

**DOMESTICATION AND CONSERVATION PRACTICES OF *DIOSCOREA DELTOIDEA*,
HEDYCHIUM SPICATUM, *POLYGONATUM VERTICILLATUM*, *ANGELICA GLAUCA*
AND *DACTYLORHIZA HATAGIREA* FOR BOOSTING HEALTH, SUSTAINABILITY
AND RURAL PROSPERITY**

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ABSTRACT

Present study deals with threat assessment, cultivation, sustainable utilization and conservation of 5 threatened plants (*Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca*, *Dactylorhiza hatagirea*) of Nihri tehsil of district Mandi, Himachal Pradesh Nihri (latitude 31°43'12.5" N and longitudes 77°07'01.2" E) is a temperate region of Western Himalayas rich in high valued commercially useful plants. Some of plants growing here like *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca*, *Dactylorhiza hatagirea* are unique to this region and heavily demanded by pharmaceutical companies, so they are over-exploited by locals traders As a result natural population of these plants has been declined significantly. In present study threat categorization of these species has been done based on the habitat, distributional range, nativity, wild status of plants, their UV and DMR value. Data analysis shows that among these plants *Dactylorhiza hatagirea* is critically endangered (having Uv General=0.22 & DMR score =13) followed by *Angelica glauca* and *Dioscorea deltoidea* which are placed in endangered category (having Uv General = 0.40 & 0.45 and DMR score= 17 & 21) respectively, followed by *Polygonatum verticillatum* and *Hedychium spicatum* which are placed in vulnerable category (with UV General = 0.24 & 0.60 and DMR score =16 & 23) respectively. In order to maintain the harmony between demands and supply in-situ and ex-situ conservation of these plants is need of hour. So, the present study has been attempted to raise nursery, distribute planting material, aware locals for cultivation, sustainable harvesting and utilization of documented plants from March, 2022 to March, 2023.

KEYWORDS: Threatened; Cultivation; Conservation; Sustainable; Utilization.

1. INTRODUCTION

Himalaya is one of the mega biodiversity regions of the world (Heywood, 2000) and Indian Himalayan region being part of Western Himalayas possesses the world's richest medicinal plant heritage, traditional and local knowledge. It is considered a vital source for economic wellbeing and is utilized by locals for fulfilling their basic necessities of life (Singh 2002; Vibhuti *et al.* 2018). Acc. to Samant, 1998 the Indian Himalayan region (IHR) supports over 1748 (32.2% of India) floral elements of known medicinal value, many of these are in high demand by pharmaceutical companies. A few of them mostly those whose reproductive parts are generally useful have entered in the threatened category. Prominent causes of biodiversity loss recognized here are

over exploitation, habitat destruction and species introduction (UNEP, 2001; Pande 2016). As a result the valuable plants like *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca* and *Dactylorhiza hatagirea* are facing the pressure to survive in nature. According to IUCN and TRAFFIC researchers. India is a hub of the wild-collected medicinal plant industry in Asia, but a significant decline in key species have seen to meet the domestic and foreign market demands. After COVID-19 a significant increase has been observed in collection and harvesting practice of immunity boosting floral elements leading to risk of extinction of not only those medicinal plants which are already in threatened list but even to those which are abundant at present in natural habitat (Sen, 2021; Devi., 2021). Current situation of extinction is

worse in the developing countries like India where mostly, medicinal plants are over exploited for income and are becoming extinct. Other reason behind their declining are habitat destruction, overgrazing, poor seed germination and unscientific method of collection, as a result the species documented in present study (whose underground parts are mainly useful) are disappearing rapidly, requiring their conservation and sustainable management. Focused study on cultivation and conservation of *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca* and *Dactylorhiza hatagirea* has not been attempted in Nihri tehsil of district Mandi, Himachal Pradesh till now. So, the present study has been undertaken to assess the threat risk and study cultivation practice for their distribution and conservation in study area.

2. METHODOLOGY

2.1 Study area

The present study has been conducted in the Nihri tehsil (latitude 31°43'12.5" N and longitudes 77°07'01.2" E) of district Mandi, Himachal Pradesh. Initially it was a sub-tehsil in Sunder Nagar. It is located 69 Kms from District headquarter Mandi. It is located at an elevation of 2100 m. It covers approximately 28,508-hectare area, comprises of 19 Panchayats, 203 villages. The total population of the study area is 20,280. It supports diverse habitat, species, communities and ecosystem.



