	Botanical Name	S/No	Botanical Name
1	*Dactylorhiza hatagirea*	13	*Berberis* spp.	25	*Gloriosa superba*
2	*Habenaria intermedia*	14	*Aconitum heterophyllum*	26	*Zanthoxylum armatum*
3	*Habenaria edgeworthii*	15	*Aconitum balfourii*	27	*Urginea indica*
4	*Fritillaria roylei*	16	*Picrorhiza kurrooa*	28	*Canscora decussate*
5	*Lilium polyphyllum*	17	*Dioscorea deltoidea*	29	*Rubia cordifolia*
6	*Malaxis muscifera*	18	*Desmodium gangeticum*	30	*Arnebia benthami*
7	*Melaxis cylindrostachya*	19	*Uraria picta*	31	*Taxus baccata*
8	*Eulophia dabai*	20	*Acorus calamus*	32	*Jurinea dolomiaea*
9	*Nardostachys jatamansi*	21	*Tinospora cordifolia*	33	*Valleriana wallichii*
10	*Gentiana kurroo*	22	*Polygonatum* spp.	34	*Angelica glauca*
11	*Paris polyphylla*	23	*Rheum* spp.	35	*Podophyllum hexandrum*
12	*Swertia chirayita*	24	*Rauvolfia serpentina*		

Species open for Sustainable collection

S/No	Botanical Name	S/No	Botanical Name	S/No	Botanical Name
1	*Bergenia ciliata*	13	*Adhatoda zeylanica*	25	*Plumbago zeylanica*
2	*Celastrus paniculatus*	14	*Pueraria tuberosa*	26	*Trichosanthes spp.*
3	*Murraya koenigii*	15	*Cissampelos pareira*	27	*Hedychium spicatum*
4	*Callicarpa macrophylla*	16	*Abrus precatorius*	28	*Didymocarpus aromaticus*
5	*Vitex negundo*	17	*Cassia fistula*	29	*Chondrus crispus*
6	*Paederia foetida*	18	*Cinnamomum tamala*	30	*Parmelia perlata*
7	*Terminalia chebula*	19	*Selinum tenuifolium*		
8	*Terminalia bellerica*	20	*Tanacetum dolichophyllum*		
9	*Emblica officinalis*	21	*Stephania glabra*		
10	*Asparagus racemosus*	22	*Tephrosia purpurea*		
11	*Helicteres isora*	23	*Mimosa pudica*		
12	*Aegle marmelos*	24	*Skimmia laureola*		

Species open for collection

S/No	Botanical Name	S/No	Botanical Name
1	*Phyllanthus urinaria*	13	*Datura metel*
2	*Azadirachta indica*	14	*Solanum nigrum*
3	*Sida cordifolia*	15	*Teramnus labialis*
4	*Abutilon indicum*	16	*Cymbopogon* spp.
5	*Phaseolus trilobus*	17	*Mentha arnensis*
6	*Fumaria indica*	18	*Nelumbium spiciosum*
7	*Boerhavia diffusa*	19	*Rosa damascena*
8	*Ricinus communis*	20	*Hibiscus rosa sinensis*
9	*Tribulus terristris*		
10	*Eclipta alba*		
11	*Achyranthes aspera*		
12	*Calatropis procera*		

CAMP workshop 2003/2010

Critically Endangered (CR)	Endangered (EN)
1. *Aconitum heterophyllum*	1. *Angelica glauca*
2. *Arnebia benthami*	2. *Arnebia euchroma*
3. *Dactylorhiza hatagirea*	3. *Ceropegia bulbosa*
4. *Gentiana kurroo*	4. *Datisca cannabina*
5. *Lilium polyphyllum*	5. *Dienia muscifera*
6. *Nardostachys grandiflora*	6. *Dioscorea deltoidea*
7. *Picrorhiza kurrooa*	7. *Ephedra gerardiana*
	8. *Fritillaria roylei*
	9. *Habenaria intermedia*
	10. *Juniperus polycarpos*
	11. *Jurinea dolomiaea*
	12. *Meconopis aculeate*
	13. *Paris polyphylla*
	14. *Podophyllum hexandrum*
	15. *Rheum emodi*
	16. *Saussurea obvallata*
	17. *Swertia chirayita*
	18. *Taxus wallichiana*

Contd..

Vulnerable (VU)	Near Threatened (NT)
1. *Embeliatsjeriam-cottam* 2. *Eremostachys superba* 3. *Ferula jaeskeana* 4. *Gloriosa superba* 5. *Heraoleum lanatum* 6. *Hypericum perforatum* 7. *Plaurospermum angelicoides* 8. *Polygonatum cirrhifolium* 9. *Polygonatum verticillatum* 10. *Rauvolfia serpentina* 11. *Rheum webbianum* 12. *Rhodiolaheter odonta* 13. *Roylea cinerea* 14. *Saussurea gossypiphora* 15. *Symplocos paniculata* 16. *Valeriana jatamansi* 17. *Zanthoxylum armatum* 18. *Allium stracheyi* 19.*Cinnamomum tamala* 20 *Didymocarpus pedicillata* 21. *Aconitum balfouri* 22. *Aconitum violaceum*	1. *Artemisia maritime* 2. *Bergenia stracheyi* 3. *Betula utilis* 4. *Hippophae rhamnoides* 5. *Hippophae salicifolia* 6. *Hyssopus officinalis* 7. *Litsea glutinosa* 8. *Physochlaenaprae alta* 9. *Rheum moorcroftianum* 10. *Rhododendron anthopogon* 11. *Rhododendron campanulatum* 12. *Rhododendron lepidotum*

Study:
To prepare state medicinal plant conservation and sustainable use strategy

Salient feature of the study

The main objectives of the strategy were:-

- To ensure conservation of medicinal plants resources
- To make available medicinal plants resources to all user groups
- To contribute to health security
- To enhance livelihood options
- To establish regulatory framework to support the above objectives
- Research, funding and administrative mechanisms

Recommendations

A. CONSERVATION:

- Data base on Medicinal plants/ Resource inventory
- Establishment of Conservation Areas like MPCA for in-situ conservation and formation of Management Groups for their management
- Workshop for CAMP exercise
- Documenting sacred groves
- Augmentation of priority medicinal species
- Strengthening of existing herbal gardens
- Sustainable harvest protocol development
- Measures to control illegal collection

Contd..

B. CULTIVATION

- Selection, breeding and fine tuning of Agro-technology
- Establishment of Medicinal plants processing zones and infrastructure in selected clusters
- Quality planting material for commercial cultivation
- Minimum support price for cultivated produce
- Research for development of high yielding variety

Contd..

C. Trade and Livelihood

- Strengthening of existing marketing mandies
- Promotion and branding of state specific herbal brand like “DevBhoomi Herbs”
- Market Information System, Websites, SMS alerts etc.
- Organising Herbal Fairs, exposure visits to stakeholders, etc
- Development of community owned enterprising / viable Public-Private-Community partnership
- Value chain assessment of selected medicinal plants

Contd..

D. Research

- Research on different aspects of medicinal plants like – product development, value addition, tissue culture protocols, bio-activity guided fractionation, bio-chemical and genetic variability, ethical bio-prospecting, etc.
- GI registration and Converting TK /indigenous species to knowledge products and revalidation of traditional knowledge and trans disciplinary research
- Identifying alternate to RET and high demand species

Contd..

E. Institutional mechanism

- Nodal agency (SMPB) strengthening
- MP Cell in related departments, etc.
- Capacity building and Human Resource development for sector
- Documentation of Traditional Knowledge
- Registration of Traditional Healers/Vaidhyas
- Promotion of Local Health Traditions
- Formation of BMCs / organising collectors & producers/ listing of stakeholders/ facilitation of in-situ conservation and buy back arrangements, etc.

Contd.

S. No..	Activity / Action Points	Implementing Agency	Time Frame	Budgetary Requirements (Rs. InLakhs)	Possible Source of Funding	Remarks
01	Centralised Data base on Medicinal plants/ Resource inventory of MAPs in State (consolidation of existing data, region wise survey with uniform methodology, status of priority species, report preparation, herbarium, etc.)	Forest Department (FD), Wildlife Institute of India (WII), Botanical Survey of India (BSI), Forest Research Institute (FRI)	Short Term (ST)	50.00	-NMPB under existing scheme -Externally aided Projects -State Government	-FD and WII have done good work and there is a need to fill the gap and compile the all existing information in one platform under uniform format. -FRI, BSI,CCRAS, NBPGR have also compiled information which can be used

Thanks

Conservation and cultivation of high altitude medicinal plants in cold desert region of the Western Himalayas

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Abstract

Efforts for conservation and development of agrotechniques for high altitude medicinal plants *viz*., *Picrorhiza kurrooa, Aconitum heterophyllum, Podophyllum hexandrum, Crocus sativus, Artemesia* spp*., Hippophae* spp*. Inula racemosa, Salvia sclarea, Dactylorhiza hatagirea, Saussurea costus, Trillium govanianum* and *Panax ginseng* have been made at Centre for High Altitude Biology, Tandi, Keylong (Lahaul & Spiti), H.P. by CSIR-Institute of Himalayan Bioresource Technology. Demonstration plots of these plants have been laid out at farmer's field in different locations and training on agro and processing technologies has been imparted.

Introduction

Since ages, the wider and steep foot hills of Himalayas are lavished with a variety of natural reserves which possess healing virtues for curing many physical and mental ailments. These indigenous reserves which constitute the 'plant biodiversity' of Himalaya are under threat and has been confirmed as 'Endangered' as per IUCN red list due to their unsustainable utilization and unscientific agricultural practices. According to World Health Organization about 80% of the world population of developing countries relies on medicinal plants. Because of the accelerated local, national and international interest in recent years the demand for medicinal plants has increased manifolds and pharmaceutical industry views plant wealth as a source of income. Some plant species are also utilized in the development of modern drugs. As a result plants are uprooted from their natural habitats because of market demand which increased pressure on the natural resources. The most serious proximate threats when extracting medicinal plants generally are: habitat loss, habitat degradation, and over harvesting. Conservation of medicinal plants in its biocultural perspective not only implies conservation of biodiversity but also places an equal emphasis on conservation of cultural diversity. Some of the medicinal plants which are under endangered category are listed in following Table.

Table: List of some important medicinal plants of high altitude region

S. No.	Botanical name	Common Name	Family	Status
1	*Aconitum balfourii*	Vatsanabha	Ranunculaceae	Critically Rare
2	*Aconitum heterophyllum*	Atish	Ranunculaceae	Critically Rare
3	*Angelica glauca*	Chaura	Apiaceae	Endangered
4	*Bergenia ligulata*	Paashan bhed	Saxifragaceae	Vulnerable
5	*Berberis aristata*	Kashmal	Berberidaceae	Endangered
6	*Dactylorhiza hatagirea*	Salam Panja	Orchidaceae	Endangered
7	*Nardostachys jatamansi*	Jatamansi	Caprifoliaceae	Endangered
8	*Polygonatum verticillatum*	Maha maida	Asparagaceae	Endangered
9	*Podophyllum hexandrum*	Ban kakri	Berberidaceae	Critically Rare
10	*Rheum australe*	Himalayan Rhubarb	Polygonaceae	Vulnerable
11	*Saussurea gossypiphora*	Kasturi kamal	Asteraceae	Endangered
12	*Rheum emodi*	Himalayan rhubarb	Polygonaceae	Endangered
13	*Hippophae rhamnoides*	Seabuckthorn	Elaeagnaceae	Vulnerable
14	*Ferula jaeschkeana*	Kalyash	Apiaceae	Vulnerable
15	*Ephedra gerardiana*	Somlata	Ephedraceae	Endangered
16	*Rhododendron anthopogon*	Atarasu	Ericaceae	Vulnerable

The cold desert area in India comes under the Trans Himalayan zone, lying in the shadow of the main Himalayan range, is usually described as high attitude cold desert. Cold deserts refer to an area where the climate has extreme conditions of high and low temperature with excess of dryness. It covers 2% of total land surface area. The Cold Desert of India is situated in the regions of Himalayas and stretches from Ladakh (Jammu and Kashmir) to Kinnaur (Himachal Pradesh). Ladakh region comprises of the Leh and Kargil districts in J&K, Lahaul and Spiti and a part of Kinnaur District in the state of H.P. Total area of cold desert in India is approximately 1,03.115 sq km, of which 87,780 sq km is in J&K, 13,835 in HP, and 1,500 sq km in Uttarakhand

state. Various surveys indicate that at least 90% of medicinal plant species are extracted from the wild and that 69% of the material is collected through destructive harvesting, which suggests that medicinal plants are significantly threatened (Dhar et al., 2000). With increasing demand and renewed global interest in traditional ethno pharmacy, coupled with the increasing preference for natural substances in the healthcare system, the natural stock of medicinal plants of Himachal Pradesh is under tremendous pressure. CSIR- Institute of Himalayan Bioresource Technology, Palampur (HP), India has made concentrated efforts for conservation and development of agrotechniques for high altitude medicinal plants *viz*., *Picrorhiza kurrooa, Aconitum heterophyllum, Podophyllum hexandrum, Crocus sativus, Artemesia spp., Hippophae spp., Inula racemosa, Salvia sclarea, Dactylorhiza hatagirea, Saussurea costus, Trillium govanianum* and *Panax ginseng* at its Centre for High Altitude Biology, Tandi, Keylong, district Lahaul & Spiti of Himachal Pradesh. Demonstration plots of these plants has been laid out at farmer's field in different locations and training on agro and processing technologies has been imparted to the tribal people. Cultivation of these plants in native environment will play important role in strengthening biodiversity and generation of income for tribal farmers. Conservation activities and various cultivation practices done on these plants under cold desert region are discussed hereunder:

1. *Picrorhiza kurrooa* commonly known as kutki is a perennial herb, found in the Himalayan region at an altitude of 3,000-5,000 meters asl. It has a long, creeping rootstock and grows in rock crevices and moist, sandy soil. The flowers are white or pale purple and borne on a tall spike. In Indian system of medicine it is known as kutki which is an important constituent in about 2000 drugs items derived from vegetables. The active constituents are obtained from the root and rhizomes. Kutkin is its active principal and is comprised of kutkoside and the iridoid glycoside picrosides I, II, and III. Other constituents are apocynin, drosin, and nine cucurbitacin glycosides. It has been used to treat various disorders of the liver and respiratory tract, to reduce fevers, to treat dyspepsia, chronic diarrhea, scorpion sting, asthma and jaundice (Bhandari *et al.*, 2008), various disorders of gastrointestinal and urinary system, leukoderma, snake bite, inflammatory (Verma *et al*., 2009), anti-inflammatory (Carmen *et al*., 1994), anti-allergic and anti anaphylactic activities, anti-hepatitis-B surface antigen activity.

The increasing market demand, over exploitation and consequent degradation of natural habitat of the plant are reported to be a major threat to this species in wild. To conserve biodiversity and increase farmer's income through agricultural diversification, developing cultivation technologies, setting up nurseries to propagate and supply of plant material to farmers, various training programs related to cultivation technologies has been carried out. CSIR-IHBT has collected various accessions of picrorhiza from different locations of HP, Uttarakhand and J&K. A tissue culture protocol has been developed for the *ex-situ* conservation for *P. kurrooa*. Vegetative propagation is more appropriate and successful method for propagation through rhizomes and it is considered faster and better than the seed cultivation. Stolon segments of 3-4 cm long can be used for the propagation (Fig. 1).

2. *Aconitum heterophyllum* commonly known as Atis is a small plant that is commonly found in western Himalayas at an altitude ranging from 2000 to 4000 m above mean sea level. The plant mainly grows in moist soil and clay soil and requires shade during the cultivation. Its chemical constituents includes atidine, hetisine, heteratisine, diterpene alkaloids, heterophylline, heterophyllisine, hetidine, atidine, Atisenol, F-dishydrçatisine, hetidine, hetisinone, heteratisine, hetisine, benzylleteratisine, beta -sitosterol, carotene and 3-isoatisine from rhizomes. The roots of aconitum mainly contain non-crystalline, non-poisonous alkaloid 'atisine'.

It is antipyretic, antiperiodic, aphrodisiac, astringent tonic used in diarrhoea, indigestion, cough troubles during dentition in children. *A. heterophyllum* is one of the medicinal plants of higher altitude which are under the threat of extinction due to over exploitation. Seed germination is the major problem similar to the other plants of higher altitude. CSIR-IHBT has overcame the problem of poor seed germination by treating the seeds with hot water and GA3. The plant has now been successfully domesticated in green house and open conditions. Sandy loam and acidic soil is best for seed germination, survival, better growth and yield. In general, cultivation up to 2200 m elevation having sandy textured soil with rich organic matter is recommended for cultivation. Per hectare production from mature strands in natural pockets is estimated as 800-900 kg. Market rate of dried roots varies from 3000-4000/kg. Its annual market demand is 40 t/annum.

Fig. 1. Generation of quality planting material of *Picrorhiza kurrooa* at CSIR-IHBT Palampur

3. *Podophyllum hexandrum* (*Sinopodophyllum hexandrum*) is distributed in the inner ranges of Himalayan an altitude of 3000-4200 m and commonly known as Himalayan Mayapple. *Podophyllum* is a herbaceous perennial plant belongs to the Berberidaceae family. The plant grows well as undergrowth in fir forests, on well-drained sandy loam soil rich in organic matter. This species can be propagated from seeds, seedling and also from sections of rhizomes. The rhizome and the root of the plant contain a resin, known generally podophyllin or podophyllin resin, which can be processed to extract podophyllin (podophyllotoxin), a neurotoxin.

P. hexandrum is reported to contain a number of compounds with significant pharmacological properties, e.g. epipodophyllotoxin, podophyllotoxone, aryltetrahydronaphthalene lignans, flavonoids such as quercetin, quercetin-3-glycoside, podophyllotoxinglycoside, kaempferol and kaempferol-3-glucoside. The rhizomes and roots of the plant contain anti tumor lignans such as podophyllotoxin, 4'-demethyl podophyllotoxin and podophyllotoxin 4-O-glucoside (Tyler, 1990; Broomhead 1988). It has been extensively used for the treatment of a number of ailments like *Condyloma acuminata*, *Taenia capitis*, *Monocytoid leukemia*, Hodgkin's disease, non-Hodgkin's Lymphoma, cancer of brain, lung, bladder and venereal warts (Gowdey *et al.,* 1995; Cobb, 1990; Beutner, 1990). The rhizomes and roots are considered hepatic, stimulant, cholagogue, purgative, alternative and bitter tonic. There is difficulty in seed germination due to low viability of seed.

4. *Panax ginseng* has been known for its medicinal values for thousands of years in China, Korea and Japan. It is found throughout East Asia and Russia. Ginseng grows in a climate with 100 to 125 cm of annual precipitation and an average temperature of 10°C. *P. ginseng* is a shade-loving, deciduous perennial with five-fingered leaves, tiny white flowers, red berries, and a yellowish-brown root. The root of *Panax ginseng* is a thick structure and utilized medicinally, although active compounds are present in all other parts of the plant. Ginsenosides or ginseng saponins are the principle active ingredients in ginseng and more than thirty different ginsenosides have been identified (Liu *et al*., 1992; Back *et al*., 1996). Many active compounds can be found in all parts of the plant, including amino acids, alkaloids, phenols, proteins, polypeptides and vitamins B1 and B2. It also stimulates and relaxes the nervous system, encourages the secretion of hormones, improves stamina, lowers blood sugar and cholesterol levels and increases resistance to disease. CSIR-IHBT has domesticated this plant in Lahaul since 2008 and its demonstration plots have been laid at different places in Pattan valley of Lahaul & Spiti districts of HP.

5. *Saussurea costus* commonly known as Kuth is used as an aromatic, stimulant, as a medicine for cough, asthma, fever, dyspepsia and skin diseases. It is also used in stimulating mixtures for cholera and prescribed as a stomachic, tonic for ulcers and in rheumatism. It is also used as a depurative and aphrodisiac. The species is endemic to a geographically limited part of the Himalayas, and grows on moist slopes at altitudes of 2600-

4000 m. It is a robust perennial herb of the western Himalayas, distributed in Pakistan and India. Kuth is a robust erect, perennial plant with large leaves. Roots are stout up to 60 cm long. Root is used medicinally. Sandy textured loam soil, rich in moisture and organic carbon is best for germination as well as better survival of seedlings and productivity. The plant grows in temperate and sub-alpine region. The seeds are sown in April or May in nursery. When the seedlings are 15 cm long, it is transplanted in field. Well drained loam soil is best for the cultivation of this crop. Its cultivation should be avoided on sloppy and stoney field. Usually in 2-3 years well grown mature root tubers are developed. However, yield is obtained from 3 years old crop. The crop is ready for harvest at the end of the third year in September-October. Before harvesting the crop, irrigate the field thoroughly for ease in uprooting the roots with pick axes. After harvesting, the roots are cut in 7-10 cm pieces, dried for 2-3 weeks and cleaned thoroughly for storing and marketing. Root is harvested in early September or October or early spring. The roots are cleaned with water and dried for processing. After 2-3 years of planting about 200-300 kg of dry tuberous roots per hectare can be obtained. The market rate is Rs.150-160 per kg. The oil extracted from the roots is known as Costus Oil, which is used in high-grade perfumes and in the preparation of hair oil. Costus oil is also said to be effective in the treatment of leprosy. In the Himalayan states of India, the roots are used as insecticide to protect shawls and woollen fabrics, and as incense. In the Lahaul and Spiti districts of Himachal Pradesh, dried leaves of *S. costus* are smoked as tobacco and the upper parts of its plants are used as fuel and fodder.

6. *Inula racemosa* commonli known as Puskarmool is an aromatic tonic febrifuge and expectorant with anti inflammatory, carminative, diuretic, and antiseptic properties. The plant is used in chronic bronchitis and rheumatism. Its dried rhizome and roots are used to cure loss of appetite and stomach ache. It is cultivated in Lahaul valley. The crop is harvested one and half year after plantation and yield up to 70-80 quintals of dried roots/ha. The cost of roots varies from Rs 130-150/kg. Its annual demand is about 3 t/annum.

7. *Salvia sclarea* commonly known as clary sage is an important aromatic herb. Plant is a stout biennial or perennial herb and commonly grows in temperate areas of Himalayas with no rain or scanty rain. Plant has large hairy leaves and small blue, white or purple flowers (Hayet *et al*., 2007). The genus salvia consists of many species, which have wide applications in folk medicine and also many commercial uses, especially in the production of essential oils and flavoring agents. The essential oils or extracts of the aerial part of the *S. sclarea* plant have a broad spectrum of effects: analgesic, anti-inflammatory, antioxidant, antifungal and antibacterial properties. Apart from the various medicinal uses, essential oils of clary sage are widely applied in the food and cosmetic industries. The most important components in the oils are alcohols (linalool, terpineol) and esters (linalyl acetate, α-terpinyl acetate, geranyl acetate). Its oil is widely used in cosmetics, soaps and food preparations. Besides, the oil has medicinal properties and is used in treating stress, tension, depression, insomnia, indigestion, menstruation, sore throat and hysteriac. The cost of essential oil varied from Rs. 10000 to Rs 12000/L. The sclareol and ambrox derived from this plant are also sold at premium prices in the international market.

Aconitum heterophyllum

Podophyllum hexandrum

Inula racemosa

Fig. 2 Cultivation at High Altitudes

Conclusions

It becomes obligatory to initiate steps for cultivation of these species, design low cost agrotechnologies which would maintain the desired compound in proper quantity. By doing so, local people will get an option of income generation to improve their livelihood and an opportunity for self-employment. This will allow the plant to grow naturally without any disturbances and ultimately fulfill the conservation goal through cultivation.

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Rapid survey and assessment of high altitude medicinal plants

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Rapid survey and assessment of high altitude medicinal plants: Few lessons and way forward

G. S. Rawat

Contents

- Background ~ High altitude medicinal plants
- Approaches to resource assessment
- Case studies
- Way forward

Background

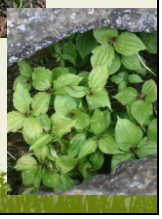
High Altitude Medicinal Plants

Ayurvedic, Yunani, Tibetan and Local (*Amchi, Vaidyas, Akhons*)

Over exploitation of high value species

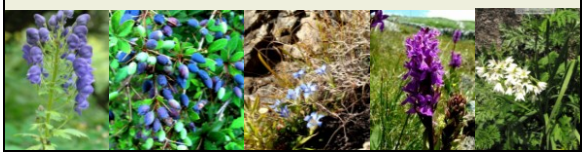
Ground orchids

Lilies



Need for surveys

- To quantify the availability of high value medicinal plants in a given area
- To generate a spatial database on the distribution and abundance of medicinal plants for the future monitoring and conservation planning
- To evolve strategies for sustainable harvest of medicinal and aromatic plants.



