Assessment of Potentiality and Production of Medicinal & Aromatic Plants and Development of Plan for conservation, Resource Development and Sustainable Management of Medicinal & Aromatic Plants

DEVELOPMENT PLAN FOR MANDI CLUSTER

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Submitted

To

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1. Introduction

Plants are natural resources as they are unique, indispensable and an estimate of their availability is complex. Among all plant species, medicinal and aromatic plants (MAP's) are of the important groups of natural resources. They can provide a good source of income if cultivated at commercial level as their demand is fast increasing. Therefore there is a need to evaluate the economics of cultivating medicinal and aromatic plants. It does not consider the threats imposed due to indiscriminate gathering and harvesting but focuses on the economic opportunities available for their cultivation. Himachal Pradesh has a huge biodiversity and all districts have immense medicinal plants and crops.

Non Timber Forest Products (NTFPs) refer to all biological materials other than timber extracted from natural forests for human and animal use and have both consumptive and exchange value. Globally NTFP are defined as "forest products consisting of goods of biological origin other than wood, derived from forest, other wood land and trees outside forests". It is estimated that 275 million poor rural people in India (i.e. 27 percent of the total population) depend on NTFPs for at least part of their subsistence and cash livelihoods. This dependency is particularly intense for half of India's 89 million tribal and rural people, the most marginalised section of society, who live in forest fringe areas. According to an estimate the NTFP sector alone is able to create about 10 million workdays annually in the country.

NTFPs are used and managed in complex socio-economic and ecological environments. In traditional forest communities, many NTFPs may be used for subsistence while others are the main or only source of income. Some NTFPs have significant cultural value, as totems, incense, and other ritual items. Others have important medicinal value and contribute to the community's health and well-being.

NTFPs have a tremendous potential to involve local collectors for establishing micro, small and medium enterprises through clear tenured rights, better collection methods, financial support, capacity development, infrastructure and institutional support in near future. With these efforts there is a potential to create large scale employment opportunity thereby, helping in reducing poverty and increasing empowerment of particularly women, tribal and poor people of the poorest and backward districts of the country.

But as forest areas shrink, human populations grow, markets change, and traditional management institutions lose their authority, the sustainable production of many NTFPs is no longer assured. Governments, conservation and development agencies and non-government organisations are steering towards finding new avenues of NTFPs for the poor people living

in or around of the forests that will ultimately help to conserve the forest and improve the biodiverstiy.

Table 1: Selected Gram Panchayats of Mandi district

S. No.	Name of Gram Panchayats	Range	Cluster
1.	Nawani	Baldwara	Mandi
2.	Patrighat		
3.	Jaral	Jhungi	
4.	Bandli		
5.	Dhwal	Kangoo	
6.	Shoja		
7.	Jamni	Sarkaghat	
8.	Tikkar		
9.	Dhumet Behli	Jaidevi	
10.	Jaidevi		

Ten panchayats of Mandi cluster were selected and surveyed for the NTFPs development and conservation plan. Mandi is located in 31°72'N latitude and 76°92'E longitude. It has an average elevation of 764 metres (2,506 feet). There is great variation in the climatic conditions of Himachal due to extreme variation in elevation. Climate is one of the major determinants of vegetation. During the discussion, it was observed that below mentioned four plant species of the cluster are growing in the area and to increase the income/livelihood of the farmers, more plantations of these plants along-with appropriate market and price can be provided. It will benefit farmers economically if cultivated in large scale.

Table 2: List of medicinal plants in present in district Mandi (HP)

Botanical names	Local names	Parts	Disease
Punica granatum	Anar	Fruit	leprosy, rind of the fruit is useful in curing dysentery and diarrhea
Aegle marmelos	Bael	Fruit, leaves	Possesses antidiarrhoeal, antimicrobial, antiviral, radioprotective, anticancer, chemopreventive, antipyretic, ulcer healing, antigenotoxic, diuretic, antifertility and anti-inflammatory properties.
Prunus persica	Aru	Fruit, leaves	Leaves are astringent, demulcent, diuretic, expectorant, febrifuge, laxative, parasiticide and mildly sedative.
Pyrus communis	Nashpati	Fruit	pears for many conditions, including indigestion, diarrhea, constipation, nausea and vomiting, and liver scarring
Phyllanthus urinaria	Bhoomi amla	Fruits	Give relief from hot flushes, fruit juice taken as tonic, also helpful in diabetes.
Rumex nepalensis	Jangali palak	Leaves	Leaves juice applied externally to relieve headache.
Taraxarum officinale	Dhudhi	Roots	Roots given to cattles to increase milk production, crushed leaves & latex applied on itchy.