Fig. 1: General overview of Study Area.

2.2 Method

Present study is based on both primary and secondary data. Rare plants were selected on the basis of primary information gathered by interviewing the knowledgeable people (Vaidya, Elders etc) of study area; through people biodiversity register study of all the panchayats of study area and through literature review of work done in other nearby areas with similar climate and altitudinal range. Survey and sampling of the plants selected for study was done between different altitudinal ranges mostly (1900-2500m) from March 2022, to March, 2023 in the study area. Plant species were identified with the help of flora of Mandi (Singh, 2018). Used value Index was used to assess the relative importance of plant. The knowledgeable persons of the study area were interviewed through questionnaire for past and present status of plants, their indigenous uses, harvesting practice and range of occurrence. Information on local names,

plant parts used, indigenous knowledge and practices of using these plants is gathered and analysed.

Threat categories of the species have been identified based on habitat, distributional range, nativity, wild status, UV and its DMR value (Sen & Thakur, 2021) To know the multiple uses of plants, criteria for data collection and analysis was (0= not used, 1=least used, 2=less, 3=good, 4=very good, 5=best). Use Value index (UV) was used to assess the relative use, importance and present or past status hence threat categorization of each plant listed in present study. Different types of UV was calculated: a General Use Value (UV general), based on citations of that species recorded in the interviews; a Current Use Value (UV current), based only on the citations of plants reported by the informants for uses still practiced at the present time; a Past Use Value (UV

past), based on the citations of plants reported by the informants as used only in the past.(Table 7)

Nursery plants were raised at Nihri by collecting propagation material from wild habitat and from local *Vadiya*. Plantlets were distributed to SHGs, farmers and local people in selected areas after awareness program on cultivation practice, harvesting and medicinal, economic and ecological importance of documented plants. 10 villages were selected at different altitudinal ranges having low density of *Dioscorea deltoidea*, *Hedychium*

spicatum, *Polygonatum verticillatum*, *Angelica glauca* and *Dactylorhiza hatagirea* for distribution of plants after raising in nursery bags.(Fig.2 and Table 3).

Parameters used for the threat categorization

All the threatened attributes divided into three grades; highest (10 marks); subsequent 6 marks and least 2 marks. The species fulfilling all the attributes in highest grade resulted in highest CU(cumulative values) and one which falls in least grade for every attribute resulted in least cumulative values (Table 1.)

Table 1: Parameters used for the threat categorization.

Scores	Altitudinal Range	H/Hs	Uv	Native & Endemic	DMR
10	>3000	1	>0.5	Native or Endemic	10-15
6	2500-3000	2-3	0.3-0.5	Non-native/endemic	16-20
2	1900-2400	>3	<0.3	Non native	>20

Abbreviation used: H/s= Habitat (s), Uv= Used value. The species having >35 CU were considered as Critically Endangered; 20-35 as Endangered; 10-20 as Vulnerable; and 0 -10 as Near threatened.

Table 2: List of village's chosen at different altitudinal ranges for distribution of nursery plants.

S. no	Village name	Altitude (in m)	Latitude	Longitude
1	Pandar	2240.58	31043'45.7" N	77005'43.4" E
2	Mundlidhar	2155.85	31040'16.1" N	77002'72.1" E
3	Rohanda	2136.64	310 46'15.0" N	77002'70.5" E
4	Badehan	2240.58	31039'64.3" N	77002'66.4" E
5	Prali	2105	31040'95.6" N	77o01'82.5" E
6	Tehta	2017.47	310 43'40.4" N	77007'25.4" E
7	Lajhag	2150.05	310 40'95.6"N	77001'82.5" E
8	Banwali	2090	31043'50.2" N	77007'43.1" E
9	Chowki	2212.84	31044'36.0" N	770 04'96.5" E
10	Bara	1950.72	310 43'12.5" N	77007'01.3" E



Fig. 2: Gathering information from local people.

3. RESULTS AND DISCUSSION

3.1 Habit, habitat & morphology of *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca*, *Dactylorhiza hatagirea* in Nihri

Total 5 plant species belonging to 5 families and 5 genera has been selected for domestication and conservation based upon their threat categorisation. (Table 7). All are herbaceous flowering plant and mostly present in shady moist habitat. Their underground plant parts (either tuber or rhizome) are mostly useful to local community.