Approaches to Resource Assessment

i. Social Science Techniques:
- Qualitative (e.g., PRA; RRA; PRM)

ii. Economic methods
- Market Information (Econometrics)

iii. Ecological Methods
- Sampling (Qualitative & Quantitative techniques)

Key considerations for ecological methods

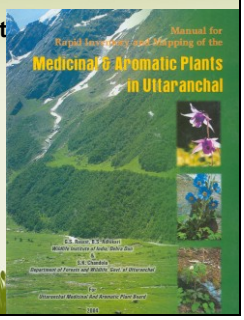
- Objectivity in sampling design
  (Systematic, Random, Adaptive Cluster Sampling
- Size and number of samples
- Independence of observations
- Abundance estimates ± C.I./ S.E.
- Resource Richness / Availability maps

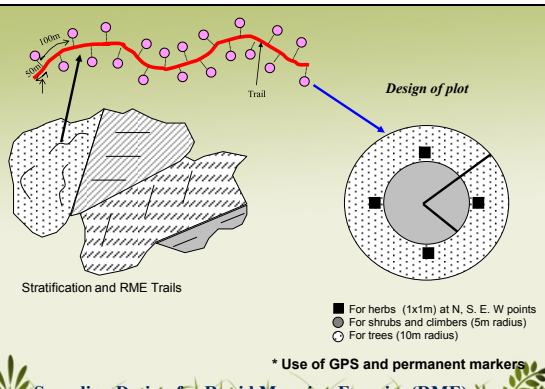
Case Studies

- Rapid mapping of high value medicinal plants in Forest Divisions of Garhwal
- Population surveys of MAPs in Western Ladakh
- Survey of Chinese caterpillar mushroom in Askot WS

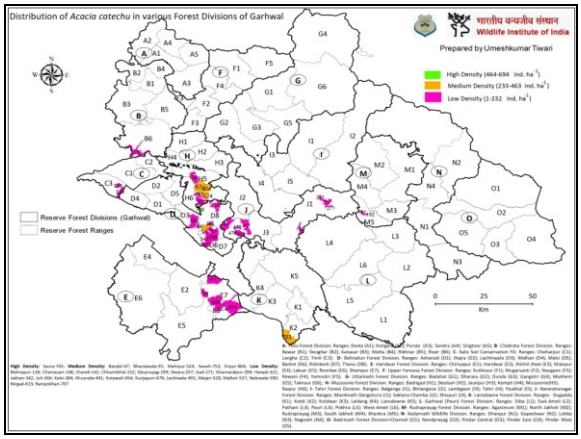
1. Rapid survey of MAPs in Garhwal Himalaya

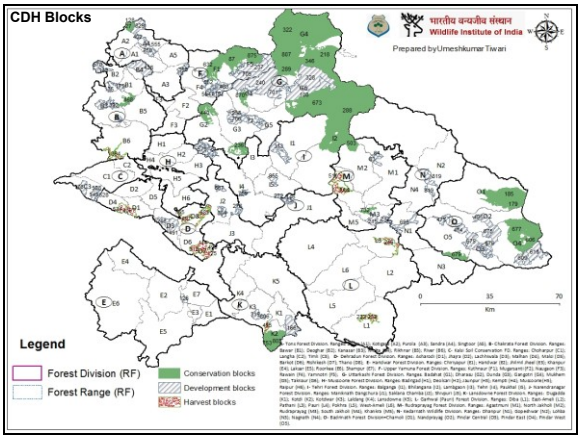
Conservation, Development and Harvest (CDH) Plans

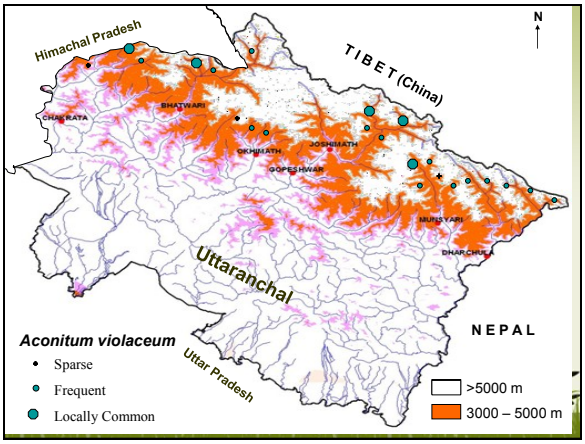


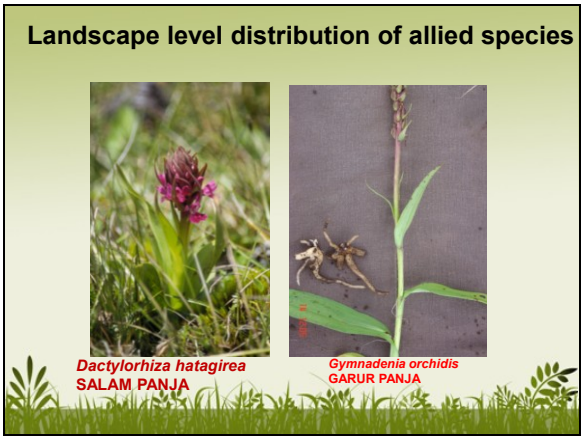


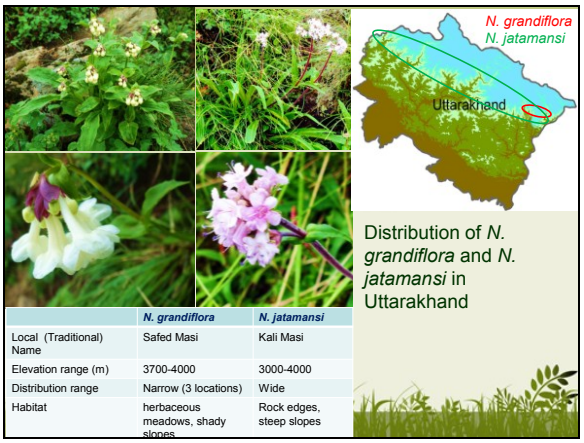
Sampling Design for Rapid Mapping Exercise (RME)





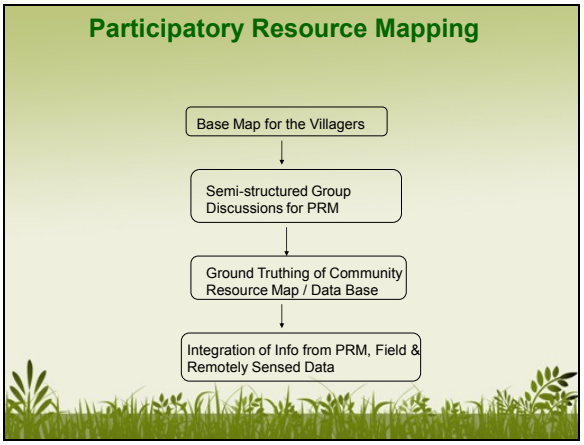






	N. grandiflora	*N. jatamansi*
Local (Traditional) Name	Safed Masi	Kali Masi
Elevation range (m)	3700-4000	3000-4000
Distribution range	Narrow (3 locations)	Wide
Habitat	herbaceous meadows, shady slopes	Rock edges, steep slopes

2. Participatory resource mapping of medicinal plants in Western Ladakh



Stratified Random Sampling: 8 Land Forms

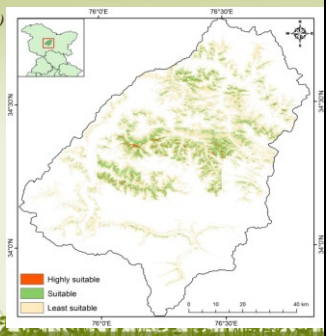
Landforms / Habitat Types	Species
Marsh meadows	*Inula rhizocephala; Dactyloriza hatagirea;*
Broken slopes	*Delphinium cashmerianum; Meconopsis aculeata; Rhodiola heterodonta; Saussurea bracteata*
Rocks and Cliff	*Bergenia stracheyi; Ephedra gerardiana; Juniperus semi-globose; Lloydia serotina*
Fallow fields	*Aconitum heterophyllum; A. violaceum; Lancea tibetica; Physoclaina praealta; Podophyllum hexandrum*
Stream banks	*Hippophae rhamnoides*
Scree slopes	*Acantholimon lycopodioides; Rheum spiciforme*
Stable slopes / Herbaceous meadows	*Arnebia euchroma; Arnebia guttata; Artemisia maritima; Cremanthodium ellisii; Rhodiola imbricata*

- *Acantholimon lycopodioides* (*Longzey*)

Habitat

Elevation 3400-4500m.

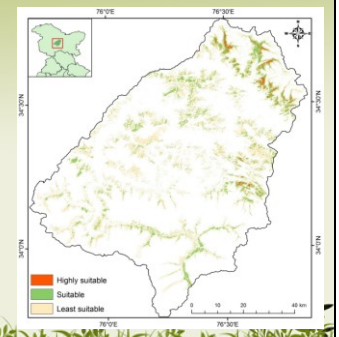
Suitability class	Area (ha)
Highly suitable	3156.30
Moderately suitable	39867.39
Least suitable	130187.70



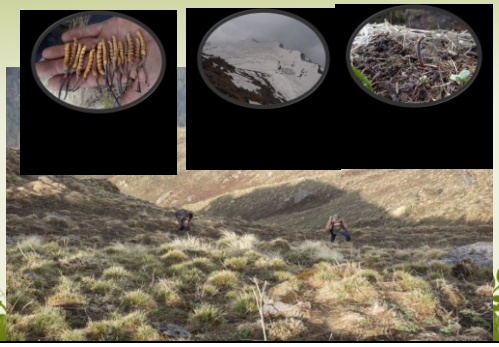
Results-

- Suitable habitat for *Aconitum rotundifolium*, vern. Boga

Suitability class	Area (ha)
highly suitable	3228.57
Moderately suitable	30158.91
Least suitable	93712.95

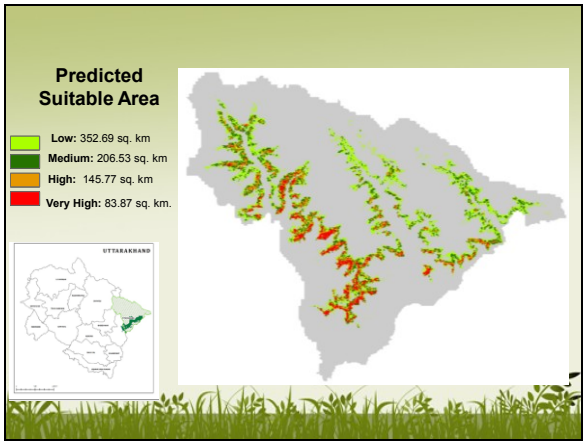


3. Distribution Modelling of *Ophiocordyceps sinensis* in Askot Landscape



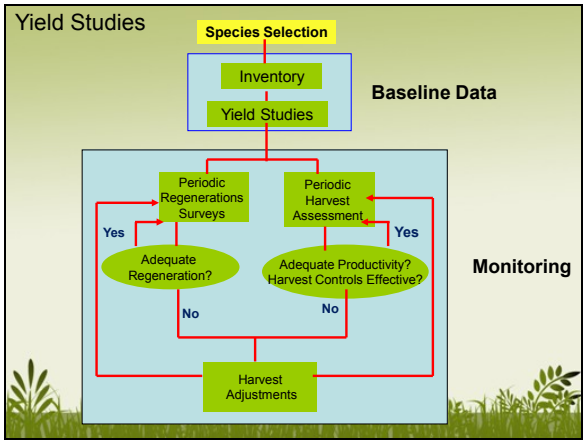
Modelling Approach:

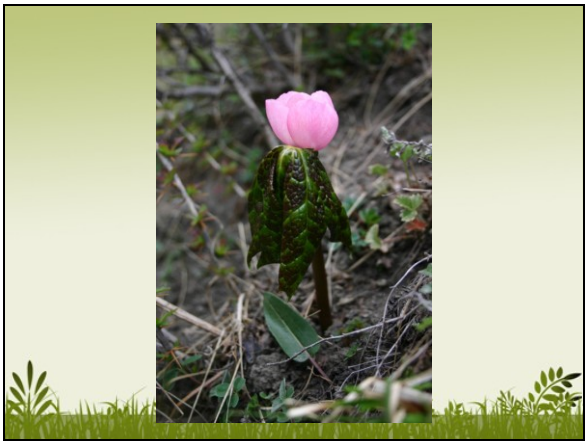
- MaxENT Algorithm
- Continuous co-variates: Elevation, Aspect, Slope and MODIS Q1 (NDVI)
- Calibration and Evaluation data were used independently.
- QGIS is used for layer generation and analysis.
- Based on similar MaXent settings, the final model is calibrated with all occurrence points.



Way Forward

1. Rapid survey and mapping gives information on +ce / -ce and good for crude estimate of species availability
2. Repeat observations and in-depth studies on populations of high value / Globally Significant MPs.
3. Basic population assessments coupled with yield studies would be must for commercially important MAPs
4. Use MPCAs for further monitoring and experimental trials on growth and yield





High altitude medicinal plants of Govind Pashu Vihar Wildlife Sanctuary, Western Himalayas

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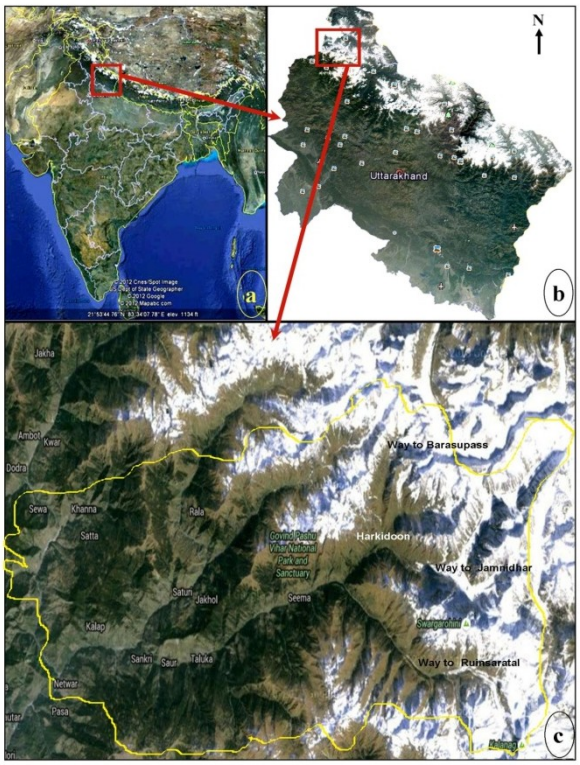
Botanical Survey of India
Northern Regional Centre, Dehradun, Uttarakhand

The Govind Pashu Vihar National Park and Wildlife Sanctuary situated in the higher reaches of Garhwal Himalayas, the sanctuary is bound in the north by Himachal Pradesh, to the east by a chain of mountain peaks, and to the south by the Tons/Yamuna watershed. It spreads over an area of 957.96 sq. km. and the altitude varies from 1300 to 6323 m. The Govind Pashu Vihar came into existence as a wildlife sanctuary in the year 1955 and is a part of Upper Tons Valley. The core zone of the sanctuary was declared as a National Park covering an area of 472.08 sq. km in 1991. The sanctuary was named after the Bharat Ratna Govind Ballab Pant and it is located between 31º 17' to 35º 55' N latitude and 77º 47' to 78º 37' E longitude in Purola tehsil of Uttarakashi district of Uttarakhand, which is situated in the Western Himalayas. Western Himalayas and together with Eastern Himalaya which is one of the largest centre of endemism in India is among the 34 biodiversity hot spots of the world. (Synge, 2005). According to Myers *et al.* (2000) biodiversity 'hotspots' are the regions containing a high proportion of global biodiversity in a small area. Also Biodiversity hotspots can be defined as areas having exceptional concentration of endemic taxa. The sanctuary is situated in the Uttarakashi district of Uttarakhand (Map-1).



Map.1 (**a-c**): **a**. India map showing location of Uttarakhand (inset); **b.** Location of Govind Pashu Vihar Wildlife Sanctuary (inset) in Uttarakhand; **c.** Collection sites in Govind Pashu Vihar Wildlife Sanctuary, Uttarkashi District

The Sanctuary has been divided into three ranges namely Rupin, Supin and Sankri, which headed by Range Officer. Each range is in turn divided into two sections viz., Himri, Parvat/Satta, Naitwar, Jakhol, Sankri, Taluka respectively and each section further divided into five beats to control illicit activity including felling, poaching, etc. and to complete developmental target. The inhabitants of the sanctuary are Rawain, Jaunsar and Gujar. The present explored area shows diversity of vegetation and it has been classified broadly as follows: 1. *Sub-tropical Pine forests,* 2. *Himalayan moist temperate forest*s, 3. *Himalayan dry-temperate forests*, 4. *Sub-alpine forests*, 5. *Moist alpine scrubs* (Champion and Seth, 1968).

Earlier botanical explorations to this part and adjoining areas of Western Himalaya have been carried out partially by various workers **(**Hooker and Thomson, 1855; Gibson, 1954, Burkill, 1965; Naithani 1984, 1985; Rana *et al*., 2003; Uniyal *et al*., 2007; Pusalkar and Singh, 2012). Further, Hooker and his collaborators have dealt with many species of Western Himalaya in *The Flora of British India* (1872-1897) and other important unpublished works include Badoni's (1989) *Herbaceous Flora of Uttarkashi District,* Bamola's (1993) *Lignosae Flora of Uttarkashi District* and Kandwal's (2009) *Grass Flora of Uttarakhand*.

At present, there are 18,159 angiosperms found in India, out of these nearly 5,725 species are said to be endemic (Nayar, 1996). The Western Himalaya is one of the three major geomorphological divisions considered as mega centres of endemic plants. Endemic species of Uttarakhand recorded from the present study area are *Cyananthus integer* Wall. ex Benth., *Impatiens badrinathii* Pusalkar & D.K. Singh, *I. leggei* Pusalkar & D.K. Singh, *Schulzia garhwalica* (H. Wolff) P.K. Mukh. & Constance. Further, some endemic species of Western Himalaya in Govind Pashu Vihar Wildlife Sanctuary are *Acer caesium, Aconitum heterophyllum, Aconitum violaceum*, *Ajuga brachystemon, Dracocephalum wallichii, Phlomis bracteosa, Saxifraga asarifolia, Scrophularia polyantha***,** *Tordyliopsis brunonis* and *Vicia bakeri.*

According to Walter and Gillett (1998), over 60,000 species have been evaluated for conservation status as per the internationally accepted criteria, of which 34,000 are classified as globally threatened with extinction. The Botanical Survey of India has published Red Data Books (Nayar and Sastry, 1987, 1988, 1990) which contain

information on 622 threatened plants, of these, nearly 30 species from the Garhwal Himalaya listed in various threatened categories, most of them are from high altitude alpine regions. The state of Uttarakhand harbours *c* 161 species of flowering plants under various threatened categories based on IUCN guidelines. Rawat *et al*., (2001) have listed 45 species which need special attention for conservation, and the species mentioned in the list are mostly from high altitudes. Further, Rao *et* al. (2003) have reported 1,255 species of vascular plants are under various threaten categories in India. Of the total, 18,159 species of angiospermic flora more than 1500 species (12%) have already been come under the various categories of threatened plants (Rao, 1994).

In the year 2000, the 51st meeting of IUCN Council Species Survival Commission was held in Gland, Switzerland, which has come out with an improved version of Red list categories and criteria version 3.1 (IUCN, 2001). According to the criteria for critically endangered, endangered and vulnerable taxa are classified mainly basing on reduction in population size, extent of occurrence and area of occupancy. Information on high altitude threatened medicinal plants of the Govind Pashu Vihar Wildlife Sanctuary, comprising 39 species of Angiosperms given in Table-1 (Manikandan and Srivastava, 2015a, b), of these 10 species are critically endangered (26%), 13 species are endangered (33%), 9 species are vulnerable (23%) and 7 species are Least Concern (18%).

Table 1. List of Threatened Plants from Govind Pashu Vihar Wildlife Sanctuary, Western Himalaya

S. No.	Name of the species	Family	Local Names	Parts used	Status
1.	*Acer caesium* Wall. ex Brandis	Aceraceae	Kainjal, Marik	Whole plant	VU
2.	*Aconitum falconeri* Holmes ex Stapf.	Ranunculaceae	Meetha, Bis Bikh, Telia	Tuber	LC
3.	*Aconitum heterophyllum* Wall. *ex* Royle	Ranunculaceae	Hatthis	Tuber	CR
4.	*Aconitum violaceum* Jacqeum. ex Stapf	Ranunculaceae	Methu, Tilla Dudhia,	Tuber	VU
5.	*Acorus calamus* L.	Araceae	Baji, Birch	Rhizome	CR
6.	*Allium stracheyi* Baker	Alliaceae	Seemori phul, Jambu	Whole plant	VU
7.	*Angelica glauca* Edgew	Apiaceae	Chora	Flower, Root	EN
8.	*Berberis aristata* DC.	Berberidaceae	Chothir,Kasmoi, Kingora	Root Stem	EN
9.	*Berberis pseudoumbellata* Parker	Berberidaceae	-	Bark, Fruit	LC
10.	*Carduus edelbergii* Rech.*f*.	Asteraceae	Kandara	Whole plant	VU
11.	*Cyananthus integer* Wall. ex Benth.	Campanulaceae	Bhandai	Whole plant	LC
12.	*Cypripedium cordigerum* D. Don	Orchidaceae	-	Flower	EN
13.	*Dactylorhiza hatagirea* (D. Don) Soo	Orchidaceae	Punja Hattahaddi	Tuber	CR
14.	*Delphinium denudatum* Wall. ex Hook.*f*. & Thomson	Ranunculaceae	-	Tender shoot	CR
15.	*Dioscorea deltoidea* Wall. ex Kunth	Dioscoreaceae	Gethi, Oakanchaw	Tuber	CR
16.	*Fritillaria roylei* Hook.	Liliaceae	Kakoli, Sheethkar	Bulb	EN
17.	*Goodyera fusca* (Lindl.) Hook.*f*.	Orchidaceae	-	Flower	EN
18.	*Habenaria pectinata* D. Don	Orchidaceae	-	Leaf, Tuber	LC
19.	*Hedychium spicatum* Buch.-Ham. ex Sm.	Zingiberaceae	Kapur-kachri	Rhizome	LC
20.	*Holboellia latifolia* Wall.	Lardizabalaceae	Gomphal	Fruit	VU
21.	*Houttuynia cordata* Thunb.	Saururaceae	-	Whole plant	EN
22.	*Jurinella macrocephala* (Royle) Aswal & Goel	Asteraceae	Dhoop, Guggal	Root Twig	EN
23.	*Malaxis muscifera* (Lindl.) Kuntze	Orchidaceae	Rsabhak	Pseudo-bulb	EN
24.	*Meconopsis aculeata* Royle	Papaveraceae	Kaliharu, Thesu	Flower	CR
25.	*Microstegium falconeri* (Hook.*f*.) Clayton	Poaceae	-	Whole plant	LC
26.	*Morus serrata* Roxb.	Moraceae	-	Fruit, Root	EN
27.	*Nardostachys jatamansi* (D. Don) DC.	Valerianaceae	Balchhar, Jatamansi	Whole plant	CR
28.	*Paeonia emodi* Wall. ex Royle	Paeoniaceae	Chandra	Leaf	CR

29.	*Paris polyphylla* Sm.	Trilliaceae	Satwa	Root	CR
30.	*Parnassia nubicola* Wall. ex Royle	Parnassiaceae	Phutkya	Whole plant	VU
31.	*Picrorhiza kurrooa* Royle *ex* Benth.	Scrophulariaceae	Kutahi, Kowdai, Kutki	Rhizome	EN
32.	*Podophyllum hexandrum* Royle	Podophyllaceae	Fungli kakkidi	Whole plant	**CR**
33.	*Polygonatum verticillatum* (L.) All.	Convallariaceae	Sakkakul	Rhizome	EN
34.	*Rhododendron hypenanthum* Balf.*f*.	Ericaeae	Altus, Althas, Kodya	Leaf	VU
35.	*Sauromatum venosum* (Ait.) Schott	Araceae	Bhasma-kand	Whole plant	VU
36.	*Saussurea obvallata* (DC.) Edgew.	Asteraceae	Brahma-kamal	Flower	EN
37.	*Schisandra grandiflora* (Wall.) Hook.*f*. & Thomson	Schisandraceae	-	Fruit	LC
38.	*Skimmia anquetilia* Taylor & Air Shaw	Rutaceae	Kathurchar, Kedar pathri	Leaf	EN
39.	*Thalictrum foliolosum* DC.	Ranunculaceae	Pilijari, Pinjari	Whole plant	VU

Note: EN- Endangered; CR- Critically Endangered, VU- Vulnerable, LC- Least Concern

Medicinal plants: The present study area has some of the widely used medicinal plants which are *Achyranthes aspera*, *Aconitum* spp., *Acorus calamus*, *Aesculus indica, Adiantum venustum, Angelica glauca, Bergenia ciliata, Berberis lyceum, Cedrus deodara, Celtis australis, Centella asiatica, Dactylorhiza hatagirea, Delphinium denudatum, Girardinia diversifolia, Grewia optiva, Hedychium spicatum, Justicia adhatoda, Verbascum thapsus*, *Origanum vulgare, Paeonia emodi, Paris polyphylla, Phyllanthus emblica, Picrorhiza kurrooa***,** *Prinsepia utilis, Prunella vulgaris, Punica granatum, Quercus leucotrichophora, Ricinus communis, Rubia manjiith, Rubus niveus, Siegesbeckia orientalis***,** *Sinopodophyllum hexandrum, Solanum nigrum***,** *Sonchus orixensis, Swertia alata, Taraxacum officinale, Taxus wallichiana, Thalictrum foliolosum, Urtica dioica, Viola canescens* and *Zanthoxylum armatum*.

- Cultivation of wild, threatened plants including medicinal and economically important plants in the high altitude region is the most effective way to sustain conservation.
- Species which are suggested as vulnerable or endangered and being exploited for their medicinal potential should be protected and multiplied under both *in-situ* and *ex-situ* conservation.
- Create awareness and to educate the local inhabitants about the utilitarian aspects of floristic wealth and also about the threatened plants including medicinal and other economically useful plants of this protected area.

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Micro propagation of threatened medicinal plants of North-West Himalaya *viz. Lilium polyphyllum, Pittosporum eriocarpum* and *Eremostachys superba*

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Abstract

North-West Himalaya is a centre of biodiversity hot spot and harboring more than 800 high value medicinal plants. The increasing pharmaceutical demands and unscrupulous use of this natural wealth from the region is posing a serious threat on their existence in the wild. The threatened natural status of the North-West Himalayan medicinal plants has created an interest and the present investigation is designed to develop the micropropagation protocol for the three threatened and endemic species of the North-West Himalaya *viz. Lilium polyphyllum*, *Pittosporum eriocarpum* and *Eremostachys superba*. Indirect organogenesis through callus culture has been induced in *L. polyphyllum* and *E. superb* while direct organogenesis was induced in shoot tip explants of *P. eriocarpum*. MS medium supplemented with 2,4-D and BAP was found most suitable hormonal combination for the callus induction in *L. polyphyllum* and *E. superba*. In vitro regenerated callus and shoot tip explants shown better shooting response in MS medium fortified with BAP and NAA. Shoots regenerated in vitro gave best rooting in half and quarter-strength MS medium supplemented with IBA. All the plants were successfully acclimatized to the open environment and also planted to the natural sites in the wild.

Introduction

The Western Himalaya is a reservoir of umpteen numbers of vital natural resources, of which vegetational aspect is predominant. Its unique physiography and micrclimatic condition support the luxuriant and varied vegetation, most of which is important for the well being of mankind particularly in nutritional, aesthetic and medicinal view point. Medicinal virtues of the western Himalayan plants are well known from the early times of the great epics of Ramayana and Mahabharata. The Indian Himalayan Region (IHR) is the storehouse of numerous herbs which are exploited not only for the pharmaceutical industries in India but outside as well. In fact, a large percentage of crude drugs in the Indian market and 50% species of the medicinal plants traditionally used in India (*ca.* 1600 species) come from this Himalayan part (Uniyal *et al.,* 2002). In recent years there has been resurgence in the demand of herbal products and plant based drugs across the world resulting in the heavy exploitation of medicinal plants. Habitat degradation, unsustainable harvesting and over exploitation to meet the demands of illegal trade in medicinal plants have led to the extinction of more than 150 plant species in the wild (Singh and Rawat, 2011). More than 90% of plant species used in the herbal industries is extracted from the wild and sub-alpine and alpine regions of the Himalaya are working as a feeder of the medicinal plants (Singh and Dey 2005).

Indian Himalayan Region (IHR) is a very fragile ecosystem and facing extremes of the environment such as temperature, light intensity and UV-radiations. The situation is further aggravated by the increasing anthropogenic pressure (overexploitation of natural resources, destruction of habitat) in the region coupled with climate change and invasion by alien species.

In the view of the overexploitation of the medicinal plants from the wild, tissue culture technique play an important alternative for the ex-situ conservation of these valuable medicinal resources and to meet the increasing pharmaceutical demands of these vital resources. In the present investigation attempts has been made to standardize the tissue culture protocol for these three viz. *Lilium polyphyllum, Pittosporum eriocarpum* and *Eremostachys superba* threatened and endemic North-West Himalayan species.