Viola patrinii	Vanaksha	Flowers	Tea made from leaves & flower helpful in cough & cold.
Mallotus philippensis	Kamal	Fruit and leaves	Mixed with mustard oil and applied topically on burns.
Murraya koenigii	Gandhelu	Leaves and fruits	Luke warm decoction is applied topically on swelling of foot and legs.
Terminalia bellirica	Bahera	Fruits	Roasted fruit for cough and cold.
Terminalia chebula	Harad	Fruits	Rubbed with mother's milk & licked to infant as a laxative.
Tinospora cardifolia	Giloye	Stem, leaves, roots	Decoction used orally in joint pains, jaundice, stomach ache
Vitex negundo	Bana, Basunti	Flower and leaves	Chewing provides relief in oral sores.
Bombax ceiba	Semul	Bark and flowers	Leucorrhoea, wounds, loose motions,burns and tumours
Berberis aristata	Daruharidra	Roots	Liver, ulcers, fever, infection in intestine, inflammation, cuts, wounds, eye and skin diseases, diarrhoea etc.
E. globules	Safeda	Leaves	Dandruff and an itchy scalp clear the throat
A. catechu	Catha	Bark	Mouth ulcers, sore throat, diarrhea
Curcuma longa	Haldi	Leaves	Wound healing, mouth ulcers, stomach ache, skin tone improvements
Plantago lancelata	Isabgol	Leaves	Heated crushed leaves applied on cuts & wounds to check bleeding
Thalictrum foliolosum	Chaitra, Sarphar	Roots	Root powder is used for ophthalmic treatments and root paste is applied to check the skin problems.
Valeriana jatamanasi	Sugandhbala	Roots	Antiseptic, cardiac stimulant, diuretic, epilepsy, nervous problems, hysteria One teaspoon of root powder is given three times a day for two weeks.
Casia fistula	Alees	Fruit pulp	Kapha and pitta dosha
Psidium guajava	Amrood	Fruit, leaves	Skin, digestion, mouth ulcers, BP
Bauhinia variegata	Kachnar	Bark, leaves, flower	Joint pain, diabetes
Roylea cinerea	Kadvae	Leaves	Fever, malaria, skin diseases and diabetes
Bohemeria macrophylla	Chamrala	Leaves	Wound healing

2. *Punica granatum* L.

Trade name : Anardana
Hindi name : Dadu
Parts used : Fruits
Family : Punicaceae

2.1 Introduction

Wild pomegranate (*Punica granatum* L.) is a wild fruit of family *Punicaceae* which resembles with cultivated pomegranate for various morphological characters. Wild pomegranate is an important non-timber forest product (NTFPs) cash crop of western Himalayan region. It is one of those fruits, which have got great economic importance.

2.2 Distribution

The mid hill zone, ranging in altitude from 800 to 1600 meters, of Himachal Pradesh has a comparative advantage of growing wild pomegranate due to congenial climatic conditions for its growth. It is distributed in Mandi, Solan, Sirmaur, Kullu, Shimla and Chamba districts of Himachal Pradesh.

2.3 Climate and soil

During fruit development, prolonged hot and dry climate is required. Optimum temperature congenial for fruit development is 38°C. For Successful pomegranate cultivation; it is essentially dry and semi-arid weather, where cold winter and high dry summer quality enables fruit production. The region with 500 m above from sea level is best suited for pomegranate cultivation. It grows under a wide variety of soils and can tolerate even alkalinity and salinity to a certain extent. Well-drained, sandy loam to deep loamy or alluvial soils is suitable for pomegranate farming. Soil having a pH range between 6.5-7.5 is ideal for pomegranate farming.

2.4 Propagation

Air-layering and stem-cutting can be used successfully for vegetative propagation.

2.4.1. Air-layering

The upright branches of 0.8-1.5 cm diameter from healthy trees are selected and rooting hormone (IBA 2000-3000 ppm) is applied on upper part of the cut. The moist rooting medium (sphagnum moss) is wrapped over the cut portion using. In general, rooting takes place between 30-40 days and well rooted layers are detached from the mother plants within 75-90 days. These air-layers after 70-80 per cent defoliation can be planted in nursery or polythene bags containing soil, sand and well rotten FYM in 1:1:1 ratio. The optimum time for air-layering is June-August. Well developed layered plants should be used for establishment of pomegranate orchards.

2.4.2 Stem-cutting

Multiplication of pomegranate by stem cuttings is a common practice and it can be successfully propagated under green house. Hardwood, semi-hardwood and softwood stem cuttings are used for propagation. The wood younger than 6 months and older of 18 months is

found unsuitable for making stem cuttings. In general, 20-25 cm long and 0.6-1.2 cm thick cuttings found to be suitable for propagation.