S.no.	Habitats
1	Shady moist
2	Dry
3	Forest
4	Waste land/roadside/Wayside
5	Marshy/Watercourses
6	Grassland
7	Cultivated/planted
8	Parasitic/ Epiphytic

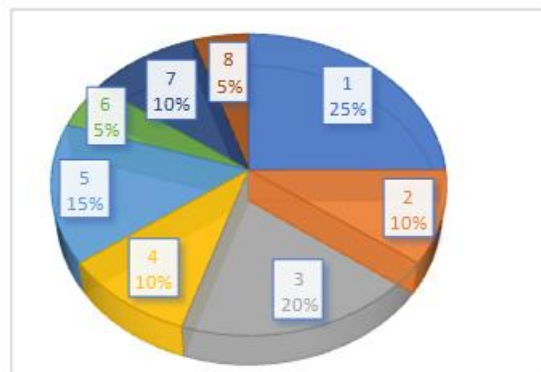


Fig. 3: Showing Habitat of listed plants.

3.2 Distribution and nativity

Among these plants distribution of *Dactylorhiza hatagirea* is limited to higher elevation range more than 2500m while rest were present in altitudinal range between 1900-2500, *Polygonatum verticillatum* was abundant in study area as compare to rest of species. Except *Polygonatum verticillatum* all the species are naive to India. (Table; 4 &7)

Table 4: Habit, habitat, morphology, distribution and nativity of threatened plants in Nihri.

Basic Information	<i>Dioscorea deltoidea</i>	<i>Hedychium spicatum</i>	<i>Polygonatum verticillatum</i>	<i>Angelica glauca</i>	<i>Dactylorhiza hatagirea</i>
Family	Dioscoreaceae	Zingiberaceae	Asparagaceae	Apiaceae	Orchidaceae
Common names	Wild yam	Kapoor Kachouri,	Whorled Solomon's Seal	Smooth Angelica	Hatta Haddi
Local name.	<i>Singali- mingali</i>	<i>Shoyee</i>	<i>Salam mishri</i>	<i>Chora</i>	<i>Salampanja</i>
Altitude	1900 to 2100m.	1200-3000 m	1800-3200m	2000 to 3000m	2500-5000 m,
Habitat	1,3,8	1,2,3,4,5,7	1,2,3,4,5	1,3	6
Nativity	Indian oriental	Reg. Himalayas (Endemic)	Europe, Asia.	Reg. Himalayas (Endemic)	Reg. Himalaya
Morphological features	A glabrous twinning vine, upto 3m tall, grow from Tu. Lf are simple alternate, long-petiolate usually ovate- lanceolate, acuminate, base widely cordate, lobes rounded & sometimes dilated outwards. Male & female spikes are solitary. Capsules are broadly winged. Sd is rounded.	A leafy robust Hb, up to 1.5 m tall growing from a Tu rootstock. Lf broadly lanceolate ending in a tail- like tip. Fl are white fragrant & attractive due to presence of orange- red base. Spikes terminal dense, bracts green, oblong, obtuse, 1-flowered. Calyx ovate, obtuse, membranous, 3-lobed, shorter than bracts. Corolla tube much longer than calyx. Petals	Erect or sub erect Hb upto 60-120cm tall. St is angled and grooved. Rt thick & creeping. Lv sessile, in whorls of 4-8, linear or linear-lanceolate, 8-20cm long, tip acute to acuminate, lower surface glaucous. Fl are greenish-white, 8-12mm long, in axillary whorls; peduncle 2-3 flowered. Perianth 6-parted; segments spreading. Fr berry. Berries globose, 6-8mm across, bright red,	Tall, erect, glabrous, Hb growing 1-3 m tall. Rt are thick, long. St is fistular. Lf large, 1-3 pinnate; leaflets often in three, sometimes reduced to 1, ovate or lanceolate, entire or lobed, irregularly and sharply toothed, glaucous beneath, Lf base sheathing, broad, inflated. Involucre of 5, long, linear bracts. Rays 20 or more. Involucel of 6-10, linear bracteoles. Fl are white or purple, in compound umbels.	Terrestrial erect, glabrous, Hb upto 30-90 cm tall arising from palmately divided Tu. Tu shows 2 or 3 fingers like lobes. Lf erect, oblong-lanceolate, obtuse, base sheathing. Inflorescence is raceme, crowded with many Fl. Fl dull, purple or pink in dense flowered spikes. Bracts green, narrowly lanceolate, the lower much longer than the Fl. Sepals and petals nearly equal, the lateral sepals spreading, the dorsal one forming with the