***Lilium polyphyllum* D. Don ex Royle:** It is a bulbous perennial herb (Fig. 1a) of Liliaceae family and commonly known as 'White lily' and Ksheerkakoli. IUCN has categorized the species as critically endangered medicinal herb and included it under the Red Listed species (Ved et al. 2003). Species commonly grows in dense humus-rich forest floors at an altitudinal range of 2100-3000m. The plant grows up to 1.0-1.5m height, produces white-creamy flowers with purple dots (Fig. 1b) and triangular capsules (Fig. 1c) with winged seeds (Dhaliwal and Sharma 1999; Pushalkar and Singh 2012). The distribution of *L. polyphyllum* is restricted to its native habitats in the Himalayan Region and sparsely distributed between Afghanistan and North-West Himalaya in India. In the Indian Himalayan Region the species is surviving with a few populations in Himachal Pradesh (Pulga-Kullu, Dhauladhar and Shimla), Jammu and Kashmir (Chatru and Doda) and Uttarakhand (Chakisain, Gargia-Pithoragarh, Chakrata, Raath Harsil, Gangotri, Valley of flowers, Kaddukhal and Dhanaulti) (Samant 1987; Dhaliwal and Sharma 1999; Gaur 1999; Ved et al. 2003; Sourabh et al., 2015).

Bulbs (Fig. 1d) are used for the preparation of various traditional and modern medicines and have an increasing demand in traditional and pharmaceutical industry. They possess soothing, astringent and anti-inflammatory properties and are used for the treatment of various ailments such as refrigerant, galactogogue, expectorant, aphrodisiac, diuretic, antipyretic and tonic in cough, bronchitis, vitiated conditions, seminal weakness, strangury, burning sensation, hyperdipsia, intermittent fever, hematemesis, rheumatalgia and general disability (Jain 1991). Paste of bulb is one of the main component in revitalising night cream and Chywanaprasha (an ancient ayurvedic herbal preparation) (Anonymous 2007). *L. polyphyllum* is one of the eight herbs of Astavarga medicinal system and bulbs of the species are traded under the name Kakoli/Ksheerkakoli in the local and national markets. Bulbs contain linalool and α-terpineol as main chemical constituent (Javed et al. 2012). The natural regeneration of the species takes place either by the vegetative propagation with the help of underground perennating bulbs or by seeds.

The unabated trade, ruthless degradation of habitat by grazing (Rana and Samant, 2010) coupled with global warming/climate change and infestation of habitat by the invasive species has shrinked the population of species in the wild. Situation is further aggravated by the epicotyl morph physiological seed dormancy in *L. polyphyllum* (Dhyani et al. 2013). The diminishing population size in the nature, has resulted the species as threatened in the Red Data Book of Indian Plants (Nayar & Sastry 1990) and subsequently as critically endangered by the International Union for Conservation of Nature and Natural Resources (IUCN) (Ved et al. 2003). Rana and Samant (2011) advocated the *in-situ* and *ex-situ* conservation measures for *L. polyphyllum*. Dhayani et al. (2014) also made efforts for propagation of species through seed germination and in vitro bulbet formation from callus with the help of PGRs.

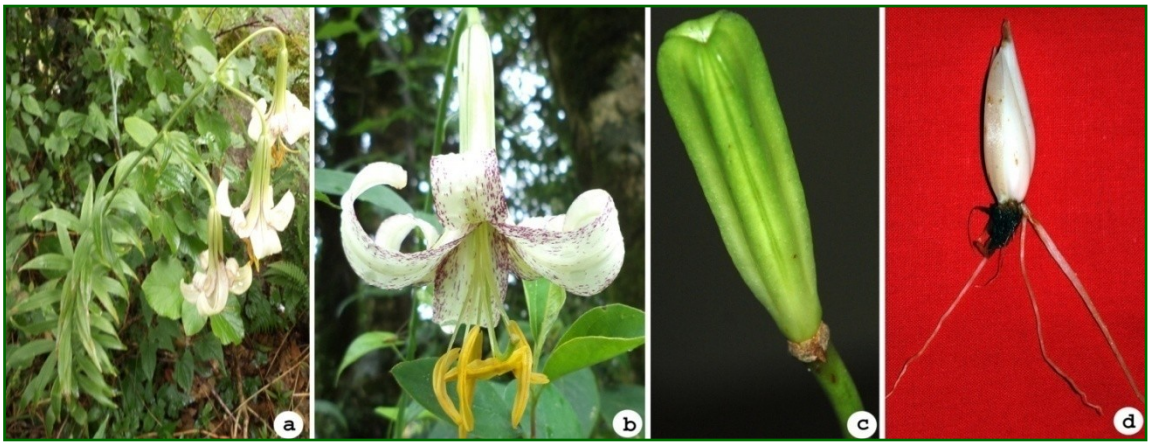

Fig. 1: (a) *Lilium polyyphyllum* habit, (b) Flower, (c) Capsule and (d) Underground bulb.

***Pittosporum eriocarpum* Royle:** It is commonly known as agni is an endangered (Walter and Gillet, 1998) plant (Fig. 2) of the temperate region and is sparsely distributed in Uttarakhand and Himachal Pradesh and grow on high rocky slopes up to 2,400 m (Thapliyal, 1994). In Uttarakhand it is distributed in lower Mussoorie hills in Western Himalaya and Kumaon hills in central Himalaya. Economically it is a multipurpose species and is lopped for fodder and fuel wood by the local people. It is also suitable for soil conservation and reclamation of degraded sites (Singh and Goel, 1999). The bark of the species is widely used for the preparation of traditional medicines and for the treatment of narcotic, expectorant, bronchitis and other ailments as well (Rawat and Rawat, 2010).

Earlier the species was reckoned as endemic to Uttarakhand (Osmaston, 1927; Kanjilal, 1928), but later on it was also reported from Chamba, Himachal Pradesh (Chowdhery and Wadhwa, 1984). In Uttarakhand the species has been located in three districts *viz.* Dehradun, Tehri and Nainital (Singh and Goel, 1999). Sahastradhara, near to Dehradun is considered as the type locality of the species (Hajra, 1983) and maximum population has been recorded from Sahastradhara, Mussoorie, Jhari Pani, Choona Batta and Kempty Fall area of Dehradun and Tehri districts. Due to its multi-purpose nature, rocky slope habitat, massive inflow of tourists throughout the year and increased human disturbance in its natural habitat, species is facing a wide array of threats in nature. Moreover, the situation is further exacerbated by the lime querying, habitat destruction in in and around the Mussorrie hills and poor seed set and seed germination in the wild. Global warming may also be one of the probable reasons for shrinking of population from the wild.

Fig. 2: Different Phenophases of *Pittosporum eriocarpum*: (a) Habit, (b) Budding of leaf primordial, (c) Young leaves with inflorescence, (d) Young flower buds, (e) Mature flowers, (f) Young immature fruits, (g) Mature fruits and (h) Dehiscence of seeds.

***Eremostachys superba* Royle ex Benth.:** *Eremostachys* Bung. belongs to the family Lamiaceae and comprises *ca* 60 species which are mainly distributed in Western and Southern Asiatic regions (Mabberely, 2008). *E. superba* Royle ex Benth. occur in India and is a critically endangered herb (Fig. 3) (Jain and Sastry, 1984). Earlier species was reckoned as endemic to Uttarakhand and restricted to only one locality at Mohand (type locality) near Dehradun, and reported to have 33 individuals (Babu, 1977; Rao and Garg, 1994), but in our recent visit (April, 2016) at Mohand (Type locality) only single individual of the species was located. Extensive exploration in the North-West Himalaya revealed six populations in Jammu & Kashmir (Verma et al., 2003) and two in Himanchal Pradesh (Kangra and Una), relocated after 72 years (Uniyal et al., 2012).

Plant is used as antidepressant and antioxidant. The extensive use of tubers by the Gujjar and Bakarwals (Shepherds) for curing mastitis and restoration of milching in cattles, are reported to be responsible for its diminishing population size (Verma et al., 2003). Habitat erosion, poor seed set and seed germination, isolated and fragmented nature of the population have set a strong genetic drift and inbreeding depression (Garg 2004). Invasion of the habitat by the exotic invasive species also cause the shrinking of the populations (Uniyal et al., 2012).

The alarming decline (single individual) in population structure of *E. superba* at the type locality have renewed the interest among conservation biologist and consequently ex situ conservation of *E. superba* was achieved to an extent. The preliminary attempts through in vitro propagation were also made by Sunnichan and Shivanna (1998) and complete comprehensive protocol has been standardized by Panwar et al., 2015, by using shoot tip explants, to conserve the species. Genetic diversity of the species with the help of RAPD markers was also studied by Verma *et al*., (2007).

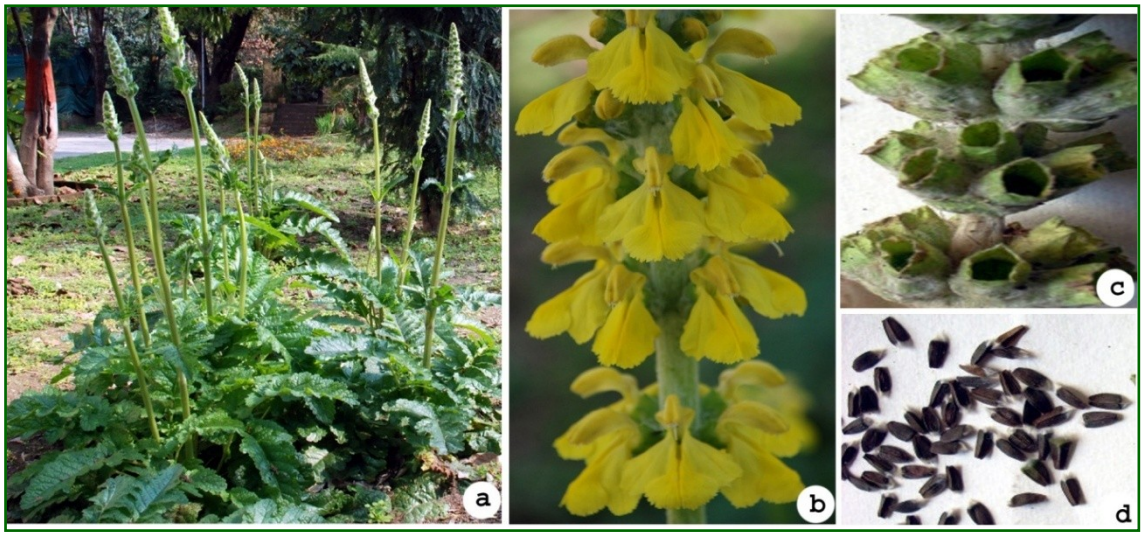

Fig. 3: (a) Habit of *Eremostachys superba*, (b) Yellow flowers, (c) Nutlets of spikes and (d) Mature seeds of *E. Superba*.

Material and Methods

Initiation of aseptic cultures: The healthy seeds or young meristematic tissues (shoot tip, young leaf, scale) were selected and washed properly in 5-10 drops of Savlon (Johnson and Johnson), a germicide and 1.0% solution of Tween-20 (Himedia Laboratories, India) in 150 ml water for 20 minutes, followed by thorough rinsing under running tap water for 20 minutes. The seeds/tissues were rinsed properly until the detergent was completely washed out. Seeds/tissues were then surface sterilised with 70% ethanol for ten minutes followed by 0.1% $HgCl_2$ for 10 minutes. After each treatment, seeds/tissues were rinsed thrice with sterilized double distilled water and properly sterilized seeds were inoculated in the basal MS medium. All cultures were maintained at 25±2^{o}C, under a 16-h photoperiod with a light intensity of 47.29 µmol m^{-2} s^{-1} provided by white fluorescent tubes (40 W; Phillips, India).

Callus induction and proliferation: The *L. polyphyllum* scales and *E. superba* young leaves were excised into small pieces (0.5 cm) and cultured in MS medium supplemented with different concentrations of 2,4-D (2.26-9.0 µM) and subsequently the most suitable concentration of 2,4-D (6.7 µM) was tested in combination with different concentrations of cytokinins *viz.* BAP (1.3-6.6 µM), kinetin (1.39-6.9 µM) and TDZ (1.36-6.81 µM). Callus cultures were subcultured at regular intervals of four weeks. The callus was further proliferated into the callus proliferation medium.

Shoot multiplication: The shoot tip explants from *in vitro* raised seedlings and callus regenerated from scale explants were excised and cultured in MS and modified MS medium. The nutrient media were supplemented with different concentration of BAP (4.4 to 11.1 µM), TDZ (2.27-9.02 µM) and Kinetin (4.6-11.6 µM). Subsequently, the most suitable concentration of BAP (6.6 µM), TDZ (4.54 µM) and kinetin (6.9 µM) was tested in combination with different concentration of NAA (0.53-1.59 µM). To prevent the browning of culture medium and necrosis of tissues from white-milky exudates of *E. superba* explants, media were supplemented with activated charcoal (1.0 g L^{-1}) and poly-vinyl-pyrrolidone (PVP: 1.5 g L^{-1}) (Himedia Laboratories, India). Shoot clusters were subcultured at regular intervals of 4-weeks. Multiplication rates were calculated on the basis of percentage of explants with a positive response, number of total shoots per explant and shoot height were recorded 6-weeks after culture initiation. Necrotic tissues due to exudates, if any, were removed during the subculture to fresh medium.

Rooting*:* Cluster of three to five shoots in *Lilium polyphyllum* & *E. superba* and single shoots in *P. eriocarpum* measuring around 4.0-6.0 cm in length were transferred to different rooting media. Initially, the shoot clusters were cultured on MS, and modified MS supplemented with major salts reduced to half, quarter and zero strength. Later, these basal media were supplemented with various auxins (Himedia Laboratories, India), *viz.* IAA (2.85 to 14.27 µM), IBA (2.46 to 12.26 µM), and NAA (2.65 to 13.25 µM) individually. Since, in all the media tested, the results were better in quarter-strength MS medium (*E. superba*) followed by half (*L. polyphyllum* and *P. eriocarpum*), full and zero-strength MS mediums supplemented with IBA (7.36 µM).

Hardening and transplantation: The *in vitro* raised healthy plantlets with well-developed shoots and roots after 4 weeks of culturing in rooting medium were taken out from the culture tubes, and washed gently under running tap water to detach the traces of the medium from the roots. Plantlets were shifted to root trainers containing sterile soil and vermiculite in 1:1 ratio. Plantlets were covered with transparent polythene foil to ensure high humidity and were watered every three days with half-strength modified Hoagland solution (Epstein, 1972). The polythene foil was removed after 2 weeks in order to acclimatize plants to field conditions. After 4 weeks, plantlets were transferred to pots containing compost enriched soil and maintained in the greenhouse.

All the experiments were carried out in triplicates. The effects of the different treatments were observed, and the level of significance was determined by analysis of variance using SPS software. Significant differences between the means were assessed by Duncan's multiple range test at *P*=0.05 (Duncan, 1955).

Results and Discussion

Lilium polyphyllum: The scales inoculated in MS medium (without PGR) did not show any callusing. Incorporation of different concentrations of 2,4-D (2.26-9.0 µM) has initiated the callus induction in scale explant and 65.40% callusing was achieved in 2,4-D (6.7 µM). Further, supplementing the medium with different concentrations of cytokinins *viz.* BAP (1.3-6.6 µM), TDZ (1.36-6.8 µM) and Kinetin (1.39-6.9 µM) was found enhancing the callus induction percentage and 95.32, 90.07 and 87.11% callusing was reported, respectively. Among all the three cytokinins used BAP was found most effective and 95.32% callusing was reported in the medium containing 2,4-D (6.78 µM) and BAP (4.4 µM). Callus obtained was yellow, globular and friable in texture. Callus was further proliferated in the same medium (Fig.4a). However, Dhayani et al. (2014) found only 69% callusing in MS medium supplemented with IBA 25 µM. BAP and 2,4-D were also found suitable for callus induction in *Lilium speciosum* (Chang *et al.,* 2000) and the superiority of BAP over other cytokinis *viz.* TDZ and kinetin in callus induction was also reported in *Rauwolfia serpentina* (Panwar *et al*., 2011).

In the growth regulator free MS medium, the frequency of shoot induction in callus was negligible and no morphogenetic response was found. Incorporation of BAP (2.2- 8.9 µM), TDZ (1.36-6.8 µM) and kinetin (2.32-9.3 µM) separately into the medium enhanced the shoot multiplication rate upto 65, 60 and 58%, respectively. Different concentrations of BAP, TDZ and kinetin tested, 4.4 µM BAP, 4.54 µM TDZ and 6.9 µM kinetin proved to be the most effective. Since BAP (4.4 µM) TDZ (4.54 µM) and kinetin (6.9 µM) yielded the maximum proliferation, they were tested in combination with varying concentrations of NAA (0.53-1.59 µM), in which significant enhancement was found in the multiplication rate and average shoot length. BAP (4.4 µM) and NAA (0.53 µM) proved to be the most optimum concentration for the shoot induction in *in vitro* regenerated callus and 97.45% shooting was achieved with 19.2 average number of shoots and 8.6 cm of shoot length (Fig. 4b & c). Supplementing the above medium with GA_3 (20 ppm) has significant effect on the shoot proliferation as well as the number of shoots. The combined application of BAP and NAA was found best for multiple shoots induction and proliferation in callus explants and 97.45% shooting was achieved with average mean shoot number and length of 19.2 and 8.6 cm, respectively. This combination was also reported suitable for shoot induction in callus of *Habenaria edgeworthi* (Giri *et al*., 2011). In our experiments, TDZ showed a negative effect on morphogenetic processes in callus explant as also observed in *Hypericum* species (Coste *et al.,* 2012) and *Agastache rugosa* (Zielinska *et al*., 2011).

The well-developed shoots were shifted to rooting medium in a cluster of 2-3 shoots. Shoots shifted to growth regulator free medium showed 5% rooting frequency. However, incorporation of IBA (2.46-12.26 µM), NAA (2.65-13.25 µM) and IAA (2.85-14.27 µM) in MS medium of different salt strength (full, half and quarter), remarkable increase was observed in rooting percentage. Besides rooting, callusing was also found at the cut ends of shoots in media containing full strength MS salt content. Since half salt strength MS medium yielded better morphogenetic response, further experiments were conducted in half-strength MS medium. Among different auxins tested, IBA was found most effective than IAA and NAA, respectively. The half-strength MS medium, fortified with IBA (9.8 µM), were found as the optimal medium for the root induction and 100% rooting was achieved with 14.4 average numbers of roots per shoot and 4.0 cm root length (Fig. 4 d, e & f).

The plantlets with well-developed roots were shifted to half strength modified Hoagland solution for 2-3 weeks (Fig. 4g) and then into plastic glass containing sterile soil and vermiculites in 1:1ratio (Fig. 4h). Plants were kept inside the greenhouse for one month and then shifted to plastic glass containing compost enriched soil. They were transferred to the polyhouse after one week (Fig. 4h). The plants were finally transferred to

field with 85% success. Plants transferred in the pots starts drying after sometimes and simultaneously bulb formation also takes place. These bulbs start growing in the next season after getting conducive atmospheric conditions.

In half-strength MS medium supplemented with IBA (9.8 µM), 100% rooting was achieved, which was found potent root inducer as compared to IAA and NAA. The roots were better developed in half-strength MS medium as compared to full strength MS medium. Nearly 85% survival rate was achieved after six weeks of transplantation in the field. The potted plants starts drying after sometimes and bulbs were developed as an underground part. These bulbs start growing after getting conducive atmospheric conditions.

Pittosporum eriocarpum: To optimize the plant growth regulators and medium conditions, properly sterilized shoot tip explants of *P. eriocarpum* were inoculated into MS basal medium fortified with different cytokinins *viz.* BAP, TDZ & kinetin. Shoot tip explants inoculated into the control medium did not show any morphogenetic response. Supplementing the medium with different concentration of BAP (2.22-6.6 µM) alone the shoot tip culture started giving morphogenetic response and 32.21 to 64.33% shooting was rerecorded (Fig. 5a). Similarly, another set of basal MS medium was supplemented with different concentration of TDZ (1.36-5.9 µM) and Kinetin (2.32-6.92 µM) alone and 59.51 and 56.27% shooting was observed after 6 weeks of inoculation, respectively. The optimum concentration of three cytokinins, in which best shooting response was observed, were further supplied with different concentration of NAA (0.53, 1.59 and 2.65 µM) in MS basal medium. Among all the three concentration of NAA used, 1.59 µM was observed as the optimum concentration for shoot induction in *P. eriocarpum* shoot tip explants. Best shooting response was observed in medium supplemented with BAP + NAA (93.54%) followed by TDZ + NAA (85.29%) and Kinetin + NAA (83.64%), respectively. Among the various concentrations of BAP and NAA, the combination of 5.7 µM BAP and 1.59 µM NAA resulted in maximum shooting percentage *i.e.* 93.54% per explants (Fig. 5b). After one or two subculture of these shoots on this medium new shoots developed profusely and 24 shoots/ explant with an average length of 5.8 cm was recorded after six weeks of inoculation (Fig. 5c). Similarly, among the various concentrations of TDZ + NAA and kinetin + NAA, the combination of 4.54 µM TDZ + 2.6 µM NAA and 5.9 µM kinetin + 2.6 µM NAA resulted in maximum shooting with an average of 18.2 and 17.5 shoots/ explant, respectively. Comparing the efficiency of BAP to other cytokinins, significant differences were observed in number and length of shoots in BAP + NAA supplemented media than other cytokinins. This revealed the superiority of BAP over the other cytokonins used. Superiority of BAP over other cytokinins has been demonstrated in *P. napaulensis* (Dhar *et al*., 2000), *R. serpentina* (Singh and Guru, 2007) and other tree species as well (Siril and Dhar, 1997).

Shoots obtained from cultures on MS medium fortified with 5.7 µM BAP and 2.6 µM NAA were used for the root induction. Shoots (≥ 5.0 cm) were excised from shoot induction cultures and were inoculated into three different strength MS medium *viz*. full, half and quarter strength, without growth regulators. Shoots inoculated in full strength MS medium failed to produce any rooting response and callusing was observed at the cut ends. While, shoots inoculated in half and quarter strength MS medium produced 5 and 11.3% rooting response in growth regulator free media, respectively. This prove the high rooting efficiency of quarter strength MS medium compared to half and full strength MS medium, respectively. After observing the higher root induction efficiency of quarter strength MS medium, further all the root induction experiments were conducted in quarter strength MS medium. A set containing quarter strength MS medium without growth regulator served as control and shoots with 0.5 cm root length were considered as rooted. Inoculating the shoots into quarter strength MS medium fortified with different concentration of auxins *viz.* IBA (2.4-9.8 µM), NAA (2.6-10.6 µM) and IAA (2.8-11.4 µM), produced adventitious roots within two weeks of transfer. The auxin IBA was found more potent in root induction followed by IAA and NAA, respectively. Maximum rooting percentage 95.78 with average 17.4 roots and 3.6 cm root length was observed in 7.3 µM IBA (Fig. 1d). Beyond the 7.3 µM IBA the cut ends starts developing callus besides the roots. The supremacy of IBA was also observed in *P. naupaulensis* (Dhar *et al*., 2000).

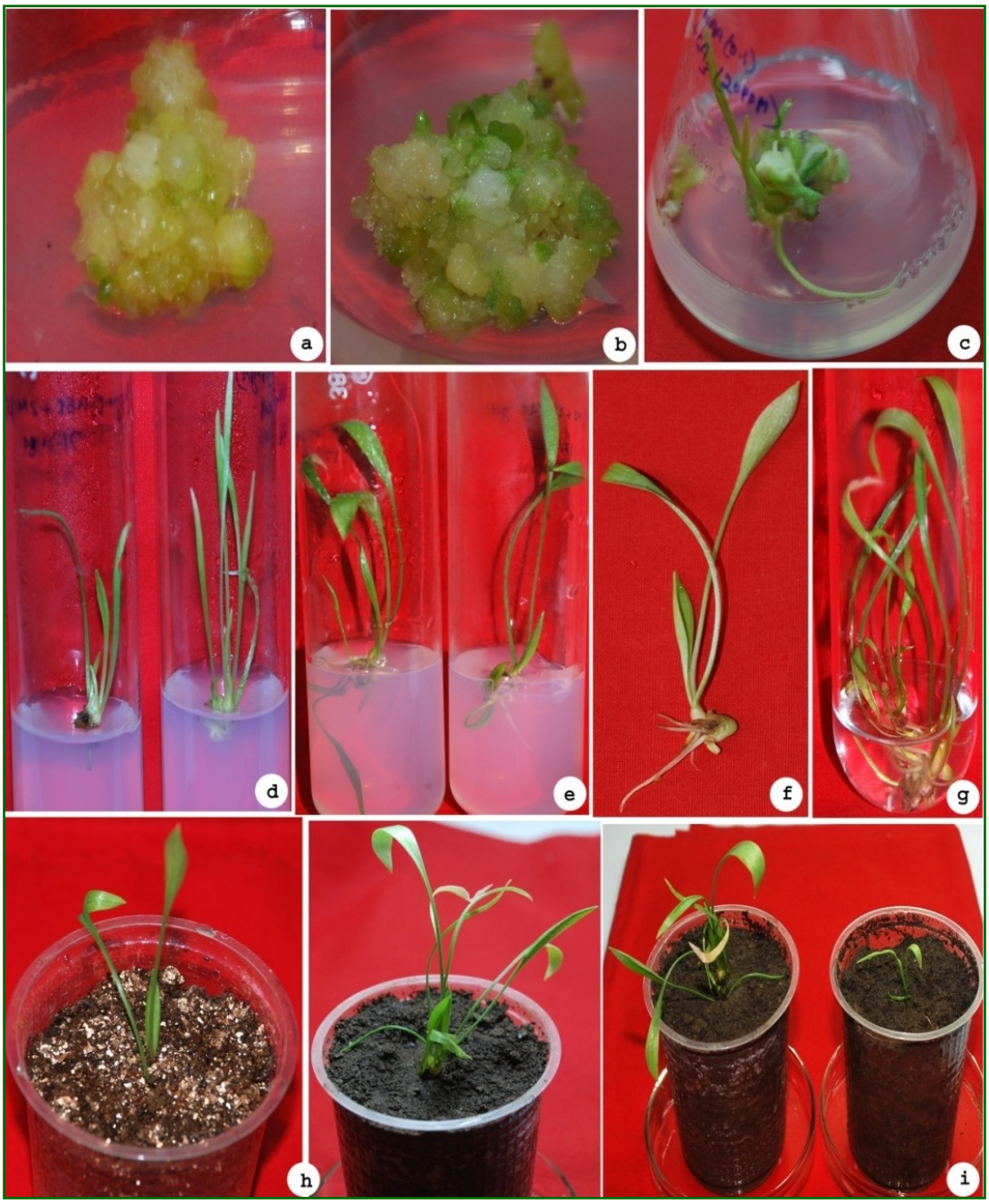

Fig. 4: Micropropagation of *Lilium polyphyllum*: (a) 3-weeks old callus developed from scale explant, (b) & (c) young callus showing shoot primordia and well developed multiple shoots, (d) well-developed shoots inoculated in the rooting medium, (e) & (f) well-developed roots, (g) Well rooted plants in Hoagland solution, (h) hardening in vermiculite and soil (1:1v/v) ratio and (i) hardening in compost enriched soil.

After proper development of roots (3 weeks) 50 plantlets with average root length 3.6 cm, were washed properly and shifted to polythene bags containing mixture of vermiculite and soil (1:1w/v) and maintained in a growth chamber at 25 ± 2 ^{o}C under 16-h photoperiod with a light intensity of 40 µmol m^{-2} s^{-1} provided by cool white LED bulbs (Fig. 5e &f). The pots were covered by the transparent polythene bags to ensure the required humidity content and watered with ¼ modified Hoagland's solution on alternate day. The bags were removed after 15 days. Of the 50 plantlets, 42 were first transferred to pots (Fig. 5g) in the polyhouse and eventually transferred to the field with survival rate of about 84 per cent.