2.5 Orchard establishment

***2.5.1 Planting system, spacing, pit digging and time of planting*:**

As far as planting system is concerned square or rectangular planting system can be followed. Planting distance should be decided depending upon soil type, soil depth, climatic condition and variety Pits of 1mx 1 m x 1 m or 0.75 m x 0.75 m x 0.75m are dug at a spacing of 4.5 m x 3.0 m. Closer spacing in long run may invite disease and insect pest problems. Pits are dug about a month prior to planting and kept open for at least 1 month so that it is disinfected by intense solar radiation. Well developed cuttings/air-layered plants preferably 5-12 months old raised in polythene bags should be used for planting. Light irrigation is given immediately after planting. Planting should be done during spring season (February-March) subject to the availability of irrigation water; otherwise July-August is an ideal time of planting in different parts of the country.

2.6 Irrigation supply for pomegranate

Irrigation may be given depending on soil, climate, and availability of water. Pomegranate is a drought-tolerant fruit crop, which can sustain underwater scarcity to some extent. Regular irrigation is also essential to reduce fruit splitting, which is the major disorder of fruits.

2.7 Harvesting

Maturity and harvesting are the factors which affect the quality of fruits. Wild pomegranate is a non-climacteric fruit which is harvested at ripe stage. At maturity, the surface of green immature wild pomegranate fruit turns to yellowish green whereas, the green purple rind colour of immature fruit of cultivated pomegranate turns to deep pink with reddish and yellowish patches at maturity. The milky white colour of arils at early stage turns to creamy pearl white when fruit matures and with the advancement of fruit maturity, the percentage of arils increases, while that of seed, rind and the thickness of rind decreases gradually in pomegranate.

2.8 Marketing

Marketing is done with an agent or broker’s help, whereas own marketing is possible only at a low production level. Pomegranate fruits can make a sale at the wholesale rate of 20 to30/kg fruits in domestic markets.

2.9 Relative economics of pomegranate

Analysis of economy of the plant can be undertaken from absolute economic behaviour in terms of the cost and income flows. Focus will be here to understand the process through which farmers will be benefited.

Table 3: Cost analysis during plantation period:

Material (fixed charges)	**Investment in Rs**
Fencing charges	5,000.00
Land preparation	2500.00
Pit preparation	1500.00
Cost of fertilizers and manure	1,000.00
Plant material cost	12,00.00
Planting and irrigation	1,000.00
Total	**12,200.00**

Table 4: Pomegranate production cost during the gestation period:

Material	**Investment in Rs**
Human Labour	1,000.00
Manure and fertilizers	1,500.00
Irrigation charges	1,200.00
Plant protection chemicals	6,00.00
Total	**3800.00**

Table 5: Cost of pomegranate production during fruiting years:

Material and Labour	**Investment in Rs per year (from 4 year onwards)**
Human labor charges	5,000.00
Manure and fertilizers	2,500.00
Irrigation	2,500.00
Planting protection charges	1,000.00
Miscellaneous	2,000.00
Total	**13,000.00**

The total yield from the farm 450 kg approximately.

The cost of each kg of wild pomegranate is Rs 30.

Total income from the farm in the 6 to 12 year of farming is: total yield x cost per each unit (30 x 80 kg x 30) = Rs 72,000

Cost Benefit Ratio = Total cost/Earning total benefits

=29000/43000=0.67

Profit from the farm is approximately around Rs. 43000 on the total investment structure.

3. *Aegle marmelos*

Trade name : Bael, wood apple, stone apple
Hindi name : Bael
Parts used : Fruits, leaves, bark, roots, and seeds
Family : Rutaceae

3.1 Introduction

Wood apple has excellent health benefits along with some religious use. Farmers in dry regions with less rainfall can opt for this crop. When it comes to its plant and fruit description, wood apple is a large tree with long leaves, a hard berry fruit and an inner sticky brown pulp. The wood apple fruit is round to oval, 5-12 cm wide, with a hard, woody, grayish-white, scurfy rind about 6 mm thick. These trees can be grown in any waste lands or back yards. Bael leaves are used as sacred offering to 'Lord Shiva'.

3.2 Distribution

Wood Apple is one of the edible fruits native to India and parts of Bangladesh, Pakistan, Sri Lanka and Southeast Asia East to Java. *A. marmelos* is a semitropical plant that flourishes at an approximate altitude of 1200 meter from sea level. It is mainly obtained in hill areas and dry forests. It is found almost all states in India like Himachal Pradesh, Andhra Pradesh, Bihar, Jammu and Kashmir, Kerala, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Uttar Pradesh, Tamil Nadu and West Bengal.