		<p>white, linear, spreading, lip white with two elliptic lobes with an orange base. Fr is capsule. Capsules are globular, 3- valve, with an orange-red lining. Sd are numerous, black, enclosed in a red aril.</p>	<p>becoming dark purple when ripe.</p>	<p>Calyx-teeth none, petals 5, obovate, emarginated. Stamens. Fr are glabrous, flattened, oblong, dorsal and intermediate ridges thick, not winged, lateral ridges expanded into wings.</p>	<p>petals a hood over the column. Lip rounded shallowly 3-lobed, spotted dark purple. Spur straight, cylindrical, and nearly as long as the ovary. Column very short. Anthers adnate to its face, cells</p>
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Abbreviation used: Hb=Herb, Lf=Leaf, Lv=Leave, Fl=Flower, Sd=Seed, Tu=-Tuber, Rt=-Root, Fr=Fruit.



Dioscorea deltoidea cultivation & dried roots



Hedychium spicatum in different stages of life



Angelica glauca showing different parts



Polygonatum verticellatum in different stages of growth



Dactylorhiza hatagirea plant

Fig. 4: Morphology of documented plants.

3.2 Indigenous uses

5 threatened plants in present study are rich in nutritive, medicinal and economic values, so useful plant parts of these plants like leaves, shoots, fruits, seeds, buds, flowers, roots or other underground parts are utilized as source of food, oil, fodder, household items, medicine and materials. All these plants shows 4 or more than 4 uses so are considered as multipurpose in nature. Among their plant parts utilized maximum leaves are utilized indigenously followed by roots.(Table.5, Fig.4,5 and 6).

All the plants are traditionally used in one form or other and also harvested for income generation by selling their useful plant parts. Plants like *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum* are known to have market value and sold at high rate in local, national or International market, So, are good source of earning for local people. Woman and children are mainly involved in collection and selling of these plant produce. (Table 5, Fig. 5 and 6).

Table 5: Indigenous use (Medicinal, edible & economic potential of threatened plants).

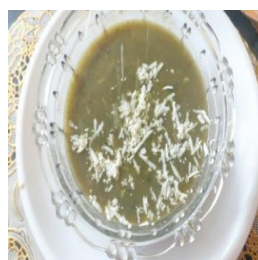
S. No.	<i>Dioscorea deltoidea</i>	<i>Hedychium spicatum</i>	<i>Polygonatum verticillatum</i>	<i>Angelica glauca</i>	<i>Dactylorhiza hatagirea</i>
1.Edible uses	Local alcoholic drink (<i>dheli</i>) in combination with other medicinal herbs. Tu pickled: cooked as veg or boiled to stuff in local dishes (<i>kachouri</i> , <i>parantha</i> , <i>siddu</i>) with potatoes.	Rh, Fl & Fl buds are eaten cooked or used as flavoring agent in <i>rayata.</i> , chilla (<i>Kachru</i>). Rh pickled & taken as a spice in tea.	Lf & shoot terminals taken as veg. Lf chilla (<i>Kachru</i>), <i>parantha</i> , <i>pakor</i> , <i>sambhar</i> etc. Rt are either eaten roasted or powdered & taken as tonic with milk or as a thickening agent in soup.	Rt taken both fresh and dried as a spice, condiment or flavoring agent in local food items. These are also used as an addition to local alcoholic drink.	Rt powder either taken as tonic; as a thickening agent in soups or an addition to many traditional dishes, like <i>Halwa</i> and <i>Sirra</i> (Sweet dishes prepared from wheat flour & starch).
2.Medicinal uses/ Local Uses	Powdered Rh is given orally to get relief from snake bite. Paste of Tu is used to kill body lice.	Rh considered useful to cure liver & bowl complaints, vomiting, fever, diarrhea & rheumatic swellings.	Rt powder is taken with milk as a tonic to increase fertility, vigor & physical strength.	Rt useful in toothache. Considered good to enhance appetite, healing of wounds & cuts.	Tu are taken as tonic to increase strength & vigor
Uses in Literature:	It shows anti-rheumatic properties & treat ophthalmic disorder. Powdered Rh of this plant is taken orally to cure dysentery, abdominal pain and piles (Jain, 1975; Kumari et al. 2012).	Powdered Rh is useful in the treatment of wide spectrum of diseases viz liver complaints, fever, vomiting, diarrhea, inflammation, pain snake bite, indigestion, blood thickening, asthma, blood diseases, foul breath, bronchitis hiccough & vomiting Decoction of Rh is taken as a tonic to improve the brain health. (Badola HK; 2009)	Rt improve sexual potency, increase body temperature, & cure gastric troubles. Rh are cooling, antiperiodic, sweet, cardio tonic, antitussive, hypoglycemic, demulcent, diuretic, sedative & energizer. They are used in treatment of dry coughs and pulmonary. (Srivastava et al., 2012). Dry powdered Rh with honey cure tuberculosis & cure leucorrhoea If taken with water twice in a day. (Bhatt, 2014).	Rt are useful in treatment of hyperglycemia bronchial asthma, hypotension, muscle tremors, restlessness, tachycardia, flushing, convulsions & adrenal crisis. (Boushey, H. A., & Katzung, B. G. (2009).	Hb shows resistance to bacteria, effectiveness in improving sexual organ & preventing sexual disorders. (Ranpal 2009; Thakur and Dixit, 2007)
Veterinary Uses	Tu juice is given to treat roundworm (5-7 teaspoon twice a day) & constipation of sheep. 30-40 g paste of tuber is applied to cows and buffalos to cure mastitis.	Pieces of Rh mixed with green fodder fed to livestock to enhance lactation.	-	300gm of Rt mixed with water & used to cure Tympany and Bloat in cattle specifically cattle (twice a day).	-