Fig. 5: Different Micropropagation stages of *P. eriocarpum*: (a) Shoot initiation from shoot tip explant, (b) shoot induction, (c) Proliferation of shoots, (d) Root induction, (e), (f) & (g) Hardening and acclimatization.

Eremostachys superba: In the growth regulator free MS medium, the frequency of proliferation of shoots from callus explants (Fig. 6a & b) was 20% *i.e.* the incipient morphogenetic response was found. Incorporation of BAP (2.2, 4.4, 6.6, 8.9 and 11.0 µM), TDZ (2.27, 4.54, 6.8 and 9.09 µM) and kinetin (4.6, 6.9, 9.3 and 11.6 µM) separately into the medium enhanced the shoot multiplication rate upto 77.8, 65 and 66.2%, respectively. Different concentrations of BAP (2.2 to 11.0 µM), TDZ (2.27 to 9.09 µM) and kinetin (4.6 to 11.6 µM) tested, 6.6 µM BAP, 4.54 µM TDZ and 6.9 µM kinetin proved to be the most effective resulting in a proliferation rate of 3.89, 3.25 and 3.31-fold, respectively. During the culture incubation the explants secretes white milky exudates that caused rapid browning and necrosis of tissues. To avoid browning of the medium and necrosis of tissues, the cultures were transferred to a fresh medium of the same composition every week. Since BAP (6.6 µM) TDZ (6.8 µM) and kinetin (6.9 µM) were yielded the maximum proliferation, they were tested in combination with varying concentrations of NAA (0.53-1.59 µM) and significant enhancement was found in the multiplication rate and average shoot length. In the full strength MS medium, besides shoot proliferation, callusing was also found, which was overcome by reducing the MS salt strength into half. The browning and necrosis of cultures was controlled to an extent by adding PVP (1.5 g l^{-1}).

Based on all the experiments, half-strength MS medium supplemented with 6.6 µM BAP, 0.53 µM NAA and 1.5 g l^{-1} PVP was regarded as the optimal medium composition with a consistent multiplication rate of 5.0-fold with a per culture mean shoot number and shoot length of 21.6 and 5.9 cm, respectively (Fig.6 c & d). The superiority of BAP over kinetin was also reported in *E. superba* (Sunnichan and Shivanna, 1998; Panwar *et al*., 2015), *Rauwolfia serpentina* (Panwar and Guru, 2007). Sunnichan and Shivanna (1998) reported BAP and IAA as the best combination for shoot induction in nodal segment explants of *E. superba* with 19.1 average numbers of shoots and 4.8 cm height. Similarly, Panwar *et al*., 2015 has reported BAP and NAA as the best combination for shoot induction in shoot tip explants with average number of 24.5 shoots.

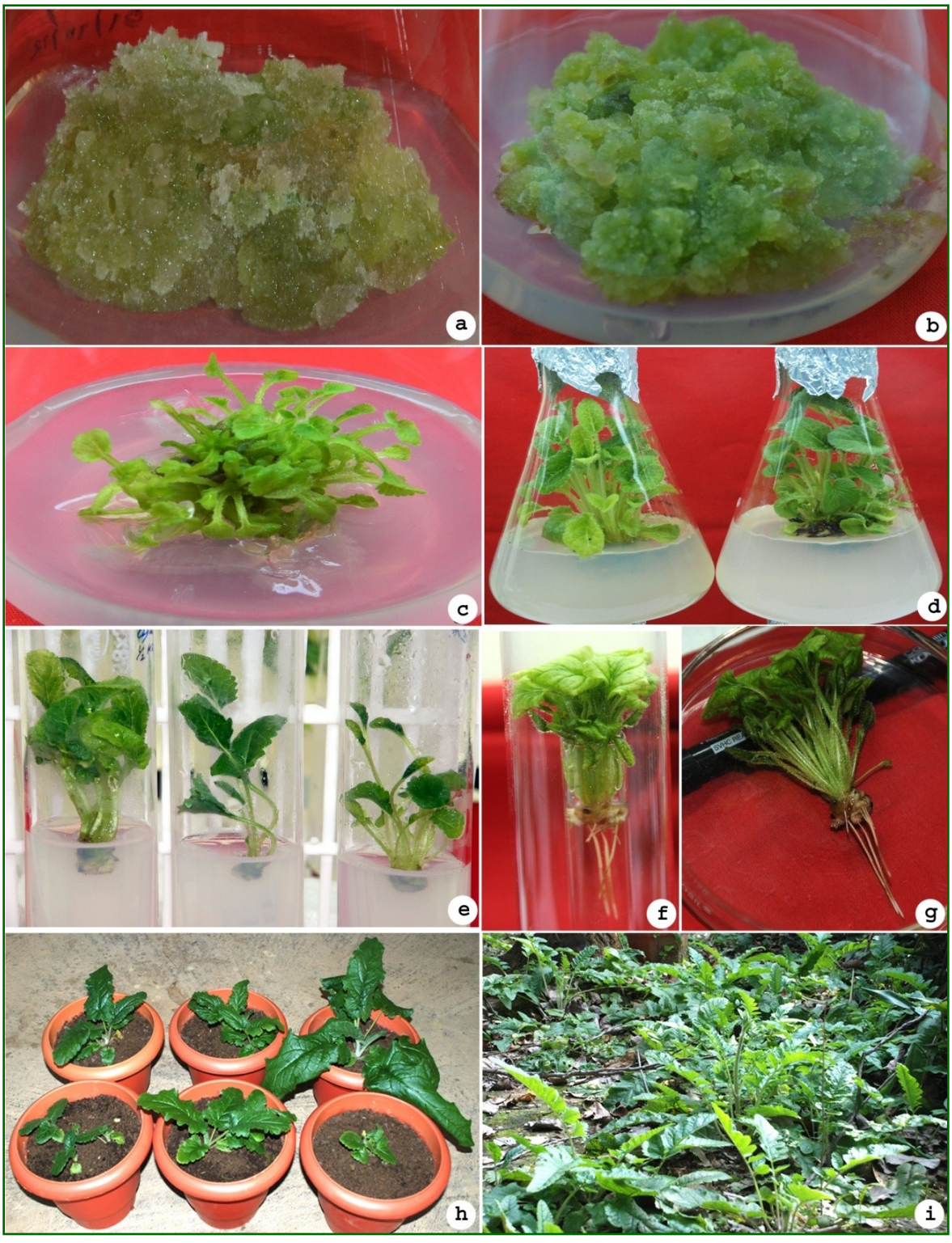

Fig. 6: Micropropagation of *Eremostachys superba*: (a) & (b) Fully developed callus, (c) Shoot induction in shoot tip explant, (d) Shoot proliferation in proliferated media, (e) Rooting in quarter strength solid MS medium (f) Rooting in quarter strength liquid MS medium, (g) A complete plantlets, (h) Plantlet transferred to pots after 6-months and (i) field transferred plants.

The well-developed shoots were shifted to rooting medium in a cluster of 2-3 shoots. Shoots shifted to growth regulator free medium showed 5% rooting frequency. However, incorporation of IBA (2.46-12.26 µM), NAA (2.65-13.25 µM) and IAA (2.85-14.27 µM) in MS medium of different salt strength (full, half and quarter), remarkable increase was observed in rooting percentage. Besides rooting, callusing was also found at the cut ends of shoots in media containing full and half strength MS salt content. Since quarter salt strength MS

medium yielded better morphogenetic response, further experiments were conducted in quarter-strength MS medium. Among different auxins tested, IBA was found most effective than NAA and IAA, respectively. The quarter-strength MS medium, fortified with IBA (7.36-9.8 µM), were found as the optimal medium concentration and 100% rooting was achieved with average 16.4 numbers of roots per shoot (Fig 6 e & f). Contrary to this Sunnichan and Shivanna (1998) reported only 89% rooting in *E. superba* after 14 days of incubation in quarter-strength solid MS medium supplemented with IBA and GA_3 which also proves the economic feasibility of the current protocol. In the present investigation it was also observed that the roots were better developed in liquid MS medium as compared to semisolid and solid medium, which is in accordance with Negi and Saxena (2011).

The plantlets with well-developed roots (Fig 6g) were first shifted to root trainers containing sterile soil and vermiculites in 1:1ratio. Plants were kept inside the greenhouse for one month. After one month the plants were shifted to plastic pots containing compost enriched soil and were transferred to the polyhouse (Fig 6h). The plants were finally transferred to field with 100% success (Fig 6i).

Conclusion and future prospective

This is the first study to describe a comprehensive direct (*P. eriocarpum*) and indirect (*L. polyphyllum* and *E. superba*) regeneration and micropropagation protocol through organogenesis from shoot tip and callus explants. This micropropagation system assured effective establishment, proliferation, rhizogenesis, and acclimatization of the plantlets, offering an *in vitro* strategy for the conservation of these endangered and valuable medicinal plants. Besides tissue culture, efforts should be made to conserve these natural resources through cultivation practices and by the establishment of more medicinal plants conservation areas (MPCAs) in the region. Moreover, every plant has the medicinal property and therefore, it is the need of hour to explore the phytochemical potential of rest of the unexplored species.

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Cultivation through cluster approach – A case study of Swertia and other species

Dr. Lal Singh
Himalayan Research Group, Shimla (H.P.)

CULTIVATION THROUGH CLUSTER APPROACH-A CASE STUDY OF *SWERTIA* AND OTHER SPECIES

Dr Lal Singh
lalhrg@gmail.com

HIMALAYAN RESEARCH GROUP (HRG)
CORE GROUP
(DEPARTMENT OF SCIENCE & TECHNOLOGY GOVT. OF INDIA)
UMESH BHAVAN, CHOTTA SHIMLA
SHIMLA-171002 H.P.

Chirayita

Family- Gemtianacea comprising 87 Genera
Genus –*Swertia* is one of them having

Internet Systemic Botany listed Species- 362

Publication listed species- 170
India-40 species and 8 varieties
H.P. 15 species and 1 variety
Traditionally all wild species were collected and used under trade name- CHIRATA or CHIRAYITA

Ayurvedic Pharmacopoeia of India
Part-I Vol. I
Total Plants Description 80
Kiratatikta (*Swertia chirata* Buch.Ham) Plant No. 47
Page No. 98-100
Identity Purity and strength
Appendix , 2.2.2, 2.2.3, 2.2.4, 2.2.6, 2.2.7

***Swertia cordata* (Wallich ex G. Don)**

Plant

Flower (5 Petals)

Flower (4 Petals)

- Family Gentianaceae
- Distribution (1200-3000 m)
- Biannual Herb
- Source of Glucosides

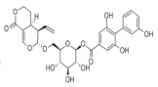
Agrotechnology and Quality of Chirayita Crop

Chirayita Seed Germination

Chirayita Crop at harvesting stage

Chirayita Crop

Main ingredients:



- Amarogentin
- Cheratin
- Swertia-amarin
- Swerchirin

- Regular yearly analysis of the cultivated produce

Quality testing and marketing of cultivated Chirata

INSTITUTE OF HIMALAYAN BIORESOURCE TECHNOLOGY
(Council of Scientific & Industrial Research)
Post Bag # 06, Palampur-176 061 (H.P.)
Format No. SOP/S.10/01/F.01

TEST REPORT

Report No...IHBT-48..... Date. 12-11-08 Numbers of Page...6

1. Name & address of the Customer/Organization..... Dr. Lal Singh, Director, Himalayan Research Group, Core Group, Department of Science and Technology, Govt. of India, Umesh Bhavan, Chotta Shimla- 171 002, H.P.
2. Sample Details ... 4 samples of semi dry whole plant of *Swertia chirata* 3. Quantity ..500g each..
4. Sampling details (if applicable).....N.A.....

10. Report/Recommendations.....

S. No.	Sample ID (Customer)	Sample Code (IHBT)	Component analyzed	Result (%)	Remarks
1	White Chiraita (Wild)	IHB-NPP-FF-250	Amarogentin	0.0074	-
2	Chiraita Jhalese	IHB-NPP-FF-251	Amarogentin	0.009	-
3	Syas Chiraita	IHB-NPP-FF-252	Amarogentin	0.006	-
4	Chiraita Mengal	IHB-NPP-FF-253	Amarogentin	0.003	-

11. Recommendations (if any) .....

Prepared by Name Mrs. Vijaylata Analyst
Validated by Name Dr. Pralay Das Supervisor
Approved by Name Dr. A. K. Sinha TM
Counter signed by Name Dr. Bikram Singh QM

Quality testing of cultivated Chirayita

Swertia cordata (Cultivated).		
	µg/mg	
Plant Part	Swertamarine	Mangiferin
Leaf	ND	13.39
Root	0.43	0.25
Flower	9.43	18.91
Tap root	3.54	1.00
Stem	2.83	2.27

Analysis Department of Biotechnology, J.P. University Waknaghat, Solan

Quality testing of cultivated Chirayita

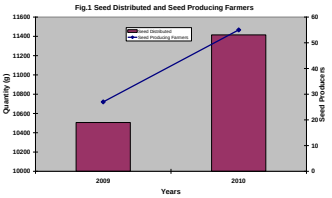
S.No.	Parameters	Units	Observation	Indian Ayurvedic Pharmacopoeia Standards
1	Foreign Matter	% w/w	1.47	<2.0%
Physicochemical				
1	Loss on Drying	% w/w	9.10	-
2	Total Ash	% w/w	3.40	<6.0%
3	Acid Insoluble Ash	% w/w	1.60	<1.0%
4	Water soluble extractive	% w/w	21.20	>10.0%
5	Alcohol (60.0%) soluble extractive	% w/w	23.70	>10.0%
6	Bitter Content	% Assay	1.5	>1.3%

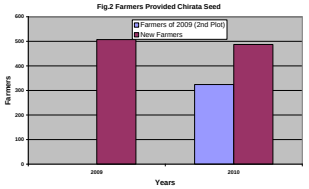
HRG Lab Analysis

ORIENTATION AND SEED DISTRIBUTION

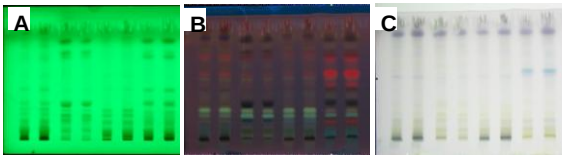
SEED SOWING

Involvement of >1000 women farmers in Chirayita Cultivation





Comparative quality testing of Chirayita Species



HPTLC fingerprinting of *Swertia* species **A**: Under UV 254 nm **B**: Under UV 366 nm after derivatization. **C**: Under visible light after derivatization

S,No	Plant species	Code	Swertiamarin (%)
1	*Swertia paniculata* (Wild)	white	0.04-0.05
2	*S. ciliata* (Wild)	Pink	0.30-0.33
3	*S. cordata* (Cultivated)	Cultivated	0.16-0.19
4	*S. chirayita (Ref. NBRI)*	Reference	0.60-0.64

Quality Assurance & Post Harvest Management

Chirayita infected with early blight

Grading of Chirayita

Quality Control Measures & Semi processing

- Free of Chemical Fertilizers, pesticides and fungicides
- Vermicompost used only organic manure for cultivation
- Adhering soil with roots removed
- Dried in defused sun
- Harvested crop graded to remove fungus infected plants
- Keeping sale record of each women/farmer

Weighing of Chirayita

Quality Assurance & Post Harvest Management

Final quality checks

- Free of moisture
- Free of foreign matter like adulterants and adhering soils
- Free of rodents and their fecal matter

Packaging

- Packaging in Hasein Cloth for quality maintenance
- Packaging in plastic is not recommended

Packaging of Chirayita

Chirayita Marketing

S. chirayita Germplasam acquired from UHF, Nauni Solan and Dabur India Limited

Health benefits of Chiratya

(1) **Useful in diabetic:** blood sugar & regeneration of beta-cells of islets of langerhans of pancreas.
(2) Excellent tonic for digestive system.
(3)Hepato-protective benefit.
(4) Useful for cardiac problems & cold-cough, cancer etc, and as antioxidant.
Not to be used by pregnant, breast feeding & those with duodenal (intestinal) ulcer.

The new model is to make sachet of size of 5 g each either singly initially and later on with combination of some other materials for adding value to the product and ease of modern consumerism.

Chirayita Sachet

Chirayita Production and Returns

S.No.	Years	Harvesters (No.)	Harvest (Kg)	Returns (Rs)	Forest Fee (Rs)
1	2009-10	26	138	48,300/-	1,050/-
2	2010-11	143	1352	6,57,000/-	17,500/-
3	2011-12	371	2203 (Stock)	6,25,000/- (Estimated)	-------
4	**Total**	**540**	**3693**	**7,05,300/-**	**18,550/-**

Chirayita Seed Production and Returns

S.No.	Years	Seed Producers	Seed (Kg)	Returns (Rs)
1	2008-2009	27	10.190	1,45,815/-
2	2009-2010	56	11.225	1,68,375/-
3	**Total**	**73**	**21.415**	**3,14,190/-**

***Picrorrhiza kurrooa* Royle ex Benth.**

- **Family -Scrophulariaceae**
- **Distribution (Altitude) 3000-4000 m**
- **Perennial**
- **Herb**

- **Source of**
- **Glucosides, Picrorhizin, Picrohrizetin, Kutkin,**
- **Use of Stolon for Hepato-protective Drug & Bitter Tonic**

***P. kurrooa* Stolon**

***P. kurrooa* Harvested Stolon**

Propagation technique	**Stolons Rooting/seeds**
Season of planting cutting	**July- August**
Planting distance	**30 cm**
Plantation	**Rows in Beds on slopes**
Compost	**2000 kg/ hectare**
Weeding	**3- 4 times/ year**
Flowering	**June-July**
Harvesting	**October- December**

***Taxus wallichiana* Zucc.**

Fruit

Rooting of Cuttings

Rooted Cuttings

- **Family Taxaceae**
- **Evergreen Tree**
- **Distribution (Altitude)**
- **1800-3300 m**
- **Main Source of**
- **Taxol® (Paclitaxel)**
- **Part used- Leaves**
- **Use- Chemotherapy**

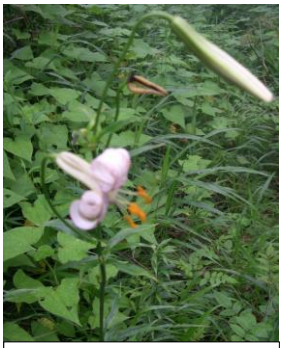
- **Cost effective (No capital cost & nominal recurring cost only)**
- **No Liquid fertilisers requirement**
- **No Hardening**
- **Almost 100% survival after transplantation**
- **Produce 5000 rooted cuttings annually**

Rooting of Cuttings Forest Nursery, GHNP, Kullu

***Aconitum heterophyllum* Wall.**

- **Family- Ranunculaceae**
- **Distribution (Altitude) 3000-5000m**
- **Herb**
- **Use of Roots/ Tubers**
- **Non toxic amorphous Alkaloid atisine used in fever, diarrhoea and dysentery**

Liliaceae members of Ashtawarga Group



Lilium polyphyllum

Polygonatum verticillatum

Polygonatum cirrhifolium

Seed Germination and Growth Pattern of *Polygonatum*

Fruiting of selected species in the Field Growing

Risk Management

Sustaining Himalayan Medicinal Plants Cultivation

Risks

- Activity with long gestation period
- Volatile herbal market in terms of prices
- Wild produce is cheep and is preferred over cultivated produce
- Cultivated produce also covered under Forest Department transit rules for transport permission and fees.

Management

Requires diversified SHORT TERM income activities for the medicnal plants cultivators to absorb loss of crop and market failures

- ✓ Technology Model for Livestock rearing through improved fodder practices
- ✓ Technology Model for Vermicompost preparation for sale
- ✓ Technology Model for Button mushroom Cultivation
- ✓ Model for Home Stays with linkages to traditional culture, cuisine, handicraft, handloom and agriculture.

Outcomes of Himalayan Medicinal Plants Cultivation

- ✓ Cultivation of only selected species which provide high economic returns and do not interfere with traditional cropping pattern

  Cultivation on high hill land abandoned due to wild animal menace, shortage of agriculture labour and ban on cultivation of narcotics
- ✓ Quality material production for commercial utilization
- ✓ Conservation of cultivated species in natural habitat
- ✓ Addressing health security of rural people through low cost household herbal preparations to tackle common ailments
- ✓ Employment and livelihood for rural women and youth

THANK YOU

Nursery techniques for mass production of important temperate medicinal plants

Dr. Sandeep Sharma
Himalayan Forest Research Institute, Shimla (H.P.)

Nursery Techniques for mass production of important Temperate Medicinal Plants

Dr. Sandeep Sharma
Himalayan Forest Research Institute-Shimla

Nursery

Nursery is a place where seedlings/plants are raised for planting purposes. In the nursery the young seedlings are tended from sowing to develop in such a way as to be able to endure the hard field conditions. Whether local or introduced species, nursery plants are found to have better survival than seeds sown directly in the field or through natural regeneration.

Nursery Techniques

Techniques applied for raising seedlings/ planting material in the nursery for eventual planting out in the field or in farmers field.

Some of the problems for commercial cultivation of high altitude medicinal plants

i) **Inability of the farmers to accept medicinal plants as crop.**
ii) **Mismatch of agro-climate and micro-site conditions of the area with specific cultivation requirements of high altitude medicinal plants.**
iii) **High cost of production owing to long gestation period which presently cannot compete with the raw materials collected from wild sources as well as comparative profit earned from offseason vegetables in the hills.**
iv) **Absence of any interest on the part of drug and pharmaceutical industry in purchasing the cultivated produce at reasonable price.**
v) **Lack of publicity regarding the nursery & cultivation practices developed by specialists.**
vi) **Unavailability of quality planting material in large quantities for initiating commercial cultivation.**
vii) **Delay in providing cultivation incentives to the farmers of high Himalayas.**

Pre-requisites for Medicinal Plants Cultivation in Himalayan region

These are important pre-requisites:

a) **Production/ availability of planting material**
b) **Farmer friendly agro-techniques**
c) **Arrangements for profitable marketing of the produce**

- **In case of high altitude medicinal plants nursery production is essential before cultivating these species in the field.**
- **The cultivation period (gestation period) required from sowing/planting to final harvest is 3-4 years for high altitude medicinal plants.**
- **Generally farmers can not wait so long to harvest and earn profit from those medicinal plants as crop in their farmland.**
- **Alternate to that is grow these plants in the nursery for 1-2 years and reduce the cultivation period in the farmers field to make the venture profitable.**
- **Dedicated nurseries are required to be ear-marked for continuous mass production of high altitude medicinal plants in North-Western Himalayan region.**

HFRI INITIATIVES

Brundhar Nursery, Manali

Shillaru Nursery, Shimla

Nursery Techniques for mass production of following Temperate Medicinal Plants:

1. **Atish (*Aconitum heterophyllum* Wall. Ex Royle)**
2. **Chora (*Angelica glauca* Edgew.)**
3. **Kutki (*Picrorhiza kurrooa* Royle ex Benth.)**
4. **Mushakbala (*Valeriana jatamansi* Jones)**

Nursery techniques evolved for *Aconitum heterophyllum* (Atish)

- **It is easy to propagate through seeds. November sowing was found to be better than April sowing. A seed rate of 2gm/sq m was found good for obtaining maximum germination under nursery conditions.**
- **For obtaining better germination and subsequently better survival of germinants 75% shade was found suitable in the nursery.**
- **Transplanted nursery plants required 50% shade during summer months.**
- **For vegetative propagation, the species could be propagated through disc with 15.62% survival.**
- **For best growth, optimum spacing for planting *Aconitum heterophyllum* in nursery was obtained 9-16 plants/sq m.**

Shade experiments
(35%, 50% & 75%)

Nursery Production of Atish (*Aconitum heterophyllum*)

Production of QPM of Atish in the Nursery

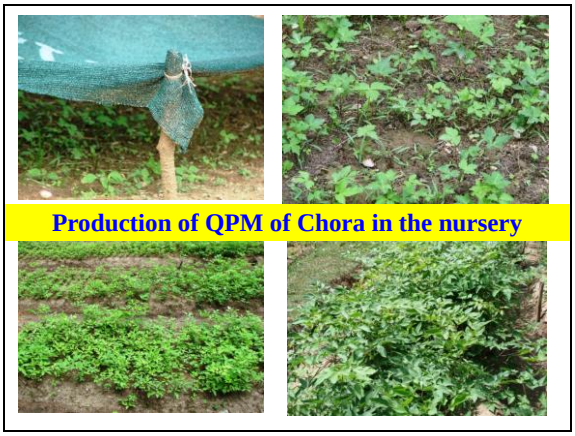
Atish at Various Development Stages

Maintenance of Atish stock for Seed Production

Seed Production in Atish

Nursery techniques evolved for raising *Angelica glauca* (Chora)

- **It is moderately difficult to propagate through seeds. Sowing of seeds in pre and post winter was found to be equally good.**
- **For biomass production November sowing was found to be better than March- April sowing.**
- **A seed rate of 4gm/sq m was found good for obtaining maximum germination.**
- **For obtaining better germination and better survival of germinants 50% shade was found suitable in the nursery during first summer.**
- **For vegetative propagation, the species could be propagated through disc (root/shoot) with >50% success under polyhouse conditions.**



Production of QPM of Chora in the nursery

Seed Production in Chora

Nursery techniques evolved for raising *Picrorhiza kurrooa* (Kutki)

- **Best time for collection of Kutki from natural habitat was found second fortnight of May with maximum survival.**
- **It is difficult to propagate through seeds and even collection of seeds is quite difficult.**
- **It was found that the species could be propagated vegetatively with >95% success during rainy season in sand beds.**
- **Through macro-proliferation technique a mature Kutki plant can be multiplied 6-10 times in every two & half to three years period.**

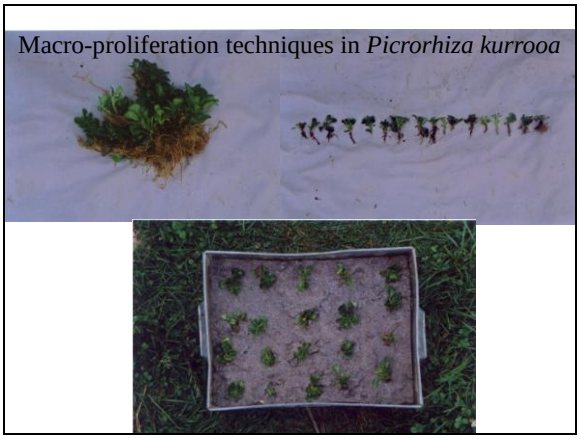
- **Macro-proliferation can be done successfully under poly-house conditions from March to November in higher temperate climate.**
- **Nursery plants require 35% shade during summer months.**
- **Nursery stock of Kutki should be produced in raised beds and over watering and water logged conditions must be avoided.**

Macro-proliferation technique evolved for raising *Picrorhiza kurrooa*

Macro-proliferation: It is low cost simple technique based on Bamboo macro-proliferation technique developed by FRI-Dehradun. This method ensures that each propagule possess some part of shoot along with stolen part & some roots at the time of separation from mature healthy plant.