3.3 Climate and soil

Wide adaptability to various climatic conditions. These trees require subtropical climate where summer is hot and dry, and winter is mild. These trees require a monsoon climate with a distinct dry season. It can thrive in wide range of soils. However, a well-drained, light sandy loam soil is ideal for its growth and fruit yield. Farm yard manure can be for better yield.

3.4 Land Preparation

Land should be prepared in such a way that there won't be any water stagnation in the field as plants are most susceptible to water logging.

3.5 Propagation

The wood apple is generally propagated through seeds though seedlings will not bear fruits until at least 15 years of age. Multiplication may also be done by root cuttings, air-layers, or by budding onto self-seedlings to induce dwarfing and precociousness. Sowing is

done in June or July. They require at least a year in the nursery to be fit for transplanting. Seedlings or budded plants are transplanted in the field at a spacing of 10-12 m. Budded plants start bearing fruits at the age of 4-5 years, whereas seedling trees require 7-8 years.

3.6 Planting, Season and Spacing

Wood apple plants require a distance of 8 m x 8 m in case of budded plants and require 10 m x 10 m in case of seedlings (propagation from seeds). As part of land preparation, it needs pits of 80-90 cm x 80-90 cm x 80-90cm and these pits should be filled with a mixture of top soil with 20-25 kg of farmyard manure (FMY) and 50grams gamma BHC up to a level of 6 cm from the ground level. In order to settle down the pits, light irrigation should be carried out. In India, the season for planting wood apple is from February-March or July-August.

3.7 Pruning

In early stages wood apple plants should be trained to build solid structure with the help of stakes. As part of training, remove the tip of main stem when the tree is about 1 meter height. It is good practice of training to select only 5 to 6 well-spaced branches of wood apple tree. Normally, there is no need of pruning to be carried out. However, any diseased, dead or sick branches should be pruned off.

3.8 Irrigation

Young plants of wood apple require good amount of water especially right after manuring and fertilization. These plants don't require any water in rainy season and once in a month after the monsoon. In case of flooding or heavy rains, make sure to drain out water as quickly as possible.

3.9 Manures and fertilizers

There is no specific nutritional requirement is suggested. However manures and fertilizers are beneficial for higher yield. Apply 10-15 kg FMY (farmyard manure), 50 grams of 'N', 25 grams of 'P' and 50 grams of 'K' for each plant. Spread these manures and fertilizers under whole canopy of the wood apple tree. Carry out irrigation immediately after applying the manures and fertilizers.

3.10 Weed control and Inter-crops

For healthy crop, suckers appearing from root stock should be removed periodically. Removing weeds on regular basis ensures uniform plant growth. Any legume crops like beans, peas, green grams, black gram can be grown as intercrops in wood apple plantation during the rainy season.

3.11 Pests and diseases

There is no serious insect pest and diseases as of now. But sooty mould has been noticed in commercial wood apple orchards which can be managed by spraying wet table sulphur + chlorpyriphos / methyl parathion+ gumacacia (0.2+0.1+0.3%).

3.12 Harvest and post-harvest management

Since apple wood is widely used for preserve making, mature green fruits are ideal for harvesting. Budded plants starts bearing fruits after 5 years of planting and seedling trees start bearing after 8 years. Usually wood apple fruits become fully mature in eight months after the fruit set. At this stage shell changes from deep green to light green and flesh from light yellow to deep yellow. In case of ripe fruits, which are to be used for beverage making, should be harvested at ripe stage. Wood apple fruits take about 11 to 12 months after fruit set to ripen on the tree. Fruits should be harvested individually from the tree along with a portion of fruit stalk. They should not be allowed to drop or fall on the ground.

3.13 Relative economics of Bael

Analysis of economy of the plant can be undertaken from absolute economic behaviour in terms of the cost and income flows. Focus will be here to understand the process through which farmers will be benefited.

Table 6: Cost analysis during plantation period:

Material (fixed charges)	**Investment in Rs**
Fencing charges	10,000.00
Land preparation	2500.00
Pit preparation	3,000.00
Cost of fertilizers and manure	2,000.00
Plant material cost 20x150	30,00.00
Planting and irrigation	3,000.00
Total Investment (A)	**23,500.00**

Table 7: Bael production cost during the gestation period:

Material	**Investment in Rs**
Human Labour	4,000.00
Manure and fertilizers	3,000.00
Irrigation charges	1,200.00
Plant protection chemicals	200.00
Total (B)	**8,400.00**

Table 8: Cost of bael production during fruiting years:

Material and Labour	**Investment in Rs per year (from 4 year onwards)**
Human labor charges	15,000.00
Manure and fertilizers	3,500.00
Irrigation	4,500.00
Planting protection charges	1,000.00
Other miscellaneous charges	4,000.00
Total (C)	**28,000.00**

The total yield from the farm 600 kg approximately.