3. Other uses:	Lv kept in winter cloth to keep away insects. Soap from Tu used to wash shawls and kill lice. Stand (Bina) from vine. are used to place clay pots.	Chopped Rh pieces are fed to milch cattle to enhance lactation. Essential oil from Tu is used in perfumery. The dried Rt is burnt as an incense.	Fodder	Fodder	Ornamental, St & Lf are used as insect repellent, fodder & considered good to improve the quality of milk. Fl extract is used in perfume industries.
Source of income	Tu = 100-200 / Rs kg	Rh=Rs150-200/kg Dried Lf foot mats. A medium sized mat= Rs. 400-500.	Rt= 500-600 Rs /kg (local market) 17,000-19,000 Rs /kg (Nation / International)	Rt= 600-900 Rs /kg (local market) 900-12,00 Rs /kg (Nation/International)	Tu = 16,000 Rs /kg

Abbreviation used: Hb=Herb, Lf=Leaf, Lv=Leave, Fl=Flower, Sd= Seed, Tu=Tuber, Rt= Root, St=Stem, Fr= Fruit, Rh=Rhizome. Veg=vegetable.



Polygonatum verticillatum leaf vegetable



Soup of *Dactylorhiza hatageria* (dried root powder)



Hedychium spicatum flowers kachru



Vegetable & Bhale of *Dioscorea deltoidea* (Tu)



Mat of *Hedychium spicatum* leaves



Bina leaf pot base of *Dioscorea deltoidea* (vine)

Fig. 6: Other Uses.

3.3 Threatened status of *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca* and *Dactylorhiza hatageria* in Nihri tehsil

All the 5 plant documented in present study are known to have tremendous medicinal and economic value, so are sold at high market rate both nationally and internationally. (Table. 5, Fig.5 & 6). These plants are heavily exploited for both personal and commercial uses. Threat categorization of these species have been done based on habitat, distributional range, nativity, wild

status, UV and its DMR value. Data analysis shows that among these plants *Dactylorhiza hatageria* is critically endangered having Uv (Genera=0.22), and DMR score (13) followed by *Angelica glauca* and *Dioscorea deltoidea* which are placed in endangered category having Uv (General = 0.40 & 0.45) and DMR score (17 & 21) respectively, followed by *Polygonatum verticillatum* and *Hedychium spicatum* which are placed in vulnerable category with UV (General = 0.24 & 0.60) and DMR score (16 & 23) respectively (Table.7)

Table 7: Threat categorization based on threatened attributes.

Botanical name	Used value (UV)			Score for UV	H/Hs	score for habitat	Score for DMR	Score for altitudinal range	Score for nativity	CV value Cumulative Value (UV+HS+DMR+AR)	Threat categorization
	General	Current	Past								
<i>Dioscorea deltoidea</i>	0.45	0.18	0.36	6	1,3,8	6	2	2	6	22	EN
<i>Hedychium spicatum</i>	0.60	0.40	0.50	6	1,2,3,4,5,7	2	2	2	6	18	VU
<i>Polygonatum verticillatum</i>	0.24	0.10	0.20	2	1,2,3,4,5	2	6	2	2	14	VU
<i>Angelica glauca</i>	0.40	0.20	0.30	6	1,3	6	6	6	10	34	EN
<i>Dactylorhiza hatagirea</i>	0.22	0.01	0.15	2	6	10	10	10	10	42	CR

Table 8: DMR score of threatened plants species with their additional uses.