- **Through macro-proliferation technique Kutki/Karu plant can be multiplied 6-10 times in every two & half years to three years period depending upon growth.**

Macro-proliferation techniques in *Picrorhiza kurrooa*



Survival percent of macro-proliferated propagule of Kutki

Month of macro-proliferation	Poly House	Sand Trays	Nursery Beds
May	100	74.67	61.33
June	100	76.00	66.67
July	100	90.67	73.33
August	100	100.00	86.67
September	100	89.33	69.33
$SE_m \pm$	NS	2.70	1.03
CD at 5%		6.23	2.38

Success rate of this technique under varied conditions

S. No.	Time of Macro-proliferation (Month of the year)	Conditions for rapid establishment of macro-proliferated propagules	Success Rate
1.	April to October	Placement in Poly-hose conditions for 1½ months and subsequent planting in the field	Almost 100%
2.	July to September	Placement in Sand trays for 1 ½ months and subsequent planting in the field	> 90%
3.	August	Direct planting in field for 2 ½ to 3 years	>75%

Nursery techniques evolved for *Valeriana jatamansi* (Mushakbala)

- ***Valeriana jatamansi* can be collected any time during growing period from natural habitat for nursery/field planting.**
- **It is easy to propagate through seeds as well as vegetative means.**
- **Through macro-proliferation technique mature Mushakbala plant can be multiplied 8-12 times in every 2-3 years period.**
- **The best period for macro-proliferation of Mushakbala was found to be June but under poly-house conditions it could be done from March to November.**
- **Nursery stock should be produced in raised beds and over watering and water logged conditions must be avoided.**

Macro- proliferation technique in *Valeriana jatamansi*

Survival percent of macro-proliferated propagule of Mushakbala

Month of macro-proliferation	Poly House	Sand Trays	Nursery Beds
May	100	78.67	69.33
June	100	100.00	100.00
July	100	100.00	97.33
August	100	96.00	94.67
September	100	90.67	82.67
$SE_m \pm$ CD at 5%	NS	1.26 2.92	1.74 4.01

Success rate of this technique under varied conditions

S. No.	Time of Macro-proliferation (Month of the year)	Conditions for rapid establishment of macro-proliferated propagules	Success Rate
1.	April to October	Placement in Poly-hose conditions for 1½ months and subsequent planting in the field	Almost 100%
2.	June to September	Placement in Sand trays for 1 ½ months and subsequent planting in the field	> 95%
3.	June to August	Direct planting in field for 2 ½ to 3 years	> 90%

For the best growth in nursery optimum spacing for planting *Valeriana jatamansi* is 9 plants/m^2. A Multiple Nursery Planting Bar has been fabricated for this purpose

Under NMPB funded & other projects (Last 10 Years)

Produced around 10.0 lakhs quality planting material of *Valeriana jatamansi*, *Picrorhiza kurrooa*, *Aconitum heterophyllum* and *Angelica glauca* as detailed below:

A. *Valeriana jatamansi*

i. Brundhar nursery, Jagatsukh (Manali): 58,000
ii. Shillaru nursery (Shimla) : 57,000
iii. Shilly nursery (Solan) : 2,55,000
Sub Total : 3,70,000

B. *Picrorhiza kurooa*

i. Brundhar nursery Jagatsukh (Manali) : 2,30,000

C. *Aconitum heterophyllum*

i. Shillaru nursery (Shimla) : 2,50,000

D. *Angelica glauca*

i. Brundhar nursery Jagatsukh (Manali) : 60,000
ii. Shillaru nursery (Shimla): 90,000
Sub Total : 1,50,000

Published two booklets in Hindi:

i) Karu ki Kheti

ii) Atish, Ban Kakri va Chora ki Kheti

Four Pamphlets in Hindi on Kutki, Atish, Ban Kakri and Chora

Case Study of Successful Cultivation of *Swertia chirayita* - High Altitude Medicinal Plant of Himachal Pradesh

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Introduction

Swertia chirayita is a native of temperate Himalayas, found at an altitude of 4000 to 10,000 ft from Kashmir to Bhutan and in the Khasi Hills at 4000 to 5000ft. (Clark, 1885; Blatter, 1984). The large continuous pith, dark colour and intensely bitter taste are sufficient to distinguish *S.chirayita* from other species of this genus, which are used as adulterants (Anonymous, 1976). The bitterness, antihelmintic, hypoglycemic and antipyretic properties are attributed to amarogentin, swerchirin, swertiamarin and other active principles of herb. Herbal medicines such as Ayush 64, Diabecon, Mensturyl syrup and Melicon ointment contain chiretta extract in different amounts for its antipyretic, hypoglycemic, antifungal and antibacterial properties (Joshi and Dhawan, 2005). It is credited with tonic, febrifuge, laxative, stomachic, anthelmintic and antidiaorrheal properties. It is also good for joint pains, scabies, leucoderma, skin inflammations and eye sight. The stem in combination with other drugs, is prescribed in the treatment of scorpion sting, good for vomiting in pregnancy; causes "Vata" (Kirtikar and Basu, 1975). *Swertia chirayita* enjoys a good domestic and international market which is increasing at the rate of 10 per cent annually (NMPB, 2008). Low germination and viability of the seeds, long gestation period requiring delicate field handling are some of the factors which discourage the commercial cultivation of the plant.

Swertia chirayita has already been categorized as critically endangered species by International Union for Conservation of Nature and Natural resources (Joshi and Dhawan, 2005). The National Medicinal Plant Board, Govt. of India, New Delhi has already enlisted this species among 32 medicinal species prioritized for commercial cultivation in the country (NMPB, 2008). Inspite of the demand, importance and threat status of this species, considerable quantities of its raw material are still being mostly wild harvested and traded. Over the years the dwindling natural populations have given way to intentional or unintentional substitutions mostly by related species (Anonymous, 1976) or even cheaply available *Andrographis paniculata* raising quality concerns affecting the drug efficacy. Often similar looking plants with bitter taste are passed on as *Swertia chirayita*. Thus, there definitely is need for having correct morphological description of this species which will act as one of the diagnostic keys for evaluating the authenticity of the available material both wild as well as cultivated stock of this species for commercial use without adulteration.

Material and Methods

The present study was carried out at Medicinal and Aromatic Plants Research Farm, Shilly (Altitude 1550m amsl, latitude- N 30^0 54' 30" and longitude E 77^0 07' 30") under Dr. Y. S. Parmar University of Horticulture and Forestry, Solan, H.P., India. The plants were raised through seeds. Qualitative and quantitative morphological features were recorded on randomly selected 25 plants as per Lawrence (1951), Collett (1921) and Kaufman *et al.* (1989) etc. The sequential growth events were recorded from the day of seed sowing to senescence of plants after seed setting & maturation.

Results (Morphological studies)

Habit: Plants of *Swertia chirayita* were erect, profusely branched, robust, pluri-annuals (once flowering in third year) attaining a maximum height of approximately 143 cm at full bloom stage.

Stem: Characterized by single erect stem which was circular in lower region and quadrangular in upper portion especially in the branches with prominent decurrent line at each angle. Colour of stem varied from dark green with purple tinge in lower region to light green with or without purple tinge in upp er region and containing large continuous yellowish pith. The main shoot appeared in third year after seed sowing in the month of April/May and undergoes senescence in November of the same year.

Roots: Characterized by light yellow coloured tap root system with main root tapering and growing upto short distance with profuse secondary and tertiary roots (a verage length 18.84 ± 2.86cm)) developing around the collar region .

Radical leaves: During the vegetative phase lasting almost two years, the plants are characterized by the presence of huge rosette of subsessile broadly lanceolate and 5-7 nerved radical leaves (fig.2) with colour varying from light green to purplish–dark green in the same plant. Radical leaf size varied from 24 to 29 cm in length and 5.5-6.4 cm in breadth with the lamina lance shaped with multicostate convergent reticulate venation. The number of radical leaves per plant showed a gradual reduction with the emergence/ development of the main shoot and were completely absent at floral bud initiation stage.

Cauline leaves: Broadly ovate lanceolate, 5-7 nerved, subsessile with acute tipped ranging in length from 9.7 to 17.2 cm and 3.1 to 6.8 cm in breadth, and however, there was general reduction in size from base to the tip of the plant. Young cauline leaves were characterized by dark purplish tinge on the lower surface which however changed to dark green at maturity. Mostly plants with opposite and decussate leaf arrangement with straight shoot were present.

Floral attributes: Numerous small flowers borne in leafy panicles bearing axillary or terminal clusters of 3-5 flowers with quadrangular peduncle were encountered. The flowers were bracteate, pedicillate, actinomorphic, complete, bi-sexual, superior, tetramerous and light green with purple streaks on inner side. Profuse synchronous flowering from August to October and fruiting (fig.10) from October to early November in the third year was observed. Calyx consist of four equal sized persistent sepals fusing at base, green, lanceolate with acute tip, shorter than corolla and elongating at capsule maturation stage. Corolla consisted of four equal sized petals which were longer than calyx and divided near the base into four radiating ovate, lanceolate greenish yellow tinged with purple streaks towards the margin and acuminate tip segments. Each petal lobe bore a pair of nectaries at its base covered with oblong hairy scales (fig.9) extending upto half of the length of the corolla lobes. Average length of capsule ranged between 3.80-5.10 mm. The seed surface (as seen under simple phase contrast microscope) was characterized by polygonal reticulations and 1000 seeds weighed 27.025± 0.065 mg.

Discussion

Correct identity of the traded raw material of *S. chirayita* is always under doubt as several species like *Exacum tetragonum*, *E. bicolor*, *E. pedunculatum, Slevolgia orientalis*, *Swertia alata, S.angustifolia*, *S.bimaculata*, *S.ciliata, S.densifolia*, *S.elegans, S.lawii*, *S.minor*, *S.paniculata, S.multiflora* and most commonly *Andrographis paniculata* are commonly used as adultrant or substitutes of *Swertia chirayita* (Anonymous 1976; Joshi and Dhawan 2005). This creates lot of confusion and results in improper assessment of its price & efficacy as a drug. During the course of present investigation, correct identity of this species was assessed on the basis of morphological characters recorded in standard taxonomic literature (Clarke 1885; Blatter 1984) and also on the basis of presence of amarogentin , the compound present only in *S. chirayita* and *S. japonica* (Keil *et al.* 2000). All the morphological parameters like yellow roots, quadrangular upper stem portions, lanceolate cauline leaves, axillary inflorescence etc (Clarke, 1885; Blatter, 1984) perfectly matched with the plants under investigation. In addition, broadly ovate lanceolate, 5-7 nerved, sub-sessile, opposite and decussate cauline leaves with dark purplish tinge on the lower surface, inflorescence consisting of numerous flowers borne in leafy panicles bearing axillary or terminal clusters of 3-5 flowers, bracteate, pedicillate, actinomorphic, complete, bi-sexual, superior, tetramerous, lurid green coloured flowers with each petal bearing a pair of hairy nectaries at their bases, green, egg shaped, flattened from one side capsular fruits exhibiting septicidal dehiscence bearing numerous small, dark brown angular seeds with testa surface having polygonal reticulations and all parts of the plant tasting intensely bitter were the other morphological parameters based upon which its correct identity was established and their characters were in conformity with earlier reports (Anonymous, 1976; Bentley and Trimen, 1983; Kirtikar and Basu, 1975 and Shah, 2008).

However, there is no consistency in the literature regarding the habit of *S. chirayita.* It has been variously described as an annual (Anonymous, 1976; Kirtikar and Basu, 1975; Bentley and Trimen, 1983; Chauhan, 1999), biennial (Nautiyal and Nautiyal, 2004; Garg 1987; Shreshtha and Joshi, 1992) or pluri-annual (Edwards, 1993; Shah, 2008). During the present investigations, the pluri–annual (once flowering herb with flowering and senescence in the 3rd year after seed sowing) habit of its plants was established. It was observed that radical leaves which were large, sub sessile and lanceolate persisted in dense rosettes upto main shoot initiation. There was gradual reduction in their number up to floral bud initiation stage and were completely absent at and after flowering stage. The cauline leaves are much smaller in size than radical leaves and both types of leaves are infrequently observed simultaneously on the same plant. These results were found in conformity with the reports of Bentley and Trimen (1983) and Clarke (1885).

Based on this study, the critical morphological features for correct identification of *Swertia chirayita* are:

(i) once flowering herb (ii) robust stem circular below and quadrangular above containing a large pith (iii) stem colour changes from dark purplish to dark purplish-green (up to ¼ of stem height) initially and later on becomes completely dark green (iv) radical leaves large sized arranged in dense rosettes and broadly lanceolate with purplish colour on the underside and persisting almost for a year before main shoot development after which they completely dry up. (v) cauline leaves opposite, decussate and lanceolate (5-7 nerved) gradually diminishing in size upwards (vi) Inflorescence a panicle bearing 3-5 flowers in each cluster (vii) flowers lurid green and tetramerous (viii) each corolla lobe bearing a pair of nectar glands with long hairs at its base extending up to half the length of corolla lobe (ix) Capsular fruit bearing numerous dark brown

minute angular seeds (x) testa surface characterize by polygonal reticulation (xi) yellow coloured tap root system and (xii) all parts of plant taste extremely bitter.

Life Cycle of *Swertia chirayita*

Seed sowing in nursery (June 2006) ⇒ Germination initiation (28th June- 10th July,2006)

⇓

.Cotyledonary leaf stage (29th June - 16th July, 2006)

⇓

2- true leaves stage (21st July -17th August, 2006)

⇓

4- true leaves stage (24th August-3rd September, 2006)

⇓

6- true leaves stage (6th September-18th September, 2006)

⇓

8- true leaves stage (Pricking in polybags) (21st September-10th October, 2006)

⇓

8-10- true leaves stage Transplanting in field (6th April,- 10th April, 2007)

⇐

Radical mature leaf stage (Dense rosette of radical leaves) (April, 2007 to March, 2008)

⇑

Emergence of aerial shoots and appearance of cauline leaves (April, 2008)

⇑

Height increase of main shoot and emergence of lateral branches (June, 2008)

⇑

Emergence of floral buds (June, 2008)

⇑

Flowering stage (August, September, 2008)

⇑

Fruit and seed setting (October, 2008)

⇑

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CASE STUDY OF SUCCESSFUL CULTIVATION OF HIGH ALTITUDE MEDICINAL PLANTS OF HIMACHAL PRADESH

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BIODIVERSITY IN HIMACHAL PRADESH

Number of flowering plants in HP	±3,500
Medicinal plants	900
Aromatic Plants	150
Plants of Ethnobotanical Importance	350
Commercial medicinal and aromatic plants available	150-200
Plants species harnessed for trade and industry every year	85-100

CASE STUDY OF CULTIVATION OF *SWERTIA CHIRAYITA*

Botanical Name : *Swertia chirayita*
Family : Gentianaceae
Trade Name : Chirata
Common Name : Anaryatikta, Ardhatikta, Bhunimba, Chiratika, Chiratitka, Haima, Jvarantaka, Kairata, Kandtiktaka, kiranta, Kirataka, kiratatikta, Naditikta, Naipala, Nepalanimba, Nidrari, Ramasenka, Sannipatha, Sutiktaka, Trinanimba and Viktaka **in Sanskrit,** Cherayata in **Patna,** cherata in **Nepal,** Chiraita and Kairaita in **Mumbai,** Chirayatin in **Gujarat,** Chireta in **Bengal,** Nilaveppia in **Kerala** and Sekhagi in **Burma**. It is also called as Chiaravata (**Urdu**); Qasabuzzariah (**Arab, Farsi**); charayatah (**Deccan**); Nelabevu (**Kannada**); Nenilawandi; Nilavembu, Shirattakuchi (**Tamil**).

Plant Part Used: Whole Plant.

Recorded Distribution:

- Native of temperate Himalayas
- Kashmir to Bhutan(4000 ft. to 10,000 ft.)
- Khasi Hills (4000 ft. to 5000 ft.)

IMPORTANCE:

- Used in Traditional System of medicines-Ayurveda, Unani and Sidha etc.
- Medicinal usage reported in Indian Pharmaceutical Codex, American Pharmacopeia, British Pharmacopoeia.
- Blood purifier.
- Liver tonic.
- Antipyretic/Treatment of fever.
- Curing of Skin diseases.
- Antifungal.
- Antibacterial.
- Antihelmintic.
- Hypoglycemic.

Major Chemical Constituents:

The major bitter compounds include amarogentin and amaroswerin. Sweroside is another bitter compound present in *S.chirayita*.

Herbal Preparation:

- Ayush 64.
- Diabecon.
- Menstrual Syrup.
- Melicon V – Ointment.

Present Status:

- **High in demand.**
- **Domestic (Indian) and International market increasing @ 10 % annually.**
- **Critically Endangered plant.**
- **Almost nil Cultivation.**
- **Wild Harvested**

Adulterants and Substitutes:

- The trade and economics of chiretta is affected by adulterants of the herb.
- *S. angustifolia* is the most common adulterant of *S.chirayita.*
- *Swertia alata*, *S. bimaculata*, *S. ciliata*, *S. densifolia*, *S. elegans*, *S. lawii*, *S. minor*, *S. paniculata*, *S. multiflora* are also found as adulterants along with the true chiretta.
- Also substituted/adulterated by cheaply available *Andrographis paniculata.*
- In a study conducted at UHF on market samples of drug "Chirayata" procured from throughout Indian markets, only 40.45 % market samples of **drug Chirayata** were genuine.

Morphological & life cycle features of *S. chirayita* as reported in literature

A.	HABIT	
Sr. No.	**Description**	**Reference (s)**
1.	Annual herb.	Anonymous, 1976; Bentley R. and Trlmen H.,1983 ;
2.	Biennial herb.	Garg, 1987; Shreshtha and Joshi, 1992.
3.	Annual or biennial herb.	Nautiyal and Nautiyal, 2004.
4.	Pluri-annual.	Edwards, 1993.
5.	Annual or once flowering.	Kirtikar and Basu, 1975.

B.	Stem	
Sr. No.	**Description**	**Reference (s)**
1.	Robust, erect, terete except near the top.	Gupta, 1968.
2.	Stem 2-5 feet, 4- lineolate or subterete.	Clarke, 1885.
3.	Robust, 2-5 feet, branching, terete except near the top.	Collet, 1921; Kirtikar and Basu, 1975; Blatter, 1984.
4.	Erect, branched in the upper part; stiff, smooth and cylindrical below; bluntly quadrangular above, slightly thickened at nodes, with very large pith, often hollow in the lower part.	Bentley R. and Trimen H., 1983.
5.	Robust, branching, cylindrical below, 4- angled upwards, containing a large pith.	Anonymous, 1976; Chauhan, 1999 .

C.	Leaf	
Sr. No.	**Description**	**Reference (s)**
1	Cauline leaves subsessile, elliptic, acute, 5- nerved. Lower leaves of stem often much larger sometimes petioled.	Clarke, 1885.
2	Ovate or ovate- lanceolate, opposite sessile, smooth, rounded and semi amplexicaule at the base, acuminate at the apex,5 or 7 prominent parallel curved nerves below.	Bentley R. and Trimen H., 1983.
3.	Lance – shaped, lower sometimes stalked.	Blatter, 1984.
4.	Lanceolate, acute.	Collet, 1921 ; Gupta, 1921; Kirtikar and Basu, 1975.
5.	Lanceolate, acute, opposite.	Nautiyal and Nautiyal, 2004.
6.	Broadly lanceolate, 5 nerved, subsessile.	Anonymous, 1976; Chauhan, 1999.

D.	Inflorescence	
Sr. No.	**Description**	**Reference (s)**
1.	Large leafy panicles, many fid.	Clarke, 1885.
2.	Large panicles.	Anonymous, 1976.
3.	Panicles large, many flowered, leafy.	Blatter, 1984.
4.	Numerous, small, axillary, opposite, lax cymes (often reduced to a single flower) arranged on the short branches and the termination of the stem while forming an elongated tapering panicle 2 feet in length.	Bentley R. and Trimen H., 1983.

E.	Flower	
Sr. No.	**Description**	**Reference (s)**
1.	Small and stalked.	Bentley R. and Trimen H., 1983.
2.	Lurid, greenish yellow tinged with purple.	Anonymous, 1976; Chauhan, 1999.
3.	Tetramerous.	Handa et al., 1998.

F.	Fruit	
Sr. No.	**Description**	**Reference (s)**
1.	Capsule, ovate and acute upwards.	Clarke, 1885
2	Small, one celled capsule. Pericarp transparent, yellowish, septicidal dehiscence from above into two valves.	Bentley R. and Trimen H., 1983.
3	Capsule, egg shaped, pointed.	Blatter, 1984.
4	Capsule, egg shaped, many sided and sharp pointed.	Chauhan, 1999.

G.	Seeds	
Sr. No.	**Description**	**Reference (s)**
1.	Polyhedral, smooth, testa close or not reticulated .	Clarke, 1885.
2	Numerous, minute, many sided, angular testa pitted, embryo very small in fleshy endosperm.	Bentley R. and Trimen H.,1983.
3	Smooth, finely netted or not.	Blatter, 1984.
4	Smooth, many angled .	Anonymous, 1976; Chauhan, 1999.

Life Cycle of *Swertia chirayita* as studied at UHF.

No. of months since seed sowing	Growth and Development features
0 (June,2006)	• Seed sowing in nursery
1 (July,2006)	➢ **Radical emergence** ➢ Cotyledonary leaf stage (leaf length equal to leaf breadth= 0.2 cm)  **Embryonic leaves with retuse tip** ➢ Initiation of 2- true leaves stage (length upto 0.5 cm and breadth upto 0.3 cm)  **True leaves with obtuse tips**

No. of months since seed sowing	Growth and Development features
5 (October, 2006)	➢ Seedlings 6-8 leaved (length upto1.93 cm and breadth upto 1.43 cm) ❖ **Seedlings pricked in polybags** ❖ Long (length upto 3.26 cm) elongated thin light brown tap root 
11 (April,2007)	• **Polybag raised seedlings field transplanted** • Seedling 8-10 true leaves (length upto 6-8 cm and breadth upto 1.50-2.00 cm) • Seedlings with a dense rosette of radical leaves

Contd…….

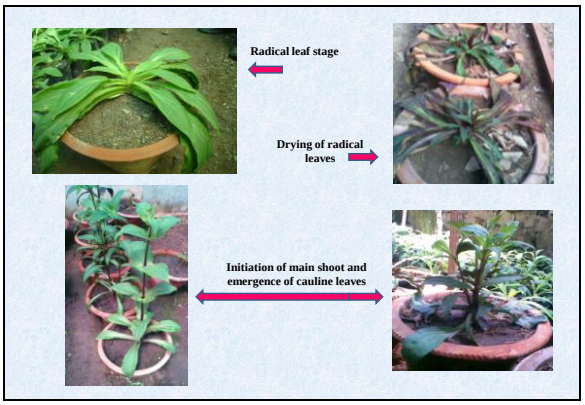
12 (May, 2007)	• Polybag raised seedlings grew further showing dense rosette of radical leaves • Radical leaves lanceolate, subsessile and large (length upto 7.81 cm and breadth upto 1.75 cm)
15 (August, 2007)	• Further expansion in the mass of radical leaves • Radical leaves arranged in dense rosettes, 5-7 nerved • Radical leaves large (length upto 26 cm and breadth upto 6 cm)
17 (October,2007)	• Further increase in number and size of radical leaves (length upto 30 cm and breadth upto 6.2 cm)
19 (December, 2007)	• Radical leaves show symptoms of browning with the onset of winter • Partial drying of radical leaves • Leaf margins become slightly wrinkled

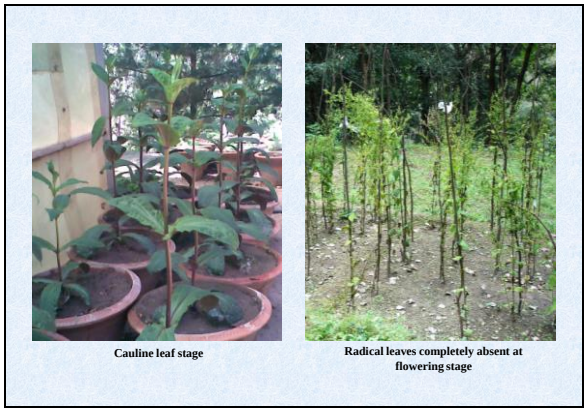
Contd…….

23 (April,2008)	• Drying of radical leaves • Initiation and rapid increase in height of main shoot (upto 30.5cm) • Appearance of cauline leaves • Abaxial surface of Cauline leaves dark purplish • Stem cylindrical and dark purplish throughout
24 (May, 2008)	• Stem cylindrical erect, dark purplish from base upto 1/4th of stem height and green above • Plant height shows further increase upto 75 cms • Cauline leaves opposite alternate and decussate gradually diminishing in size above • Drying of radical leaves
25 (June, 2008)	• Lateral branches smooth, tender, green and arise in the axils of cauline leaves • Internodal length increases • Plant height upto 118 cm • Further increase in the size of cauline leaves (Length upto 17 cm and breadth upto 7 cm) • Abaxial cauline leaf surface purplish and adaxial surface green • Number of radical leaves decreases further • Number of cauline leaf pairs remains constant

Contd…….

26 (July, 2008)	• Initiation of floral buds • Radical leaves completely absent • Stem starts becoming quadrangular above middle portion • Plant height shows further increase upto 145 cm • No further increase in size of cauline leaves
27 (August,2008)	• Anthesis begins • Asynchronous profuse flowering • Buds of different growth stages on same branch • Panicle bearing 3-5 flowers in each cluster • Plant height increases upto 198 cm
28 (September, 2008)	• Fruit and seed setting
29 (October, 2008)	• Fruit maturation • Initiation of senescence





Life Cycle as studied at UHF

- Plants of this species are once flowering (Pluri-annual) herbs and the flowering takes place in the third year after seed sowing.
- Seed germination to seedling (field transplantation) stage takes about 10 months from the sowing date (first year).
- The established plants in the field take about almost one complete year while being at the radical leaf stage. During this period the plants produce dense rosette of radical leaves.
- In the third year, simultaneous with the production of main shoot, there is gradual degeneration of radical leaves. The main shoot bears cauline leaves and flowering occurs in the same season.
- After seed set the entire plant dries up (third year).

Critical morphological features for correct identification of *Swertia chirayita* are:

- Once flowering herb
- Robust stem circular below and quadrangular above containing a large pith
- Stem colour changes from dark purplish to dark purplish-green (up to ¼ of stem height) initially and later on becomes completely dark green
- Radical leaves large sized arranged in dense rosettes and broadly lanceolate with purplish colour on the underside and persisting almost for a year before main shoot development after which they completely dry up.
- Cauline leaves opposite, decussate and lanceolate (5-7 nerved) gradually diminishing in size upwards.

- Inflorescence a panicle bearing 3-5 flowers in each cluster
- Flowers lurid green and tetramerous
- Each corolla lobe bearing a pair of nectar glands with long hairs at its base extending up to half the length of corolla lobe
- Capsular fruit bearing numerous dark brown minute angular seeds
- Yellow coloured tap root system
- All parts of plant taste extremely bitter.

Constraints in Cultivation:

- Unavailability of planting material.
- Long gestation period.
- Delicate field handling.
- Lack of Standardized nursery practices.

Propagation : through seed

✓ Seed minute (40,000 ≈ 1 g)

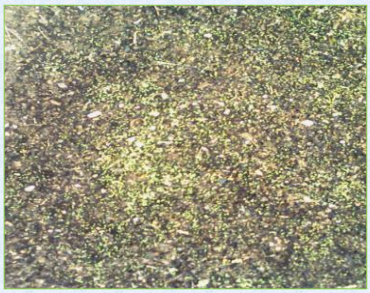
✓ Loose viability during normal storage

Nursery raising: Standardized at Medicinal and Aromatic Farm Shilly, Dept. of Forest Products UHF Nauni, Solan, H.P.

Sowing time : April – May

Media: Sieved Soil: FYM: Oak leaf manure :: 3 : 1 : 1

- Sterilize media with formalin.
- Enrich media with bio-fertilizers.
- Prepare beds.
- Protect nursery with UV stabilized plastic sheet.
- Provide shade with 50 % shade net.
- Treat seed with 100 ppm GA_3
- Sow seed on top of the bed and cover with sieved media (1-2 mm).
- Irrigate daily three times with the fine mist by using spray pump.
- Seed germination: 25-30 days.



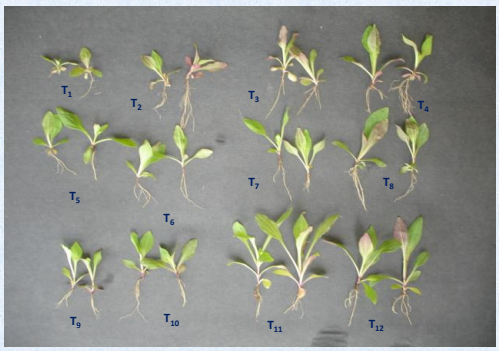
Germinated Seedlings

- 2 true leaves - 60 to 65 days.
- Reduce watering to twice a day.
- 4 true leaves - 85 to 90 days.
- 6 true leaves - 100 to 110 days.
- Reduce watering to once a day.
- 8 true leaves - 120 to 125 days.
- Prick seedlings at 6 to 8 leaves stage in P. bags filled with media.
- Irrigate carefully after pricking for 5-6 days.
- Can be watered with rosecan after establishment.
- Seedling ready for transplanting after 6 months during March- April.

Seedlings ready for Pricking

Pricked Seedlings

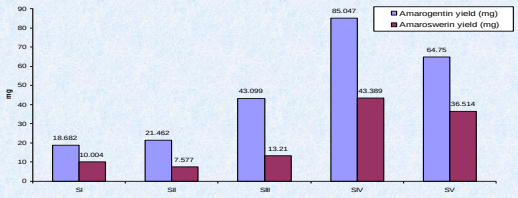
Seedlings ready for planting in field



Seedlings of different treatments at pricking stage

Transplanting time : April-May
Spacing : 30x45 cm (70,000 plants/ha)
Harvesting : Sept.- Oct.(Third Year)

Yield dynamics of bitter compounds in *Swertia chirayita*



SI = *Pre-emergence of aerial shoot/radical leaf stage*; SII = *emergence of aerial shoot*; SIII = *pre-flowering*; SIV = *flowering* and SV = *post flowering/leaf senescence*

Yield:
3500-4000 Kg/ha (dry herbage)

Current Market Rate:
Rs. 350/Kg

Total Return/ha:
Rs. 12,25,000

CASE STUDY OF CULTIVATION OF *ACONITUM HETEROPHYLLUM*

Aconitum heterophyllum

Common Name: Atish, Patish and Atvisha

Status: Endangered medicinal herb endemic to north-west Himalaya.

Family: Ranunculaceae.

Distribution :

- The Genus *Aconitum* (Ranunculaceae) is widely distributed across North Asia and North America, 27 species of which are found in India.
- *Aconitum heterophyllum* is confined to sub-alpine and alpine regions of Himalayas, distributed between 2800 and 4500 m amsl
- It prefers grassy slopes and pasturelands. It is one of the most used non-poisonous aconites and distributed within the country in Jammu and Kashmir, Himachal Pradesh and Uttaranchal. It also occurs in Afghanistan, Pakistan and central Nepal.
- In Himachal Pradesh it occurs at 2500-4500 meters amsl in Chota Banghal and Bara Banghal areas of Kangra, Mani Mahesh in Chamba and some parts of Sirmour, Lahaul and Spiti, Shimla, Kullu and Kinnaur

Adulterants:

- *Cyperus rotundus* (*Musta*)
- *C. scariosus*
- *Cryptocorynespiralis* (Country *Ativisha*)
- *Aconitum kashmiricum* Stapf
- *Chaerophyllum villosum* Wall

Useful part : Tuberous roots

MEDICINAL PROPERTIES :

- **Dysentery**
- **Diarrhoea**
- **Stomach disorders**
- **Fever malarial**
- **Vomiting**
- **Tuberous roots have been used by various ethnic communities for curing different ailments (rheumatism, fever, paralysis etc.)**
- **Root powder is put in tooth cavities against tooth ache**
- **Its root extract are used as a tonic and as a substitute of quinine**
- **The tuber is used as anti- inflammatory, analgesic, febrifuge especially for poisoning from scorpion or snakebite and fever from contagious diseases**

Varying tuber yield estimates have been reported by different workers.

- Nautiyal and Nautiyal (2004) : Tuber yield of 44 kg per acre from a natural stand.
- 10 to 12 times more under greenhouse conditions is economically more beneficial as compared to natural conditions
- Propagation through vegetative means at 2200m amsl altitude has been reported to yield 33.73 kg per acre .
- However, through seed propagation, after three years a yield of 250-300 kg per hectare has been reported
- According to Anonymous (2008):After three years 518 kg per hectare and 579 kg per hectare has been reported if raised through seedlings and vegetative means respectively.

ECONOMICS: The rate for a kg. of dried tuberous root ranges from Rs. 3000-4000. (YEAR-2004)

CHEMICAL CONTENTS

- Tubers contain a non- crystalline, non – toxic alkaloid atisine (0.4%)
- Nearly 0.79% of the total alkaloids in the plant are in the root
- Alkaloids : Heteratisine (0.3%), histisine, heterophyllisine, heterophylline, heterophyllidine, atidine and hitidine
- Aconitic acid, aconitine, tannic acid, mixture of oleic, palmitic and stearic glycerides and ash.
- The roots contain 4.3% indacotinine, aconitic acid and starch

Key points of the study

- Vegetative characters as well as tuber yield are positively impacted by domesticated conditions.
- *Aconitum heterophyllum* is amenable for domestication/cultivation which gives higher tuber yield as compared to wild conditions
- Non significant variation in seed output between domesticated and wild conditions indicates that under domesticated conditions seed set is not compromised
- Molecular characterization through ISSR have shown genetic diversity among the populations.

Cultivation of high altitude medicinal plants through cluster approach in Uttarakhand

Dr. V.P. Bhatt
Herbal Research and Development Institute, Mandal (Gopeshwar)

Sustainable Development of Medicinal and Aromatic Plants through cluster based cultivation approach in high altitude of Uttarakhand Himalaya

Vijay Prasad Bhatt, Herbal Research & Dev. Institute, Gopeshwar, Chamoli,Uttarakhand

All the respected members of organizers' committee, speakers, delegates and participants are welcomed to this presentation from the remote part, but one of the major homes for celestial medicinal herbs.

Vision

- To Develop Uttarakhand as Herbal State by diversification of land use from low productive cereal based cropping system to high value and low volume medicinal and aromatic crops .
- To enhance income level of farmers through sustainable development of medicinal and aromatic plants.
- To make medicinal sector as main growth driver for economic development of State and enhancing share of medicinal sector in GSDP of State by increasing marketed surplus and processing of produce.
- Creating employment opportunities for unemployed rural youth .

Mission

- Survey, documentation, conservation and cultivation of MAPs.
- Research on biodiversity, biotechnology, quality control, value addition, post harvest technology and genetic improvement of MAPs.
- Development and transfer of agro-technology for cultivation and processing.
- Documentation of traditional and folk medicinal system.
- Human resource development and dissemination of information related to the MAPs sector.
- Coordination among research and development institutions and other stakeholders working in MAPs sector.
- Establishment of linkages with Central Government, various funding agencies and Industries.

Policies for Development of MAP Sector in Uttarakhand

- Prioritisation of 28 species for cultivation in different agro climatic zones.
- Facilitation for nursery development, cultivation, value addition and marketing.
- Production and free distribution of planting material.
- Registration of MAPs growers.
- 50% subsidy on prioritised species.
- Establishment of collection centres, Mandies and drying facilities.
- Providing transit permit for marketing of MAPs produce.
- Implementation of CDH (Conservation, Development and Harvesting) plan for *in situ* and *ex situ* conservation, development and harvesting of MAPs.
- Extension activities at Block level through Master Trainers.
- Revolving fund for purchase of aromatic crops and essential oils.
- Minimum support price for aromatic crops.

Major Programmes/Schemes

1. Ayush Mission on Medicinal Plants:- Under this scheme following activities are implemented:-

- Nursery development.
- Area Expansion through cultivation of medicinal plants.
- Post Harvest Management (Grading, Packing center).
- Training of farmers / entrepreneur / officials.

2. State Sector Scheme:- Under this scheme following activities are implemented:-

- Research and Development activities are undertaken for development of package of practices for various medicinal plants.
- Assistance is provided to farmers for cultivation of medicinal plants.
- Production of planting material of medicinal plants in Government Gardens / nurseries.
- Training of farmers / entrepreneur / officials.

Why Himalaya and Himalayan Plants?

- Himalaya is an abode of valuable medicinal plants since ages?
- Most of the high altitude areas are gifted with severe and diverse climatic condition.
- Hence, most of the species survive in diverse climatic conditions.
- And as a result they produce highly valuable secondary metabolites of high medicinal value?
- Finally they are of high value medicinal plants in the world.

Importance of cultivation of high altitude medicinal plants

- Cultivation is only an easy alternatives to conserve plats in nature as it reduces dependence on nature for demand of medicinal plants.
- Cultivation ensures proper botanical identity of plants example kuth and *Arctium lappa.*
- Cultivation has pharmacological benefits over wild collection as the cultivated material is always high in organoleptic properties.
- However, proper agro-technology of most of the high altitude medicinal plants is yet to be standardized?

Species for cluster based cultivation in high altitude

- Atis (*Aconitum heterophyllum*): ***500 kg. per month***
- *Kuth (S. costus):* ***Dabur***
- *Jamboo (Allium spp):* ***Local Market***
- *Kala jeera (Carum and Bunium):****Local Market***
- *Gandrayan (Pleurospermum angelicoides):* ***Local Market***
- *Kutki (Picrorhiza kurrooa):****International trade***
- *Tagar (Valeriana jatamansi):* ***All pharmaceutical co.***
- *Puskarmool (Inula racemosa):* ***Dabur***
- ***Other Mansi, podophyllum-cultivation problem?***

How to promote cultivation?

- Very less land holdings and migration from high altitude?
- Long gestation period of most of the species
- High transportation charges? Farmers need transportation subsidy!
- Lack of quality planting material.
- Post harvest, Processing, value addition and marketing?

Growing medicinal plants

Cultivated medicinal plants under NMMP


Kala jeera


Cheepi


Atis


Jamboo under cultivation

Cultivation of MAPs in cold desert areas of Uttarakhand


Kutki cultivation


Kuth nursery plants


Post-harvesting Kuth


Cheepi cultivation

Processing and Drying of *Allium* (Jamboo) in Milam Valley, Pithoragarh

Special Initiative: GI of UttarakhandTejpat

•Tejpat of Uttarakhand is the first medicinal plant of the State which is under the process of registration under geographical indication (GI)with the support of UNDP.

Emergence of new herbs in trade: a major threats to *in situ* conservation

- Sometimes, new species of herbs come either into national or in international trade and its unscientific and many time illegal collection begins for economic earning leading the species on the verge of extinction.
- Collection of Caterpillar mushroom (*Ophiocordyceps sinensis*) beyond carrying capacity during and after 2000 AD from above 4000 m., more than 10,000 families got benefitted economically but leading this and along with other species on the verge of extinction , i.e. *Juniperus* for fuel wood besides collection of other species of herbs. *Cordyceps* has tremendous demand in Chinese and Hong Kong market. At present the rate is more than 10 lakh per Kg in Indian side.
- Similarly, Satuwa (*Trillidium govanianum*, Rs. **2500 per Kg**.) and Van-Lahsun (*Fritillaria cirrhosa*, Rs. **10,000 per Kg**.) suddenly came into trade in China and today difficult to see them in wild.
- These activities are mainly carried out only for economic gain.

Collection of *Cordyceps sinensis* from the cold desert areas of Uttarakhand

Documentation of ethno-botanical knowledge: developing an art – A lession from Bhotia tribal from Uttarakhand

- They live very close to nature and most of the areas are inaccessible to market facilities and they have dependence on natural resources both in time and space. Mostly, as other tribes of the World, they are solitary.
- They are storehouse of traditional botanical and zoological knowledge but this knowledge is declining at the rate faster than ever, because most of the families have migrated to the cities for jobs and education. **Example from Uttarkashi Jadh community is explained here. Sanjeevani in Dronagiri.**
- The knowledge of using plants, ways of worshiping of God and Godess, cultural and social rites in different valleys differ from each other, i.e. *Ephedra gerardiana* known as ***Chai*** in Uttarkashi and inhaled with smoke to cure cough and cold while the Marcha of Chamoli call it ***Jodghanta*** because of the presence of node and internode but they do not use it, it was only traded up to the last decade of 20th century. Not known to Bhotia of Pithoragarh
- Develop family relation with them, respect their cultural and social rites, follow their rules and customs, participate in their domestic works, enjoy their meals and definitely some benefits of sharing knowledge should accrue to them (**IPR Issue is important**).

Sea buckthorn has been shown to have a potent antioxidant activity, mainly attributed to its flavonoids and vitamin C content	• **Cancer therapy** • Liver tonic
Cardiovascular diseases	• **Liver cirrhosis** • **Gastric ulcers**
Cosmetic Products	• Skin diseases • Sun burns in high altitude

Scope of Documentation of ethno-medico-botany

- More than 80 % of the medicinal plants from the High altitude have not been explored scientifically. (Physical disorders and Mental disorders and treating them).
- These date will help in production of new herbal products thus benefitting human life from serious ailments and diseases.
- This will eventually help understanding these peoples more closely in relation to their cultural and social custom and knowledge which itself is on way to extinction.
- The proper identification of species and finally using them medicinally at least in the internal trade will generate new avenues for employment generation to these poor people and this will finally control their migration from the villages.
- These activities will lead to the conservation of biodiversity of medicinal plants in high Himalaya.

Conclusion

- Documentation of traditional knowledge should be an important and essential part of the research especially in the tribal areas. Most of the benefits should accrue to the local peoples.
- Locally used species should be identified properly and should be tested for biological activities in the laboratory.
- Rare and endangered species should be brought under cultivation.
- Cultivation protocols should be developed for these species.
- Training module on post harvest technology and value addition should be developed for these species.
- *in situ* conservation of rare and endangered species should be promoted.

Case study of successful cultivation of high altitude medicinal plants in Uttarakhand

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Abstract

The potential of medicinal and aromatic plants is widely recognised and the cultivation of important threatened species is considered to be of great importance for the protection of their diversity as well as an option for livelihood. In India about 20 species are under commercial cultivation and nearly 90% of the medicinal plant raw material supplied to the market is harvested illegally from the wild, often in a destructive and irrational manner. In Uttarakhand, except for a few species that are grown in kitchen gardens, the cultivation of few medicinal plants is in an initial stage. However, as the state wishes to be recognised as a herbal state, large scale cultivation of wild, threatened medicinal and aromatic plant species is needed urgently. Most of the population of Uttarakhand lives at middle to high altitude (1000 -2800 m). Many of them are looking for alternative enterprises as their traditional crops are getting less productive. They earn little from growing cash crops like potato and rajma, mainly because of high transport costs and unorganised marketing channel. Cultivation of medicinal plant species suitable for high altitudes could be an option. However, for a number of reasons, which include lack of technology, this has not happened.

The High Altitude Plant Physiology Research Centre (HAPPRC) has been working on various aspects of high altitude medicinal plant species for the past three decades. It has developed cultivation technology for a number of species. Once cultivation technology for a species is available it needs to be transferred to the field to be tested and subsequently supplied to interested farmers. This was the main objective of HAPPRC for initiating a scheme to promote the commercial cultivation of *Picrorhiza kurrooa* (Kutki) in the remote village of Gheshe (2500m) in the Chmoli district of Garhwal Himalaya in 2002. After thirteen years of continuous efforts and observations, a tangible impact of Kutki cultivation has been recorded in comparison to other traditionally growing crops i.e., Potato (*Solanum tuberosum* L.), Chaulaii (*Amaranthus spinosus* L.), Rajma (*Phaseolus vulgaris* L) etc. in the village. The commercial cultivation of this valuable species creates the additional source of income for villagers and also helps in the conservation of this species in its natural habitat.

Introduction

The Western Himalaya is one of the well-defined and better-known phyto-geographical region of the Indian subcontinent. It is extremely rich in plant life and abounds in diversity of medicinal and aromatic plants. High attitude region of Himalaya in particular harbours many medicinal and aromatic plants of great economic deal. These plants grow under various types of stresses and are considered to be the store house of secondary metabolites and therefore are important source of biopharmaceuticals and biocosmetics (Purohit, 1997).

According to cumulative estimate, Uttarakhand Himalayas has more than 3500 species of flowering plants most of which are in forests or alpine meadows (Rawat *et al*., 2001). It is estimated that 350 items of vegetable crude drugs consisting of root, rhizome, stems, leaves, flowers, fruits, seeds etc. of MAPs are exported from India to various parts of the world (Purohit, 1997). However, almost all medicinal plants are collected either legally or illegally from the nature for different purposes. Owing to large internal demands, export potential and preference for natural plants, has/ had an adverse impact on wild populations of medicinal plants. Over harvesting from the wild has brought several species at the brink of extinction. Need of conservation management schemes are eagerly felt by environmentalists to save the wild populations of these species.

Research and developmental program on high altitude medicinal plants need immediate attention. Conservation of these plants through cultivation is the most effective way, which on one hand will reduce our dependence on the natural pockets and on the other will augment the economy of local people. Hill farmers are still looking for ecologically sound energy efficient technologies to substantially increase the productivity of their land. To fulfill people expectation it is necessary to provide them new technologies especially on potential resources like cultivation of high value wild medicinal plants. This was the main objective of HAPPRC for initiating a scheme to promote the commercial cultivation of *Picrorhiza kurrooa* (Kutki) in the remote village of Ghese (2500m) in the Chamoli district of Garhwal Himalaya in 2002.

Picrorhiza kurrooa is a small herbaceous creeping alpine species, represented by two morphological variants in Garhwal Himalaya, *viz*., narrow leaf (NL) and broad leaf (BL) variants, scarcely occurring at an altitude of 2700m - 4500m asl. NL variant is generally found on rock surfaces and near springs while BL under the shrub and scrub canopies. The Centre has observed that among the two variants of *Picrorhiza kurrooa,* broad leaf (BL) variant was found suitable showing better quality and higher yield (Nautiyal *et. al*., 2001). The stolons of this species has been traditionally used to treat worms, constipation, low fever, scorpion sting, asthma, Jaundice, Diarrhoea, Influenza, Cirrhosis and ailments affecting the liver. It is also considered to be valuable

bitter tonic. High medicinal value of Kutki increased its market demand for the purpose of both allopathic and traditional medicines. The increasing demand and illegal and unscientific exploitation from wild is ultimately affecting its long run survival. Keeping this in view, Kutki has been listed in CITES- (Conservation on International Trade in Endangered species of wild Fauna and Flora) Appendix II and the Indian Red List of endangered species. This puts serious restrictions on the trade of non cultivated Kutki obtained from the wild. After the initiatives taken by HAPPRC, the cultivation of BL variant of Kutki is now being carried out by farmers in Ghese village and surrounding areas in Chamoli district of Garhwal Himalaya. HAPPRC has also taken initiatives to organize field training programmes for the farmers to start the cultivation of this species. Large scale cultivation of *Picrorhiza kurrooa* will be helpful to provide the pure drug to the pharmaceutical industries and can also reduce the exploitation pressure on the natural population, thus helping to conserve the species in its natural habitat. After thirteen years of continuous efforts and observations, a tangible impact of Kutki cultivation has been recorded in comparison to other traditionally growing crops *i.e*., Potato (*Solanum tuberosum* L.), Chaulaii (*Amaranthus spinosus* L.), Rajma *(Phaseolus vulgaris* L) etc in the village as indicated in table 1. The commercial cultivation of this valuable species creates the additional source of income for villagers and also helps in the conservation of this species in wild.

Main characteristics of Ghese village

Ghese village is located at an altitude of 2200 to 2500 meters and is spread over a large area (6-8 km in length) and individual families have relatively large land holdings a factor which favoured the launching of the programme. Most of the men in the village are retired army personnel who are open to new Ideas. They were very worried about their future because of the remoteness of the area (the road head in year 2000 had 20 km. long trek from the village) and limited options. Village is surrounded by a rich and diversified wealth of medicinal plants, and people were fully aware of the potential of this wealth. Yet the important issue was how to use this potential for the improvement of their livelihood, generation of extra income and self employment. HAPPRC took this as an opportunity to test their medicinal plant technologies, make further improvement and ensured people's participation in its development programme. That is how the programme one of the first attempts to develop large scale cultivation of high altitude medicinal plants in India was initiated.

Initial stage of cultivation programme at Ghese village

The villagers of Ghese village had immense interest for the development of their village. With this aim in mind Captain K.S. Bisht, a retired army man from Ghese village, came in contact with founder Director of High Altitude Plant Physiology Research Centre (HAPPRC) Prof. A. N. Purohit. After several meetings and discussions on the importance of high Altitude Medicinal plants, scientists from HAPPRC visited Ghese village in June 2001 to make a general survey and met the villagers. The economics of cultivation of major traditional cash crops of the village like Potato, Chaulaii and Rajma was worked out and compared with the economics of cultivation of Kutki (calculated from our demonstration site at Pothibasa). It was observed that cultivation of Kutki can give much better economic returns to the farmers in comparison to the traditional cash crops as shown in table 1. It was also found that the climate and soil conditions (especially soil moisture and organic contents) were suitable for the cultivation of high altitude medicinal plant species. This encouraged us to make a second visit in September 2001 to make the villagers aware of the potential of medicinal plants and demonstrate some primary techniques in the cultivation of selected species. During the demonstrations villagers participated actively and showed a keen interest in the cultivation of medicinal plants. Convincing the villagers of the benefits of cultivation programme, HAPPRC distributed seed and seedlings of Kutki, Atis, Jatamansi, Kuth, Archa etc. free of cost to the farmers in April – May 2002, and cultivation was initiated. This was done under the assurance that HAPPRC would provide technology and training to farmers and pay regular visits. The uncertainties raised by farmers about the economic returns of cultivating medicinal plants compelled HAPPRC to search for possibility of a buy back arrangement, easing the marketing of their medicinal plant crop. Ultimately an assurance could be given to the villagers that a buy-back agreement has been reached with a company. As a result the villagers agreed to start the cultivation of Kutki (*Picrorhiza kurrooa*) and Kuth (*Saussurea lappa*).

The tripartite agreement: Both farmers and HAPPRC were aware that the marketing of medicinal plant is beset with uncertainties. In order to estimate the demand for high altitude medicinal plant species, and to arrange for buy-back guarantees, a number of firms were contacted by HAPPRC, perhaps because most of the important High altitude medicinal plants are banned species the majority of the firms had reservation and only a few responded. One of the firms that showed interest was Dhawan International, a Delhi based firm. The firm was interested in the purchase of High altitude medicinal plant species including *Picrorhiza kurrooa* (Kutki), *Aconitum heterophyllum* (Atis), *Nardostachys jatamansi* (Jatamansi) and *Swertia chirayita* (Chirayita).

It was particularly interested in originally grown material. The proprietors of the firm visited the Center where they were informed about the cultivation programme at Ghese. They were told that in the first phase the villagers were willing to take up the cultivation of *P. kurrooa*, while other species could be included at the latter stage. Convinced that cultivation technology and expertise were available and of the people interest in the project, Dhawan International agreed to collaborate with HAPPRC through a Memorandum of understanding (MoU), which was signed on April 22, 2002. This led to the signing of a tripartite agreement between HAPPRC, Dhawan international and the Ghese villagers on August 9, 2002. This document laid the basis of the cultivation of the aforementioned species and the buy-back guarantee for harvested produce.

According to the agreement, the farmers were required to cultivate these crops organically. It was agreed that the company would buy the product from a minimum of half an acre to a maximum of 50 hectares per growing season. HAPPRC will be free to transfer its technology to other companies when cultivation extended more than 50 hectares. In return for the buy-back guarantee growers were required to sell their production only to Dhawan International. The selling price was determined with the help of a formula contained in the agreement. The price prevailing at time of the agreement was fixed as the minimum price. The selling price was determined by taking into account both the minimum price and the prevailing price one month before the time of delivery. It has been agreed that the difference between the minimum price and selling price will be shared equally between the industry and the farmer's society. This agreement gave lot of relief to the 32 farmers involved in the cultivation programme as now they were sure of being able to market their produce and at reasonable price.

HAPPRC had assured the company that it will provide the best technological assistance to farmers to ensure a high quality product. Finally the farmer's society ensured about certain quality standards as mentioned below:

- Dried root should contain at least 1% total picrotin I and II (higher priority);
- The dried root supplied should have a maximum moisture content up to 8%:
- Root size should be between 1 and 1.5 inch in length:
- No foreign matter such as soil, rodent hair, dust, stones, leaves etc. should be present.

The appearance and overall quality of the material was tested by taking a representative sample from the harvest, in the presence of all parties. The sample was tested and certified by HAPPRC. It is worth mentioning that at an earlier stage HAPPRC had already tested some sample for active ingredients. It was found that the quality was far better than described in the agreement. There was a provision in the agreement that the farmers can ask for an advance from Dhawan International. However, during the entire course of cultivation at Ghese, the farmers have not taken any financial assistance from the company relying totally on their own resource.

Table 1: Comparison of Cost-benefit of Kutki (dry rhizome) and other major traditionally cultivated crops at Ghese village

Crops	Total expenditure (Rs.)/ hectare*	Total production kg/ (Dry wt.)/ hectare (average on 3 years basis)	Current prices (Rs.)/ Kg	Total income (Rs.)/ per hectare	Net profit/ loss (Rs.)/ hectare
Picrorrhiza kurrooa (Kutki)	225000	850	800	680000	455000
Solanum tuberosum (Potato)	253000	27000	18	486000	233000
Amaranthus spinosus (Chaulaii)	125000	7500	50	375000	250000
Phaseolus vulgaris (Rajma)	172500	1850	100	185000	12500

*expenditure on cost of planting materials, land preparation, fertilizes, wages for field workers, irrigation, harvesting, monitoring and transport.

Consolidation of the programme: The selection of farmers was done neither by HAPPRC nor Industry. The villagers decided themselves who would cultivate Kutki and how much in which area. In total 32 farmers signed the agreement each indicating the area they would dedicate to Kutki cultivation. In total an area of 5 hectares was designated for kutki cultivation. The farmers registered a farmer's society (Ghese kishan samiti) at Bhaisaj Sangh to acquire a permit for commercial cultivation of Kutki.