S. No.	Botanical Name	Ed	Fd	Md	FL	RI	EV	Other uses	Rank
1	<i>Dioscorea deltoidea</i>	5	4	5	0	0	5	2	21
2	<i>Hedychium spicatum</i>	4	3	5	0	3	5	3	23
3	<i>Polygonatum verticillatum</i>	3	2	5	0	0	5	1	16
4	<i>Angelica glauca</i>	4	2	5	0	0	5	1	17
5	<i>Dactylorhiza hatagirea</i>	2	1	5	0	0	5	0	13

Abbreviation: Ed= Edible; Fd=Fodder; Md= Medicinal, FL=fuel, RI= Religious; Ev-Economical value

Need of Domestication and cultivation

From last few decades, we have seen an increasingly double burden of malnutrition worldwide, encompassing shortage of calories (hunger) at one end (in most of developing countries) and excess (obesity) at the other (in developed countries). This challenges contemporary agriculturist, horticulturist and food scientist of all over the world to seek alternative pathways for diversification, domestication and utilization of vast untapped wild edible medicinal plants as a solution to feed and cure day by day growing human population with outburst of diseases and shrinking of agricultural land. Unlocking of wild food plants like *H. spicatum* as a future immunity booster food crop will thus support sustainable agriculture at one end and ensure food security, immunity and rural prosperity at other (Sen, 2021) As *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca* and, *Dactylorhiza hatagirea* all are potential source of food, medicine and income, (Table.5, Fig.5 & 6) but has attained critically

endangered threatened status due to unsustainable harvesting practice of tubers from natural habitat and due to the lack of awareness and traditional knowledge among the young generation. The use and occurrence of all these valuable plants at present is almost negligible in Nihri. Therefore, for their optimum utilization, all these plants should strongly recommend to bring under human cultivation or domestication with government support and initiatives. This will boost health, food security, rural prosperity, of local community and ensure sustainability & conservation of rare plants species as well as traditional knowledge.

4. Cultivation practice of plants

Cultivation practice of all the documented plants in present study vary from one another. Overall all the plants are propagated by seeds or rhizome. They mostly prefers shady moist habitat for optimum growth. (Table; 9).

Table 9: Cultivation practice.

S. No.	<i>Dioscorea deltoidea</i>	<i>Hedychium spicatum</i>	<i>Polygonatum verticillatum</i>	<i>Angelica glauca</i>	<i>Dactylorhiza hatagirea</i>
1. Propagation material	Cut sections of Tu & Sd	Sd & Rh	Cut sections of Tu & Sd	Sd & Root stock splits	Cut sections of Tu & Sd
2. Germination time	1-3 weeks. (May - Sept.)	25-30 days (March - June). Harvested in winters.	5 months- 1 year (Sept. - Nov).	25-40 days. (Nov- Dec).	3 months- 1 year (June- July).
3. Soil type	Well drained & loamy.	Deep sandy or loam soil rich in humus.	Moist loamy & clay soil slightly.	Fertile loam soil rich in organic matter.	Moist meadow soils like dark grey, granular, sandy loam, sandy soils at greater depth.
4. Sunlight/ Temperature /Rainfall	Sunny position (20°C) 100-200cm	Shady area (18°C) About 1320mm	Shady or cold area (-25°C) 2000-2500m	Shade and temperate region (4°C) 46.7-1401 mm	Low temperature (10-15°C) 150-380mm
5. PH. of soil	Slightly acidic	Neutral soil	Acidic soil basic and neutral soil	Neutral soil	Slightly basic soil
6. (Time of cultivation) Sowing:	Early summer.	June - July.	Sept.	May June.	April-May
Harvesting	Late summer	Dec- January	Feb.	Oct.- -Nov.	Round the year

Abbreviation used: Sd =Seed, Tu=Tuber, Rh=Rhizome

4.1 Role of *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca*, *Dactylorhiza hatagirea* in boosting health, sustainability and rural prosperity.