Out of the 32 farmers 15 were selected for intensive training organized by HAPPRC on 23rd and 24th September 2002. The training included visits to HAPPRC's nursery site at Pothivasa, which has been developed as a demonstration cum planting material site and its alpine field station Tungnath. Farmers were encouraged when they saw fields covered by full bloom of *Picrohiza kurrooa* (Kutki) growing under climatic, topographic

and soil conditions similar to their own. Although, many farmers were interested, but due to limitation of planting material, initially only five farmers could start cultivation. However, the next year the stock raised by these farmers was used to raise planting material for more farmers who wished to be engaged in the programme. Subsequently the farmers used the old stock to raise planting material for more farmers of Ghese and adjoining villages.

In the beginning plant growth took a long time to pick up as early establishment of the plants was very slow because of slow phenological progression. Also the initial lack of technical knowhow hampered the farmers in optimizing the crop development. After proper training the farmers were able to improve the situation (partly through manuring the fields) and the plants became well established showing good growth during the next growing season and thus maintaining the interest of the farmers. Five farmers who initially took the cultivation maintained their Kutki plantation by taking proper care with timely weeding, manuring and irrigating the crop as per technical knowhow given by HAPPRC. First harvest of the Kutki was done in October 2005 by the five farmers who initially started the cultivation in 2002. A total yield of about 200kg was recorded in this first harvest and the produce was purchased by Dhawan International as per the terms and conditions of the agreement. For this purpose a small function was organized on the road head near the village in which the farmers from other villages also participated. Cost of the produce was distributed to the concerned farmer in the form of bank cheques. The purpose of this function was to give the wider publicity among the nearby farmers about the cultivation of high altitude herbs. This event ultimately assured the farmers to get the returns from the Kutki cultivation and consequently more farmers opted for its cultivation. Figure 2 shows the overall progression of cultivation of Kutki at Ghese village from 2002 to 2014. Initially the establishment of cultivation was slow and only few farmers were engaged with the cultivation but once the farmers got the returns from the first harvest, more area was covered as well as more farmers opted the cultivation of Kutki. Subsequently, as the cultivation came in the periodical blocks of 1,2 &3 years farmers started getting returns from the sale of Kutki every year. Figure 3 shows the year wise sale of Kutki (dry stolons) from Ghese village. Figure clearly indicates that subsequent to first harvest in 2005 production as well as earnings of farmers increased every year. In addition the sale of planting material mainly the stolon cuttings to other interested farmers, NGOs and government organization also augmented the income of the cultivators as

Fig 2. Year wise progression in land under Kutki cultivation

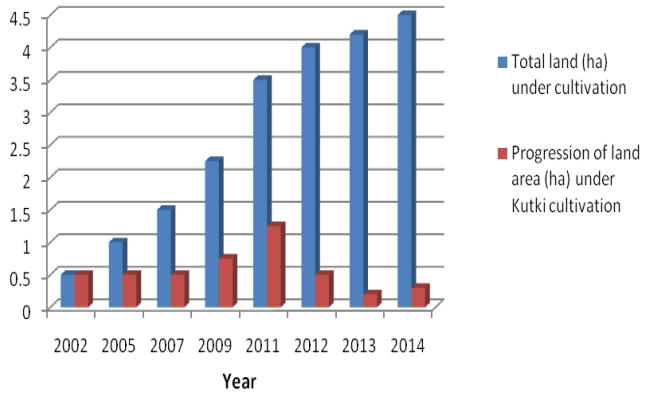
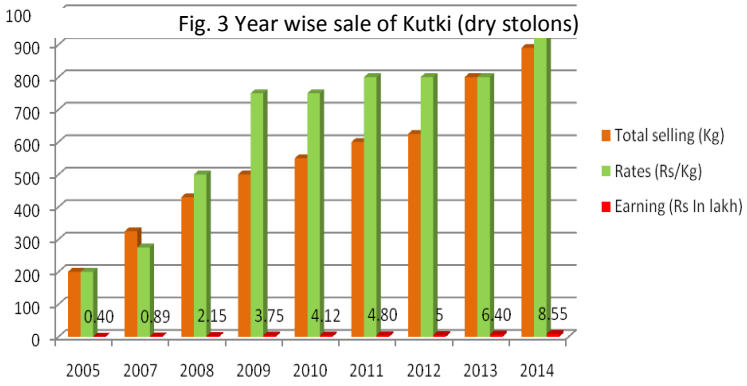


Fig. 3 Year wise sale of Kutki (dry stolons)



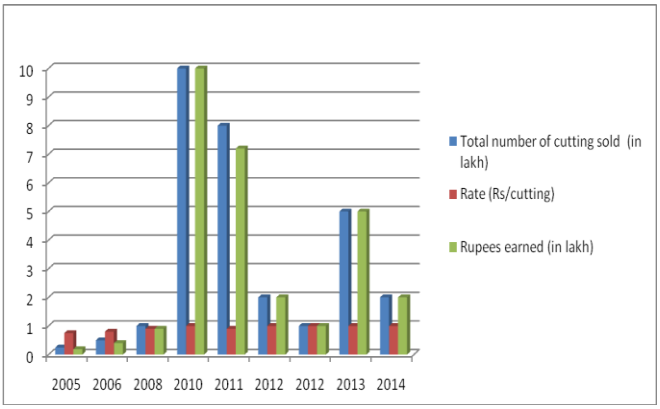


Fig. 4 Year wise progression of sale of Kutki cuttings (sprouted and rooted stolon)

indicated in figure 4. It is clear from the figure that from 2005 onwards farmers were earning a good amount through stolon cuttings and highest earnings through stolon cuttings was recorded in 2010 (about Rs. 10 lakh), followed by 2011 (7.2 lakh) and Rs. 5 lakh in 2013. All these observations clearly indicates that the cultivation of high altitude medicinal herb Kutki can be an additional cash crop for Ghese and other high altitude villages of Uttarakhand. Presently nearly 4.5 hectares land is under Kutki cultivation at Ghese, because the 35 farmers are growing it on fragmented areas instead of on large plots, and thus the cultivation looks patchy and fragmented.

Main lessons from the Ghese experiment

The medicinal plant cultivation programme at Ghese is the first of its kind in Uttarakhand. As the state government wished to develop this state as a Herbal state such programs can play a very useful role in developing the sector. Farmers are getting good economic returns from the cultivation of the selected species. As the farmers are getting good returns from harvesting of Kutki, such a model can easily be replicated as more and more farmers will be interested in cultivating medicinal plants.

HAPPRC managed to distribute planting material, arranged field visits, conduct surveys, provide regular monitoring and run training programmes using its own limited resources. These efforts are self motivated and not depended for any financial assistance or other kind of support from other institute or government departments. Since HAPPRC is a research cum educational institute with limited resources it is not possible to arrange or initiate similar efforts in many places. Keeping in view the success of this programme other Institutes working in medicinal plants sector in state can take up such programmes mainly on high altitude medicinal plants to augment the economy of high altitude farmers as well as to save the natural populations of these species.

Conclusion

1. The success of cultivation programmes such as in Ghese depends mainly on the awareness and interest of the villagers, supportive government policies, an assured market and price labels, access to simple and appropriative technical inputs (*e.g.* planting material, technology), know-how and training.
2. The ex-soldiers of Ghese were greatly concerned about the development of their areas and it led them to choose the cultivation of medicinal plants to augment their income. They were the pioneer and driving force in the implementation of the programme.
3. The initial interest of the company Dhawan International was instrumental in success of the programme.
4. In the initial stage of this programme farmers expressed doubt about the economic benefits of cultivating medicinal plants. Villagers also hesitated to adopt the cultivation of medicinal plants as a substitute for their cash crops. Such constraints got automatically overcome once the villagers got returns from the cultivation of these crops.
5. The experience of commercial cultivation of Kutki at Ghese is satisfactory so far.
6. The topographic and climatic situation of Ghese prevails in many high altitude areas in Uttarakhand and such a programme can be replicated in these areas. Government agencies should support such programmes and strengthen the existing infrastructure in this field.

Acknowledgements: *Authors gratefully acknowledged the Ghesh villagers for adopting the agro-techniques developed by HAPPRC for cultivation of Kutki. Author, sincerely thanks Padma Sri Prof. A. N. Purohit, founder Director of HAPPRC for providing the guidance and support to scientists. Author is also thankful to Ghese Kisan Samiti leader Sri Keshar Singh Bisht for boosting the moral of villagers for taking cultivation of Kutki as challenge.*

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Case study of successful cultivation of high altitude medicinal plants in Uttarakhand

***(Picrorhiza kurrooa* Cultivation at Ghesh Village in District Chamoli)**

M. C. Nautiyal
High Altitude Plant Physiology Research Centre
HNB Garhwal University, Srinagar Garhwal, Uttarakhand

Picrorhiza kurrooa

Local Name: Karwi, Kutki
Habit: Perennial creeping herb
Natural distribution: 2800-4500m asl
Flowering: June-July
Seed setting: September
Harvesting: October
Uses: Bitter tonic, antiperiodic, chalagouge, stomatic, laxative in small doses and cathartic in large doses.
Present market rate: Rs. 800-1500/Kg.

Ghesh Collaboration

Parties involved

- HAPPRC – Technical Expertise
- Ghesh Kishan Samiti - Cultivators
- Dhawan International - Trader

Activity started – 2002

- General survey of the village
- Soil analysis
- Motivation and awareness
- Sharing of knowledge with villagers on HAMPs

JUNE - 2002

- Preliminary training on some selected HAMPs
- Listing of farmers and land for cultivation
- Distribution of planting material to few farmers

Collaboration Perceptions

Ghesh

Main cash crop - Potato
Biodiversity rich
Awareness of villagers regarding the potential of medicinal plants.
Marketing risks

Industry - By-back guarantee – Assured supply
Interest in farming of some important species viz., Kutki, Atis, Jatamansi, Chirayita

Technology transfer

MOU - HAPPRC and DI on April 22, 2002.
Tripartite agreement - Ghesh Kishan Samiti, DI and HAPPRC on August 9, 2002
Cultivation area - 1/2 - 50 hectares /growing season.
Cultivation- Organic

Quality standard of raw material-

Moisture content - less than 8 %
Root/Stolon size - 1 to 1.5 inch
No foreign matter (Representative sample already sealed)
Active content - Picrotin I & II- not less than 1%.
Raw material - certified by HAPPRC at the time of delivery.

Benefits sharing

Villagers

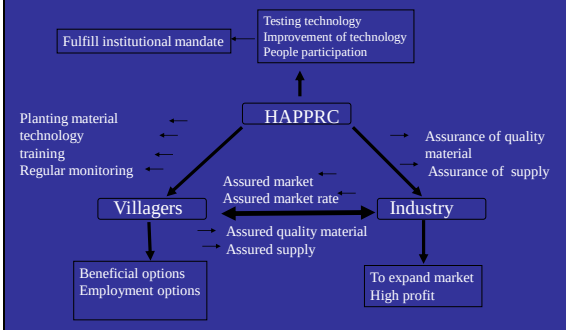
- Additional source of income
- Replacement for low value seasonal cash crops
- Assured marketing

Industry

- Assured quality produce
- Organically grown material
- Expansion of national and international market

HAPPRC

- Testing developed technology in the fields
- Promote farmers participation in sustainable utilization of natural resources
- Initiation of commercial cultivation in farmer's field
- Conservation of the species in nature.



Collaboration features for Kutki cultivation at Ghese

Comparative cost benefit analysis (per acre basis) of traditional cash crops (potato, rajma) and *kutki* cultivation at Ghesh after three years.

Sn	Crop	Cost of cultivation (in Rs)		Production (qts)	Gross income (Rs)	Net profit (Rs)
1.	**Potato**	Seed cost	1800			
		Labour cost	3600			
		Manure cost	3000			
		Maintenance	1500			
		Transport cost	22500			
		Total cost	**32400**	90	45000	**12600**
2.	**Rajma**	Seed cost	1875			
		Labour cost	3000			
		Manure cost	3000			
		Maintenance	1500			
		Transport cost	300			
		Total cost	**9,675**	6	15000	**5325**
3.	**Kutki***	Seed cost	2591			
		Field preparation	8000			
		Manure cost	4500			
		Maintenance	5000			
		Harvesting	1000			
		Transport cost	1125			
		Total cost	**22216**	4.42*	110500	**88,284**

* as per Nautiyal *et al*., 2001. Data for 1&2 are on the basis of socioeconomic survey.

Key element of training programmes

Domestication	Cultivation	Post Harvesting
Nursery Establishment	***Time***	***Drying***
Site Preparation	Sowing, Transplanting Harvesting	**Grading**
Multiplication methods		***Packing & Storage***
Seed germinability Vegetative means Any other modern Techniques	***Selection*** Elite germplasm Best multiplication methods Inter culture crops Biofertilizers	**Trade and marketing**
	Methods Seed sowing Transplanting Spacing Harvesting	
	Crop improvements	

Glimpses of Kutki cultivation at Gheshe village.

Sr. No.	Milestone	Glimpses
1.	**Villagers started cultivation in 2002**	05 no.
2.	Villagers doing commercial cultivation in 2014	34 no.
3.	Total area under cultivation in 2014	4.2 hectare (210 nali)
4.	Recently new villagers started cultivation	26 no.
5.	Total area in which new villagers started cultivation	2.2 hectare (110 nali)
6.	Total Production after 13 years:- **6.1.** Dry rhizome (approx.) **6.2.**Cuttings/Seedlings (approx.)	 4250.0 Kg 40.0 Lakhs
7.	Total Income after 13 years (Rs) :- **7.1.** Dry rhizome (approx.) **7.2.** Cuttings/Seedlings (approx.)	 27.72 Lakhs 29.75 Lakhs
8.	Total approx. income after 13 years	**57.47 lacs**

Year wise progression of kutki cultivation at Ghesh village.

Incubation Years	Yearly addition of land (hectare) under Kutki cultivation	Total land increased (hectare) yearly
2002	0	0.50
2003	0.25	0.75
2004	0	0.75
2005	0.25	1.00
2006	0.50	1.50
2007	0	1.50
2008	0.50	2.00
2009	0.25	2.25
2010	0.75	3.00
2011	0.50	3.50
2012	0.50	4.00
2013	0.20	**4.20**

Year wise progression of sale of Kutki (Dry roots) from Ghesh village.

Sr. No.	Years	Total selling quantity (kg)	Rates (Rs./Kg)	Rupees earned (Rs.) (Rs.)
1.	2006	300	200	0.60 lakhs
2.	2007	300	275	0.82 lakhs
3.	2008	450	500	2.25 lakhs
4.	2009	500	750	2.75 lakhs
5.	2010	600	750	4.50 lakhs
6.	2011	600	800	4.80 lakhs
7.	2012	650	800	5.20 lakhs
8.	2013	850	800	6.80 lakhs
9.	2014	900	950	8.55 lakhs
Total		**4250**		**27.72**

Year wise sale of Kutki (Cuttings) from Ghesh village

Sr. No.	Years	Total number of cuttings selling (Lakhs)	Rate (Rs./cutting)	Rupees earned (Rs.)
1	2005	0.25	0.75	0.18 lakhs
2	2006	0.50	0.80	0.40 lakhs
3	2008	1.00	0.90	0.90 lakhs
1	2010	10	1.0	10.00 lakhs
2	2011	8	.90	7.2 lakhs
2	2012	2	1.00	2.0 lakhs
3	2012	1	1.00	1.0 lakhs
4	2013	5	1.00	5.0 lakhs
5	2014	2	1.00	2.0 lakhs
Total		**29.75**		**28.68**

Strains in Collaboration

Long track of 20 km to reach Ghesh
Lack of interest in villagers for cultivation of MPs
Limitation of planting material/ QPM
Slow establishment of plants
Option to grow these crops as additional crops on their fallow land.

Main Lessons

Selection of potential locations for cultivation
Selection of potent farmers
Availability of quality planting material
Well defined rules and guidelines for registration and certification
To provide simple and accurate technical inputs through training, visits to demonstration / nursery site, publications, posters & charts

Conclusion

A. Success of such cultivation programme depends on
1. On the awareness and interest of villagers.
2. Supportive government policies.
3. An assured market and profitable price level.
4. Access to simple and appropriate technical inputs (Planting material and technology) know how and training.

B. Ex soldiers of Ghesh were concerned about the development of their area and thus thaey were pioneer and driving force in the implementation of programme.

C. The interest of the company DI was instrumental in the success of programme.

D. The doubts of the initial stage and constraints automatically got overcome once villagers got return from the cultivation.

conclusion…….

E. The experience of commercial cultivation of Kutki at Ghesh is satisfactory so far.

The topographic and climatic situation of Ghesh prevails in many high altitude areas in Uttarakhand and such programmes can be replicated in these areas. Government agencies should support such programmes and strengthen the existing institutions working in this field.

****

Kutki cultivation at Ghesh


Kutki ready for harvesting in farmer's field


Harvesting of Kutki from fields


Harvesting of Kutki


Harvesting


Collection of Kutki from fields


Washing & drying


Water jet washing


Cleaned and ready for drying


Drying


Drying

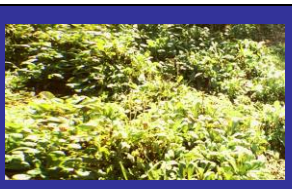

Drying

A view of Ghese village

Cultivation of kutki in slopy terrains

Kutki plantation picking up the growth during second year

Transplantation of cuttings by thinning the crops from their own fields



Kutki plants in full bloom at Ghese

Weed invasion and least care resulting slow growth

Kuth crop ready for harvesting at Ghese

Cultivation of Choru (Gandrayan) in kitchen garden of villager

THANKS

M. C. Nautiyal

Conservation and cultivation of high altitude medicinal plants in Jammu & Kashmir

S.K. Gupta
State Forest Research Institute, Jammu & Kashmir

- "Man, ever desirous of knowledge, has already explored many things, but more & greater remains concealed; perhaps reserved for far distant generations, who shall prosecute the examinations of their Creator's work in remote countries, and make many discoveries for the pleasure & convenience of life"

Linneus (1754)

Medicinal Plants J&K Perspective

- J&K is in the lap of western Himalayas decorated with snow covered silver lined Mountains, magical lakes and green grasslands.
- About 70% of Medicinal plants used in Herbal Industry is found in the this western Himalayan range.
- The ethno-botanical surveys conducted have depicted the vast stores of Herbal charms with the hill tribes in the beautiful Mountainous ranges of the State.
- Vast differences in the agro-climatic conditions from sub-tropical Jammu, temperate Kashmir to the cold Arid Ladakh add to the vast diversity of flora & fauna.

Bio-Diversity of High Altitude Medicinal plants in Western Himalayas- J&K

- **Lolab Valley**
- **District: Kupwara**
- **Situation: High Altitude**
- **Medicinal Plants Found:**

Aconitum heterophyllum, Colchicum leuteum, Artemesia absinthum, Artemesia maritaiama, Atropa acuminata, Bunium persicum, Datura stramonium, Deliphenium denudatum, Sausseria costus, Hycocymus niger, Valeriana jatamansi Rheum emodi, Arnebia benthami, Bergenia ligulata,

- **Karnah Valley**
- **District: Kupwara**
- **Situation: High Altitude**
- **Medicinal Plants Found:**

Taxus baccata, Terbulis terresteris, Artemesia absinthum, Dactylorhiza hategra, Juniperus communis, Deliphenium denudatum, Picrorhiza kurroa,

- **Gulmarg & Khilenmarg**
- **District: Baramulla**
- **Situation: High Altitude**
- **Medicinal Plants Found:**

Aconitum heterophyllum, Innula racemosa, Artemesia absinthum, Artemesia maritaiama, Podohyllum hexandrum, Bunium persicum, Datura stramonium, Deliphenium royale, Levatra cashmeriana, Innula royelena, Picrorhiza kurroa, Rheum emodi

- **Pir Panjal range & Kolhai Mountains**
- **District: Baramulla, Pulwama, Anantnag, Chenab valley-Kishtwar, Doda, Ramban and parts of Poonch, Udhampur and Kathua.**
- **Situation: High Altitude**
- **Medicinal Plants Found:**

Aconitum heterophyllum, Innula racemosa, Artemesia absinthum, Artemesia maritaiama, Podohyllum hexandrum, Bunium persicum, Deliphenium royale, Levatra cashmeriana, Innula royelena, Picrorhiza kurroa, Rheum emodi. Viola odorata

- **Ladakh Region**
- **District: Leh and Kargil**
- **Situation: Cold Desert**
- **Medicinal Plants Found:**
- *Hipophae rhamoides (Leh berry or Seabuck Thorn), Artimisia brevifolia, Aconitum heterophyllum, Berginia stracheyi, Rheum webbianum.*

CONSERVATION SCENARIO

- **Institutional:**
  - ❖Forest department
  - ❖J&K Forest Protection Force
  - ❖J&K State Forest Research Institute
  - ❖J&K State Biodiversity Board
  - ❖J&K State Medicinal Plants Board

- **LEGAL:**
  - ❖J&K Forest Act, 1930
  - ❖J&K State Forest Policy, 2012
  - ❖Biodiversity Act, 2002
  - ❖J&K Wildlife Protection Act,1978.
  - ❖Kuth Act- now repealed.

- **OTHERS:**
  - ❖Forest Department Drug Farms at

1. Chuntibagh Tangmarg
2. Pathribal Anantnag
3. Dendipura Anantnag
4. Mujmandoo Anantnag

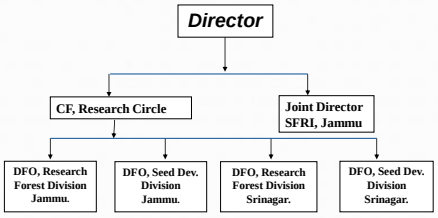
- ❖**Species:**

1. *Diascorea deltoides*
2. *Bergenia ligulata*
3. *Artemisia absinthium*
4. *Pyrenthrum spp*
5. *Atropa belladona*

- ❖**In 2004-05 ban on MFP extraction for 5 years.**

- A post of Director J&K Forest Research Institute was created vide Govt Order No: 10 FST of 1990 dated 11th January, 1990 in pursuance to **Cabinet** decision No.2 dated 10-01-1990. The Director was made responsible for setting up the J&K State Forest Research Institute for undertaking activities with regard to forestry research in the State.
- ***Board of Governors-*** *Four meetings held. Last i.e 4th meeting held on 09-09-2013.*
- ***Management Committee –*** *Seven meetings held. Last i.e 7th meeting held on 15-05-2013.*
- ***Research Advisory Committee –*** *Three meetings held. Last i.e 3rd meeting held on 30-07-2015.*

Organization setup



The SFRI establishment

S. No.	Category of Post	Sanctioned Strength	Working	Excess	Deficit
1	Director	1	1	-	-
2	Conservator (Research)	1	1	-	-
3	Jt. Director	1	1	-	-
4	DCF	2	0	-	2
5	ACF	6	4	-	2
6	Asstt. Seed Technician	2	0	-	2
7	Range Officer Gr-I	11	-	-	11
8	Range Officer Gr-II	2	15	13	0
9	Technical staff	9	4	-	5
10	Ministerial staff	15	13	-	2
11	Forester	12	6	-	6
12	Dy. Forester	6	3	-	3
13	Forest Guard	14	13	-	1
14	Drivers	7	3	-	4
15	Class IV-helpers, Malis, watcher, Chowkidar etc.	98	83	-	15
	Total	**187**	**147**	**13**	**53**

Seed Laboratories

- There are two seed laboratories one in Jammu and another in Kashmir.
- Seed collection from SPAs.
- Seed cleaning.
- Grading.
- Germination test.
- Packing.
- Supply.

Nursery Operations

- Various nurseries in Jammu and Kashmir province are being developed and maintained to produce quality planting material.
- There are 24 Nurseries under SFRI with a plant potential of 20 lakh plants
- SFRI has provided 6.52 lakh plants to various wings of Forest Department in 2015-16 upto 01/2016.

SFRI-J&K is on way to:

- Disseminating the good cultivation practices through education and training to farmers.
- Popularization of identified new propagation protocols, technologies / tools / techniques for commercialization / adoption, for rural communities
- Assistance in securing availability of quality planting material by promoting setting up of medicinal plant propagation banks / mother plant nurseries &
- Enrichment of rare & medicinal plants in their natural zones by setting up small enrichment medicinal plant forest pockets to compensate biodiversity losses in selected areas

Production of some Important Medicinal Plants.

- **Collection of propagation material.**
- **Planting in the said nurseries.**
- **Production of propagating material in nurseries for enrichment & supply.**

Species cultivated in SFRI-nurseries

- *Atropa belladona*
- *Digitalis purpurea*
- *Dioscorea deltoides*
- *Inula racemosa*
- *Saussurea costus*
- *Valeriana jatamansi*

1. Package of Practices for Cultivation of Dioscorea

- **Family: Dioscoreaceae**
- **Climate and Soil:**
  - Adapted to moderate to heavy rainfall areas.
  - Grown in a wide variety of soils.
- **Propagation by:**
  - tuber pieces,
  - single node stem cuttings or seed.
  - Commercial planting is normally established by tuber pieces only.
- **Planting:**
  - The stored tuber pieces which are ready for planting, seedlings or single node stem cuttings can be be planted in furrows with 30-40 cm between the plants .
  - The tuber pieces are planted at about 0.5 cm below the soil level.

- **Aftercare:**
  - Dioscorea vines need support for their optimum growth and hence the vines are trained over small wooden stick system or ropes for support.
- **Weeding:**
  - Initially, the vines are weak and tender and cannot compete efficiently with the surrounding weeds.
  - Periodic hand weeding as and when necessary is essential for the first, few months. .
  - Experience has shown that once the plants have climbed up on the wooden support system, the weed population is considerably reduced due to shading.
  - The plants by this stage can also compete more successfully with weeds.
- **Irrigation:**
  - Irrigation may be given at weekly intervals in the initial stage and afterwards at about 10 days interval. However, during rainy season no irrigation is needed. It can also be raised under pure rainfed conditions.
- **Duration:**
  - The diosgenin content tends to increase with age and also the tuber yield and hence a two year crop is recommended to be more economical.
- **Harvesting:**
  - The tubers grow to about 25-30 cm depth and hence harvesting is done by manual labour.

2. Package of Practices for Cultivation of *Atropa Belladonna*

- **Botanical Name:** Atropa belladonna L.
- **Family:** Solanaceae
- **Belladonna** important source for tropane alkaloids which include hyoscine, hyoscyamine and atropine
- Temperate cool loving plant
- Berries, dried after separating seeds.
- Seeds sown during March April in raised beds.
- Seeds take 4-6 weeks to germinate and the seedlings
- transplanted in field after attaining height of 15-20 cm at spacing of 60 x 60 cm or 60 x 45 cm

Irrigated well till establishment.

The alkaloid content increases steadily from transplanting till flowering stage.

Harvesting leaves about 30 cm above ground level using pruning scissors.

A total of 5-6 cuttings can be obtained normally.

The harvested leaves are sun dried by spreading them in thin layers and turning them frequently.

3. Package of Practices for Cultivation of Digitalis purpurea

- **Family: Dioscoreaceae**
- **Climate and Soil:** The foxglove prefers a fertile well drained soil. It is a sun loving drought tolerant plant thrives well in dry soil. Best grown in half shade, but can tolerate full sun.
- **Description:** Foxglove is a short lived perennial with dark green or white-wooly leaves that are 5-10" long and mostly arranged in a basal rosette.
- During first year, the plant develops its roots and stays in the basal rosette.
- In the second year, foxglove sends up one or more flowering stalks that can reach 3-5' in height and have smaller leaves that decrease in size upward.
- The flowers are tubular, shaped like the fingers of a glove, about 2" long, purple, lavender, pink, white, cream or yellow, and often with purple and white spots or streaks on the inside of the corolla.

- **Habit & Habitat:** Perennial; Foxglove does best in cool climates in moist, acidic soil with abundant organic material.
- **Light:** Foxglove grow best in partial shade.
- **Propagation:** Foxglove is usually treated as a biennial. Seeds are sown in late summer or autumn and flowering occurs the following spring and summer.
- but which can be fatal if too much is ingested.
- **Usage**
- Foxglove leaves contain cardiac glycosides which are valuable in controlling heart disease.

Digitalis (*Digitalis purpurea*) propagation in SFRI-Nursery

4. Package of Practices for Cultivation of Inula racemosa

- **Plant Family:** *Asteraceae* **Common name:** Pushkarmoola
- **Parts used:** Roots
- **Habitat:** The plant exhibits optimum growth at altitude ranges of 2600-4000 m. Though the tolerable thermal range for the species varies from 15-35ºC, optimum growth has been noted under the range of 15 to 25ºC in the high altitude regions of Himalayas.
- **Means of propagation:** Propagation is done either through seeds or through division of roots although root cuttings are preferred as means propagation.
- **Collection of Seeds:** The seeds are generally collected during September.
- **Nursery preparation:** Raised beds are can be prepared. Broadcast sowing is done in march April.
- Placing the seeds at depths greater than 1 cm can lead to poor germination or increased mean germination time for the species.
- Light irrigation is recommended after sowing in the beds.

- **Transplantation:** A number of perennials produce self-sown seedlings that can be transplantedThe seedlings and the surrounding soil must be taken during transplantation and must be firmly replanted. The seedlings must be shaded from direct sun and watered regularly until they are stable.
- **Planting density:** The seedlings are suggested to keep at least 30 cm apart from each other while line to line distance should be maintained at least 35 to 40 cm apart.
- **Water management:** *Inula racemosa* has been found to perform well under moderate to heavy moisture conditions. Alternate and improved systems of irrigation like drip, sprinkler etc.
- **Weed and pest control:** Regular weeding in the initial stages of crop establishment is an absolute necessity.
- As the crop grows, the leaf expanse of the species prevents the growth of weeds in the vicinity.
- **Maturity and harvesting:** In case of seed propagated plants, the first harvest is taken during the third year. The roots are harvested during September-October.

5. Package of Practices for Cultivation of *Sassurea costus*

- **Common Name: Kuth,** Kur, Kusthah and Costus
- **FAMILY - ASTERACEAE**
- **Habit & Habitat:** Kuth is a robust erect, perennial plant with large leaves. Roots are stout up to 60 cm long. Root is used medicinally.
- Flowering & fruits period - August-September, seeds collected during September-October.
- **Distribution:** Himanchal Pradesh, Uttaranchal, Uttar Pradesh, Jammu & Kashmir, Sikkim & Arunachal Paradesh.
- **PART USED:** Tuberous Root
- **SOIL AND CLIMATE:** Sandy textured loam soil, rich in moisture and organic carbon is best for germination as well as better survival of seedlings and productivity. The plant grows intemperate and sub-alpine region.

- **PLANTING:** Cultivation and nursery of Kuth at an altitude of 1200-1800 m is suitable. The seeds are sown in April or May in nursery. When the seedlings are ± 15 cm long, it is transplanted in field.
- **IRRIGATION:** The crop requires 5-6 irrigations between May-September. The land is irrigated when seeds are sprouting. Organic manures like, Farm Yard Manure (FYM), Vermi-Compost, Green Manure etc. may be used as per requirement of the species.
- **HARVESTING/POST-HARVESTING:** Usually in 2-3 years well grown mature root tubers are developed, yield is obtained form 3 years old crop. Root is harvested in early September or October or early spring. The roots are cleaned with water and dried for processing.

6. Package of Practices for Cultivation of Valeriana jatmansi

- **Family:** Valerianaceae
- **Local/common names:** Indian Valerian, Muskroot (English), Mushkbala (Hindi)
- **Status:** Critically endangered (IUCN)
- **Distribution and habitat:** *Valeriana* grows naturally in the temperate range of the Western and Central Himalayas at an altitude of 1800 to 3000 m
- **Environment for growth: The** herb prefers loamy soil with a pH ranging from 6.0 to 7.0 and that is rich in organic matter with plenty of moisture.
- *Valeriana* is a temperate plant and prefers very cold winters and mild summers for its good growth.
- The plant flourishes in damp and shaded places with temperatures of 15-25oC. It can be cultivated under apple orchards as a viable intercrop.
- **Parts used:** The dried rhizomes and roots are used and contain the herbal drug 'valerian', which has been used for the past 3,000 years.
- **Propagation:** The plants can be propagated by vegetative means or through seeds. It can be propagated by pieces of old rootstocks or rhizomes in autumn or spring. The plant may also be propagated from mature seeds collected from the wild.
- **Collection of seeds:** Fresh robust seeds are collected from a 3-4 year old healthy mother plants. Seed collection is done in the month of September.

- **Land preparation and soil work:** Beds with a good drainage system provide better yield. The plants planted into rows 40-50 cm apart at 20- 30 cm spacing.
- **Nursery preparation:** The seeds sown at a depth of 0.5 cm in the nursery beds.
- For one Ha of land, 500 to 600 g of seeds is required for sowing.
- Line sowing is mostly practiced at a distance of 20-30 cm between the two rows.
- Light irrigation recommended after seed sowing.
- **Transplanting:** The seedlings transplanted to the main field after 6-8 weeks from sowing, at the two-leaf stage.
- **Maturity and harvesting:** Flowering starts from April to May and seeds are ready in the month of June of the second year.

CULTIVATION SCENARIO

- INSTITUTIONS WORKING:
  - ❖State Medicinal Plants Board
  - ❖Indian Institute Of Integrative Medicine (IIIM)
  - ❖Forestry Department Of SKUAST- Jammu
  - ❖Forestry Department Of SKUAST- Kashmir
  - ❖DRDO- Station in Ladakh
  - ❖J&K Forest Department

- **Not aware of any success story of cultivation.**
- Legal Issues .
- Amendment to **J&K Wildlife Protection Act- Schedule VI in 2014**.
- Lack of Market Linkage.
- Lack of Industry utilizing medicinal plants in the state.
- All the institutions working in isolation.
- Lack of political will.
- Lack of clarity.

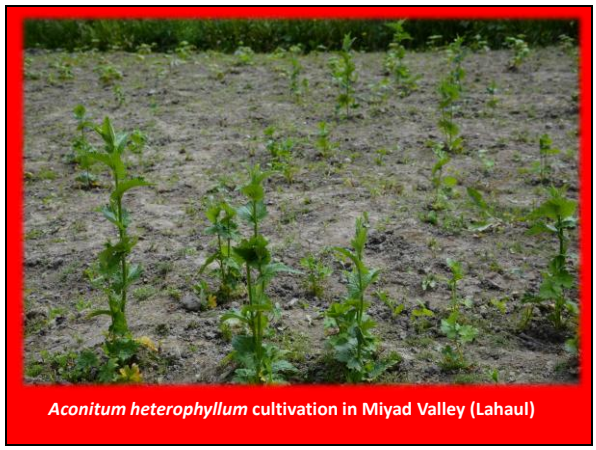
➢ **Recently, forest department constituted a committee to formulate guidelines for cultivation on medicinal plants.**

Cultivation and value addition of high altitude medicinal plants of Himachal Pradesh

Nand Lal Sharma
Nanda Medicinal Plants Traders, Manali (H.P.)

Cultivation and value addition of high altitude medicinal plants of Himachal Pradesh

Nand Lal Sharma
Nanda Medicinal Plants Traders, H.P.



Aconitum heterophyllum cultivation in Miyad Valley (Lahaul)


KUTKI


BANKAKRI


"JATAMANSI"
Valeriana jatamansi


THANK YOU

Cultivation potential and success of high altitude medicinal plants in Uttarakhand

Dr. A.K. Sharma
Forest Research Institute, Dehradun

Cultivation Potential and Success of High Altitude Medicinal Plants in Uttarakhand

Dr. A.K. Sharma FNSE
Head
Non Wood Forest Products Division
Forest Research Institute, Dehradun

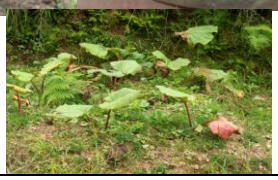
FRI Cultivation Efforts

Cultivation of Temperate Medicinal Plants attempted at Experimental scale:

- *Artemisia maritima*
- *Berginia ligualata*
- *Bunium persicum*
- *Colchicum luteum*
- *Crocus sativa*
- *Dioscorea deltoidea*
- *Habenaria intermedia*
- *Microsytlis wallichii*
- *Podophyllum hexandrum*
- *Rheum emodi*
- *Skiimia laureola*
- *Swertia chirata*
- *Taxus baccata*
- *Thymus serphyllum*
- *Valeriana wallichii*

Rheum australe seeds sown in NWFP Production nursery of F.R.I. Dehradun for Transplantation in Chakrata

Rheum australe



Bergenia ligulata

Natural occurrence of *Microstylis wallichii* (Jeevak) was mapped in different forest areas of Uttarakhand and introduction/ cultivation in natural forest area was undertaken to enhance their existing populations.

Scope of cultivation of Medicinal Plants in Uttarakhand

Scope of following species exists for promoting cultivation:

• Jadwaar / Nirvishi	*Delphinium denudatum*
• Hathajari / Salam Panja	*Dactylorhiza hatagirea*
• Jatamasi	*Nardostachys jatamansi*
• Bhutkeshi	*Valeriana jatamansi*
• Thuner	*Taxus baccata / wallichiana*
• Karoo	*Gentiana kurroo*
• Nagchatri	*Trillium govanianum*
• Satuwa	*Paris polyphylla*
• Chirayta	*Swertia chirata*
• Keadrpatta	*Skiimia laureola*
• Kirmala/ Tethwen	*Artemisia maritima*

Successful Commercial Cultivation ventures in Uttarakhand

- *Aconitum heterophyllum* (SHER)
- *Saussurea costus* (SHER ; Farmers in Pithoragarh area)
- *Carum carvi* (Farmers in Pithoragarh area)
- *Angelica glauca* (SHER ; Farmers in Pithoragarh area)
- *Picrrorhiza kurroa* (HAPPRC-Farmers-Industry; Individual farmers on small scale)
- *Cinnamomum tamala* (UNDP-GEF-MoEF project)

TRADE ESTIMATES

According to Ved & Goraya's study

Of the 960 traded medicinal plant species,

- 178 species are consumed in volumes exceeding 100 MT per year, with their consolidated consumption accounting for about 80% of the total industrial demand of all botanicals in the country.
- Analysis of these 178 species by their major sources of supply reveals that 21 species (12%) are obtained from temperate forests
- Therefore, priority should be assigned to cultivation of these 21 species.

Medicinal Plant Species in High Trade sourced from Temperate Forests

- Abies spectabilis (Brahmi talish)
- Aconitum ferox (Vachnag)
- Aconitum heterophyllum (Atis)
- Berberis aristata (Daruhaldi)
- Bergenia ciliata (Pashanbheda)
- Ephedra gerardiana (Somlata)
- Juniperus communis (Hauber)
- Jurinea macrocephala (Dhoop)
- Nardostachys grandiflora (Jatamansi)

Medicinal Plant Species in High Trade sourced from Temperate Forests

- Onosma hispidum (Ratanjot)
- Parmelia perlata (Chadila)
- Picrorhiza kurroa (Kutaki)
- Rheum australe (Revandchini)
- Rhododendron anthopogon (Talish patra)
- Swertia chirayita (Chirata)
- Taxus wallichiana (Talish)
- Valeriana jatamansi (Mushakbala)
- Viola pilosa (Banafasha)

Name of Species	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	Total
Archa/Adapalen (*Rheumemodi*)	0	0	0	0	0	15	0	**15**
Atees (Aconitum heterophyllum)	0	65.81	5.184	4.8	55	5	24.5	**160.294**
Beladona (Atropa belladona)	0	0		0	18	5	11	**34**
Bankakri (Podophyllum hexadendrum)	0	5		2.7	0	15	0	**22.7**
Chirayata (Swertia chiraiyata)	0	334.5	126	81.88	152	60	75	**829.38**
Coleus (Coleus barbatus Benth)	1179.2	694.54	3002.82	3090.939	2328.09	7416	4486.2	**22197.789**
Daruhaldi (Berberis aristata)	0	0		0	0	4	10	**14**
Jatamansi (Nardostachys jatamansi)	0	60	2	1.7	80	21	12.5	**177.2**
Kuth (Sassurea costus)	0	79.46	28.457	5.9	0	13	23	**149.817**
Kutki (Picrorhiza kurrooa)	0	48.43	14.04	2.4	5	21	21.7	**112.57**
Pushkarmool (Inula racemosa	0	0	40	0	0	3	0	**43**
Ratalu (Dioscorea bulbifera)	0	20	120	0	47	100	240	**527**
Sea Buckthorn (Hippophoe rhamnoides)	0	0	0	0	0	0	20	**20**
Tagar (Valeriana wallichi)	0	0	0	200	326.5	305	210	**1041.5**
	1179.2	**1307.74**	**3338.501**	**3390.319**	**3011.59**	**7983**	**5133.9**	**25344.25**

Species wise Achievements cultivation area (in ha.) for the year under Centrally Sponsored Scheme of "National Mission on Medicinal Plants" based on UC submitted (2008-09 to 2012-13) & Projects sanctioned (2013 -2015)

Name of Species	Himachal Pradesh	Jammu & Kashmir	Uttarakhand	Total
Atees (Aconitum heterophyllum)	11.8	0	18.494	30.294
Bankakri	2.7	0	0	2.7
Chirayata (Swertia chiraiyata)	6.4	0	0	6.4
Jatamansi (Nardostachys jatamansi)	3.7	0	0.5	4.2
Kuth (Sassurea costus)	34.9	0	91.917	126.82
Kutki (Picrorhiza kurrooa)	7.4	0	57.17	64.57
Pushkarmool (Inula racemosa	40	0	0	40
Cinnamomum tamala (Tejpat)	0	0	167.18	167.18
Total	106.9	0	335.261	442.16

Scope of cultivation of Medicinal Plants in Uttarakhand

Scope of following species exists for promoting cultivation:

- Jadwaar / Nirvishi — *Delphinium denudatum*
- Hathajari / Salam Panja — *Dactylorhiza hatagirea*
- Jatamasi — *Nardostachys jatamansi*
- Bhutkeshi — *Valeriana jatamansi*
- Thuner — *Taxus baccata / wallichiana*
- Karoo — *Gentiana kurroo*
- Nagchatri — *Trillium govanianum*
- Satuwa — *Paris polyphylla*
- Chirayta — *Swertia chirata*
- Keadrpatta — *Skiimia laureola*
- Kirmala/ Tethwen — *Artemisia maritima*

Scope of cultivation of Medicinal Plants in Uttarakhand

Scope of following species exists for promoting cultivation:

Ashtavarga species

- Vriddhi — *Habenaria intermedia*
- Riddhi — *Habenaria edgeworthii*
- Jeevaka — *Microsytlis wallichii*
- Meda — *Polygonatum verticiilatum*
- Mahameda — *Polygonatum cirrifolium*
- *Kshirakakoli* — *Lilium polphyllum*
- *Rishbhaka* — *Microstylis muscifera*
- *Kakoli* — *Roscoea procera* Wall. Syn *Roscoea purpurea* or *Fritillaria roylei*

Potential Medicinal Plants for promoting Cultivation in Uttarakhand




Potential Medicinal Plants for promoting Cultivation in Uttarakhand

- Thank you

Conservation and cultivation of medicinal plants in North-Eastern States of India

S. Hussain
Vista Agritech, Guwahati (Assam)

Adding Value to Resources

CONSERVATION AND CULTIVATION OF MEDICINAL PLANTS IN NORTH – EASTERN STATES OF INDIA

S. HUSSAIN
VISTA AGRITECH , GUWAHATI

ABOUT VISTA APL

- Agriculture based Company, registered under Companies Act 1956 on 8th May 2006
- Head Office at Guwahati
- Information centres at Sibsagar, Shillong , Dimapur, and Tawang.
- Presently operating in five states of North East Hill Region (NEHR)
- To cover activities in all states of NEHR by December 2020

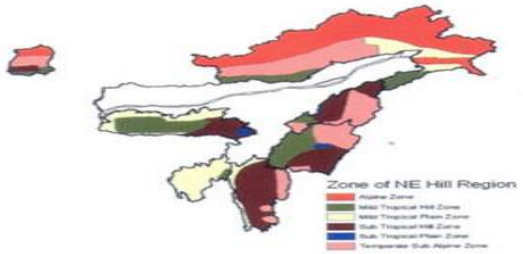
Area of focus

- Entrepreneurship Development Training, Research & Consultancy
- Contract Farming
- Industrial Project Consultancy
- Agro based Industries
- Techno feasibility Project Report
- Quality Planting Materials
- Quality Testing & Analysis of Essential Oils
- Buy-back policy of Essential Oils
- Organic, Bio-fertilizer & Pest Control Consultancy
- Agriculture / Horticulture & MASP Product Marketing

PRIORITY AREA

- Medicinal Plants
- Aromatic Plants
- Dye Plants
- Exotic Fruits
- Floriculture
- Spice Plants
- Livestock & Fisheries
- Conservation of endangered flora and fauna
- Agricultural Crop & Produce Insurance
- Organic Farming & Certification
- Value Addition & Marketing

NORTH EASTER REGION – Agro Climatic Snapshot



HIGH ALTITUTE MEDICINAL PLANTS


Aconitum heterophyllum


Podophyllum hexandram


Aconitum heterophyllum


Kutki

HIGH ALTITUTE MEDICINAL PLANTS

S. costus

V. Jatamansi

Panax Ginseng(Pseudo)

Panax Ginseng(Pseudo) - Nursery

HIGH ALTITUDE MEDICINAL PLANTS

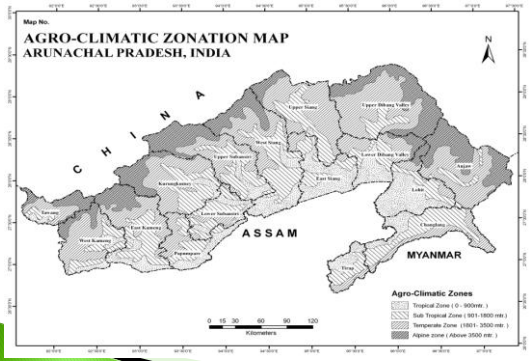
Stevia Plantation

Aconitum balfourii.

G. Orchidus(salep orchid)

S. Costus (kuth) nursery

ARUNACHAL PRADESH – High Altitude Regions Snapshot



Conservation and sustainability of medicinal plants in NER

- Conservation of medicinal plants is the need of the hour
- The world habitat is declining at an alarming rate
- Need to look at both *in-situ* and *ex-situ* conservation
- Need to identify the protected area for important medicinal plants
- Unrestricted & excessive extraction need to be regulated
- To teach proper techniques for collection of medicinal plants to the local people or JFMC's/communities
- Create new attitudes to conservation among participating groups(Viz. JFMC's/communities)
- Need to sensitize the local communities about the conservation (viz. Training, workshops)

Conservation and sustainability of medicinal plants in NER - cont.

- Maintain the protected area "as hands off areas" to a maximum possibility
- For community benefit adjoining forest area out side conservation area to be managed under JFMC's or village communities
- For sustainable management a particular efficient approach is to combine breeding and conservation
- Training the communities in good harvesting practices
- Stakeholders should be included.(SFD's, JFMC's, R&D etc.)
- Periodic monitoring is essential for medicinal plant conservation
- Regular donor support for long term sustainability of the conservation areas

Approaches to Conservation

- Promotion of herbal Gardens in JFMC/communities areas
- Encouraging home herbal garden among JFMC members
- By creating Medicinal Plant development Areas(MPDA) through JFMC's/communities
  - Selection of forest area within each forest type which are rich in medicinal plant species
  - Areas to be demarcated including community land holdings (approx.200 ha area in each vegetation type)
  - Floristic surveys for estimation of population of species (including RET) in each MPDA's
  - Priority should be given to the establishment of species-focus/Diversity-focus MPDA's

Harvest , Post harvest and value addition

- Sustainable harvest and long term conservation
  - Skill up-gradation of collector
  - opportunities for fair trade through established forward linkages
  - Continued focus on assisted natural regeneration
  - Botanical authenticity of species
- Primary processing
  - Timely and right processing of produce
  - Proper drying , packaging and storage

List of threatened and endangered medicinal plants in North-East Hill Region for conservation

Sl. no.	Botanical name	Common name	Locations	Threat status
1	Illicium griffithii		Meghalaya ,A.P., Sikkim	Critically Endangered. (C.E.)
2	Smilex glbra	chobchini	A. P., Meghalaya, Assam	C.E.
3	Podophyllum hexandrum		Sikkim , A.P. ,	C.E.
4	Texus wallichiana		Meghalaya , A.P, Sikkim	C.E.
5	Dienia muscifera		A.P. , Sikkim	C.E
6	Aconitum ferox	Bong-Nga-kar-po	A.P. , Sikkim	EN
7	Aconitum balfaurii	Bong-Nga-kar-po		

List of threatened and endangered medicinal plants in North-East Hill Region for conservation – cont.

Sl. no.	Botanical name	Common name	Locations	Threat status
8	Aconitum hetrophyllum	Bong-Nga-kar-po	A.P. , Sikkim	
9	Aquilaria malaccensis	Agar	A.P. , Meghalaya, Assam	Endangered (EN)
10	Citrus macroptera var	Soh kynpher	Meghalaya ,Assam	EN
11	Dendribium nobil	-	Assam, Meghalaya	EN
12	Flickingeria fugax			EN
13	Nepenthes khasiana	Tiew rakot	Meghalaya,	EN
14	Panx wangianeos	genseng	Meghalaya, A.P.	EN

List of threatened and endangered medicinal plants in North-East Hill Region for conservation – cont.

Sl. no.	Botanical name	Common name	Locations	Threat status
16	Bergenia ciliata		Meghalaya, A.P., Sikkim	Vulnerable
17	Cinnamomum tamala		Meghalaya, A.P.	Vulnerable
18	Hydnocarpus kurzii	chalmogra	Meghalaya ,Assam	VU
19	Mahonia napaulensis		A.P., Sikkim, Assam, Meghalaya	VU

List of threatened and endangered medicinal plants in North-East Hill Region for conservation – cont.

Sl. no.	Botanical name	Common name	Locations	Threat status
20	Piper peepuloides	Soh-marit khlaw	A.P., Assam, Sikkim	VU
21	Rauvolfia serpentina	Tdong pait-puraw	Meghalaya, Assam	VU
22	Swertia chirayita	Chirata,Tikta	Meghalaya, A.P. , Sikkim	VU
23	Valeriana hardwikki	valerian	Meghalaya, A.P. , Sikkim	VU
24	Valeriana jatamansi	Jatamasi,Long poes	A.P. Meghalaya, Sikkim	VU
25	Rhododendron anthopogon	Balu	A.P.	VU
26	Picrorhiza kurroa	Kutki, khonglen	A.P. Sikkim	VU

Cultivation - Source of eternal supply of medicinal plants in NER

- Identification of the plant species within the selected areas of the JFMC's/village communities
- Optimal cultural conditions(viz. soil , climate ,irrigation)
- Selecting good planting materials , need to follow authentic techniques and standardize the cultivation practices
- Minimize the use of chemicals and encourage use of bio-fertilizers(Vermi-compost, compost etc.)
- Need to target on the cultivation of threatened and endangered species

Cultivation - Source of eternal supply of medicinal plants in NER – cont.

- To have better ways to control weeds
- The best way to meet the demand is to cultivate
- Would stop the wild depletion of wild stocks
- It reduces the possibility of mis-identification and adulteration
- It has pharmacological advantages over wild collection

ARUNACHAL PRADESH

Districts	Species
Tawang	Aconitum Balfouri, Ferox, Panax Pseudogiseng, Picrorrhiza Kurroa, Podophyllum Hexandrum, Swertia Chirayita, Taxus Baccata, Valeriana Jatamansi, Zanthoxylum Armatum, S. Costus, I Racemosa,
West Kameng	Illicum Graffitti, Rubia Manjith, Swertia Chirayta, Acrous Calamus, Valeriana Jatamanshi
Lower Subhansiri	Rubia Manjith, Swertia Chirayta, Panax Ginseng, Acorus Calamaus
Changlang	Acorus Calamus, Tinospora Cordifolia
Papum Pare	Stevia rebaudiana, Lemon Grass, Tumeric
Lower Dibang Valley	Stevia Rebaudiana, Lemon Grass, Turmeric, Tinospora Cordifolia, Coptis Teeta
Upper Subhanshiri	Acorus Calamus, Panax Ginseng (accamicus), Lemon grass, Turmeric, Tinospora Cordifolia

NAGALAND

Districts	Species
Tuensang	Alpinia Galanga, Turmeric, Tinospora Cordifolia, Kaempferia Galanga, Panax Ginseng
Longleng	Alpinia Galanga, Kaemferia Galanga, Cymbopogon flexeosus, Aqularia agallocha
Makokchung	Alpinia Galanga, Lemongrass, Turmeric Tinospora Cordifolia
Dimapur	Stevia rebaudiana, Alpinia Galanga, Pogostemon cablin, Cymbopogon flexeosus
Kohima	Valeriana Jatamanshi, Taxus Baccata
Phek	Valeriana Jatamanshi, Taxus Baccata, Panax ginseng

MEGHALAYA

Districts	Species
South Garo	Gloriosa Superba, Acorus Calamus, Piper Longum Piper Nigram, T. chebula, Emblica officianlniss (Amla), rauvolfia Serpentina, Cinamom Tamala
East Khasi Hills	Valeriana jatamanshi, Taxum baccata, Panax ginseng (accasmicus), Gloriosa superba, Acorus calamus, Piper longum, Piper nigram, T.chebula, Homalomena aromatica
Ribhoi	Gloriosa superba, Acorus calamus, Piper longum, Piper nigram, T.chebuala, Embilica officialniss, Rauvolfia serpentina, Saraca ashoca, Oroxylum indicum, Holalomena aromatica, Kaemferia Galagana
Jatantia Hills	Gloriosa Superba, Acorus calamus, Piper longum, Piper nigram, T.chebula, Emblica offcialniss, Rauvolfia serpenita, Saraca ashoca, Oroxylum indicum, Homelonena aromatica, Kaemferia galanga

ASSAM

Districts	Species
Karimganj	Alpinia Galanga, Homalomena aromatica, Acorus calamu
Jorhat	Agarwood
Sibsagar	Agarwood
Golaghat	Agarwood

Activities at Glance


Activities at Glance – cont.


Processing unit


Awareness & Training


Thank You !

Appendix – A

List of Participants			
1	Sh. D. K. Ved Advisor, Foundation for Revitalization of Local Health Traditions, #74/2, Jarakabande Kaval, Post Attur via Yelahanka Bangalore - 560 064 Email: dk.ved@frlht.org	2	Dr. Mayaram Uniyal Ex-Director, Ex-Advisor Medicinal and Aromatic Plants, Uttarakhand Shasan, Dehradun Email: mruniyal2@gmail.com
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