Medicinal plants play a vital role in treatment of various diseases. During the Covid 19 pandemic when no proper medicine was available to fight against the disease, various traditional herbs have been used as medicine, which boost the immunity of patients. The present study have discussed various medicinal plants (herbs) *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca*, *Dactylorhiza hatagirea*,

which boost the immunity and help in preventing a wide spectrum of diseases. (Table.5).

These medicinal plants also provide numerous opportunities for the rural wellbeing. Because these are the source of many products that are sold at premium prices. Thus their cultivation (Table.9 and fig.7) as agricultural crop and selling can help in raising income of local community at one end and in contribute to the health of millions at another. This will also help in conservation of these plants and boost the sustainability of the Nehri.



***Dioscorea deltoidea* cultivation**



Cultivation practice of *Hedychium spicatum*



Field preparation and cultivation practice of *Polygonatum verticillatum*



Cultivation of *Angelica glauca*



Cultivation practice of *Dactylorhiza hatageria*

Fig. 7: Cultivation practice & raising.

5. Conclusion and future prospectus

Overharvesting of underground parts of documented plants is greatest threats to the survival of these species in study area. It is also hazardous to overall ecosystem stability in Nehri. At present cultivation of threatened and rare plants species is considered a conservation strategy that can reduce pressure on the plants growing in forests as well as in other natural habitats. This strategy will not only conserve wild populations of the target specie, but can also help to meet the growing market demand of high rated plants at one end and maintain chain of demand and supply at another. So, cultivation of threatened plants *Dioscorea deltoidea*, *Hedychium spicatum*, *Polygonatum verticillatum*, *Angelica glauca* and *Dactylorhiza hatagirea* will be useful to promote livelihood and sustainable utilization of these plants. For better outcome same study should be replicated at different altitudinal range and geographical zone of Western Himalayas as well as to the other rare and valuable floral elements of Nehri.

Recommendations

1. Mass awareness for medicinal, edible and economic potential of documented Plants.
2. Mass awareness for cultivation and sustainable harvesting practice.
3. Distribution of seeds and plantlets.
4. Engaging young minds in cultivation, traditional processing and use of this plant in their day to day life.

6. REFERENCES

1. Agnihotri Vijai. K., Thappa Rajendra. K., Baleshwar Meena., Kapachi Bal. K., Saxena Rajendra. K., Qazi Ghulam. N and Agarwal Shri. G. Essential oil composition of aerial parts of *Angelica glauca* growing wild in North West Himalaya (India). *Phytochemistry*, 2004; 65: 2411– 2413.
2. Dangwal and Chauhan, *Dioscorea deltoidea* Wall. Ex Griseb. A highly threatened Himalayan Medicinal Plant: An overview, *International Journal of Pharmacology and Bio Sciences*, 2015; 45: 2- 4 60.
3. Das S, Choudhury MD, Mazumder PB. In Vitro Propagation of Genus *Dioscorea* - A Critical Review. *Asian Journal of Pharmaceutical and Clinical Research*, 2013; 6(3): 26-30.
4. Devi T.): Diversity, Distribution, Nativity and Indigenous Uses of Crop Wild Relative of District Mandi Himachal Pradesh and Their Potential in Crop Improvement Programme” *International Journal of Scientific Research in Biological Sciences*, 2021; 8(1): 108121.
5. Heywood V. H. *Global biodiversity assessment*. Cambridge University Press, Cambridge, 2000.
6. Joshi, S., Chanotiya, C.S., Agarwal, G., Prakesh, O., Pant, A.K., Methela, C.S., Terpenoid compositions and antioxidant and antimicrobial properties of the rhizome essential oil of different *Hedychium* species. *Chemistry and Biodiversity*, 2008; 5: 299–309.
7. Mohan, S.; Alsawalha, M.; Al-Subaei, A.; Al-Jindan, R.; Bolla, S.; Sen, D.; Balakrishna, J.; Ravi, P.; Gollapalli, S.R.; Veeraraghavan, V.; et al. Anti-diabetic activities of *Dactylorhiza hatagirea* leaf extract in 3T3-L1 cell line model. *Pharmacogn. Mag*, 2019; 15: 212.
8. Pande, P.C., Vibhuti, Awasthi, P., Bargali, K., & Bargali, S.S. Agro- Biodiversity of Kumaun Himalaya, India: A Review. *Current Agriculture Research Journal*, 2016; 4: 16-34.
9. Qureshi IM, Kaul ON; Some endangered plants and threatened plants in South-East-Asia. IUCN Publication (new-series), Morges Switzerland, 1970; 18: 115- 126.
10. Rawat, S., Jugran, A. K., Bhatt, I. D., & Rawal, R. S. *Hedychium spicatum*: a systematic review on traditional uses, Phytochemistry, pharmacology and future prospectus. *Journal of Pharmacy and Pharmacology*, 2018; 70(6): 687-712.
11. Rokaya and Sharma; *Dioscorea deltoidea* in Nepal: Cross Validating Uses and Ethno pharmacological Relevance. *Asian Journal of Ethno pharmacology and Medicinal Food*, 2016; 2(20): 17-26.
12. Samant, S. S., Dhar, U., & Rawal, R. S. Biodiversity status of a protected area in West Himalaya: Askot Wildlife Sanctuary. *The International Journal of Sustainable Development & World Ecology*, 1998; 5(3): 194-203.
13. Singh, K.S., & Patra, A. Evaluation of phenolic composition, antioxidant, anti-inflammatory and anticancer activities of *Polygonatum verticillatum* (L.). *Journal of Integrative Medicine*, 2018; 16: 273-282.
14. Singh, K.S., & Patra, A. Evaluation of phenolic composition, antioxidant, anti-inflammatory and anticancer activities of *Polygonatum verticillatum* (L.). *Journal of Integrative Medicine*, 2018; 16: 273-282.
15. Sen, T.D., Thakur, T, Thakur, B, Past and present status of *Dioscorea deltoidea*; A highly threatened wild medicinal plant in Nihri tehsil of Himachal Pradesh, North Western Himalayas. *World Journal of Pharmaceutical and Life Sciences wjpls*, 2021; 7: 12, 14 – 25. ISSN 2454-2229.
16. Samant S. S. Diversity, distribution and conservation of fodder resource of west Himalaya, India. In: MISRI B. (eds.). *Proceedings of the third temperate pasture and fodder network (TAPAFON)*. Pokhara, Nepal, sponsored by F.A.O., Ro, 1998.
17. Satapau H; Endangered plant species and their habitats .IUCN publication-(new series) Morges, Switzerland, 1970; 18: 83-88.
18. Semwal, P., Painuli, S., & Cruz-Martins, N. *Dioscorea deltoidea* wall. Ex Griseb: A review of traditional uses, bioactive compounds and biological activities. *Food Bioscience*, 2021; 41: 100969.
19. Sen, T. D., The Role of Wild Food Plants of Himachal Pradesh in Boosting Immunity to Combat COVID-19. *Journal of Scientific Research in Medical and Biological Sciences*, 2021; 2(2): 23-62.

20. Sen, T.D. Domestication of some nutritionally important wild edible plants of Mandi Himachal Pradesh, North Western Himalayas for boosting health, immunity, rural prosperity and food security” in International Journal Of Tropical Agriculture, 2021; 39: 1-2: 87-108.ISSN 0254-8755.
21. Singh, J.S. The biodiversity crisis: a multifaceted review. Current Science, 2002; 82: 638-647.
22. Thakur, T.D.S Some wild edible plants of Western Himalayas Volume-II/ Published by Star Book Sales Mandi HP. ISBN:978-93-5526-910-2, 2021.
23. UNEP. Executive Summary, In: India: State of the Environment Report. UNEP-TERI-MEOEF, New Delhi, 2001; 1-6.
24. Vashistha R., Nautiyal B. P. and Nautiyal M. C. Conservation status and morphological variations between populations of *Angelica glauca* Edgew. and *Angelica archangelica* Linn. In Garhwal Himalaya. Current Science, 2006; 91(11): 1537-1542.
25. Vibhuti., Bargali, K. & Bargali, S.S. Effects of home garden size on floristic composition and diversity along an altitudinal gradient in Central Himalaya, India. Current Science, 2018; 114: 2494-2503.
26. Virk, J.K., Kumar, S., Singh, R., Tripathi, A.C., Saraf, SK., Gupta, V., & Bansal, P. Isolation and characterization of Quinine from *Polygonatum verticillatum*: A new marker approach to substitution and adulteration. Journal of Advanced Pharmaceutical Technology and Research, 2016; 7: 153- 158.
27. Warghat, A.R.; Bajpai, P.K.; Srivastava, B.R.; Chaurasia, O.P.; Chauhan, R.S.; Sood, H. In vitro protocorm development and mass multiplication of an endangered orchid, *Dactylorhiza hatagirea*. Turk. J. Bot., 2014; 38: 737-746.
28. www.himalayanwildfoodplants.com