The cost of each kg of bael is Rs 150 per kg.

Total income from the farm in the 6 to 12 year of farming is: total yield x cost per each unit (20 x 30 kg x 150) = Rs 90000.

Cost Benefit Ratio = Total cost/Earning total benefits= 59,900/30100= 1.99

Profit from the farm is approximately around 30100 on the total investment structure.

4. *Zanthoxylum armatum*

Trade name **:** Timru, Timur
Hindi name **:** Tejbal, Nepali dhaniya
Parts used **:** Stem bark, fruits, and seeds
Family **:** Rutaceae

4.1 Introduction

Fruits, seeds, and bark of tejbal are used as aromatic tonic in dyspepsia and fever. Tender twigs are used to brush teeth and used as a remedy for toothache. The essential oil from fruits has deodorant and antiseptic properties. Timru is an evergreen, thorny shrub or small tree, attaining a height up to 6 m. The plant can be recognized by its shrubby habit, dense foliage, with pungent aromatic taste, prickled trunk and branches, and small red, subglobose fruits. Flowers occur in dense terminal or sparse axillary panicles and are green to yellow in colour. Stamens are about six to eight in number. Ripe carpels or follicles are usually solitary, pale red, and tubercles. Seeds are globose, shining, and black. Flowering occurs from March to May, while fruiting occurs from July to August.

4.2 Distribution

The species is found in hot valleys of subtropical Himalayas, from trans-Indus areas to Bhutan, up to an altitude of 2400 m, and between 700 m and 1000 m in the Khasi Hills.

4.3 Climate and soil

The plant is adapted to subtropical climate of lower warm valleys of the Himalayas with sufficient rainfall. It grows well in open pastures and secondary scrub forests. Loamy or clayey soil rich in organic content is preferred for its cultivation.

4.4 Propagation material

Freshly harvested seeds are best for the large-scale cultivation of *Zanthoxylum* species. Mature seeds can be collected in June-July. In the absence of sufficient seeds, terminal stem cuttings may be used as propagules.

4.5 Nursery technique

4.5.1 Raising propagule

The crop can be raised by developing a nursery or by directly sowing in the main field. The seeds are sown in August-September in polybags (nursery) or main field. Stem cuttings may also be planted in the nursery during monsoon in July-August. The seeds germinate in 20-30 days after sowing. The seedlings attain a height of 20-30 cm by June–July, when they can be transplanted to the main field.

4.5.2 Propagule rate and pretreatment

About 2-3 kg seeds are required to raise a nursery for plantation on 1 hectare. Direct sowing may require about 30-50 kg seeds per hectare at spacing of 50 cm × 50 cm. No seed treatment is necessary before sowing. However, stored seeds may require cold stratification for up to three months and may germinate in February- March.

4.6 Planting in the field

4.6.1 Land preparation and fertilizer application

Land may be ploughed two to three times using disc harrow and cultivator to make it friable and weed-free. About 10-12 tonnes per hectare of FYM (farmyard manure) should be mixed with the soil as a basal dose before transplantation.

4.6.2 Transplanting and optimum spacing

After 10-12 months of growth in the nursery, transplanting in the field can be done during May-June if irrigation facilities are available. Otherwise, it is done in July-August (monsoon season) under rain-fed conditions. A spacing of 50 cm × 50 cm is recommended, which accommodates about 40 000 plants per hectare.

4.6.3 Interculture and maintenance practices

Weeding should be carried out during the initial establishment phase, 30–45 days after transplanting, and again at 60–80 days after transplanting. Later, weeding may be

carried out only as and when required. The plant can be grown as a mono crop as well as a mixed crop with herbaceous species.

4.7 Irrigation practices

The plant requires frequent irrigation during the establishment stage. Once established, the plants are able to survive in rain-fed conditions and only life-support irrigation is required during the summer months.

4.8 Disease and pest control

The crop is generally free from any disease, insect or nematode attack, and physiological disorders.

4.9 Harvest management

4.9.1 Crop maturity and harvesting

Flowering appears on five-year-old plants in March–May. Fruiting occurs in July-August. The crop, thus, takes five to seven years to mature. Fruits are collected in May-June. Stem pieces, if needed, may be cut during January-February before the flowers appear.

4.10 Post-harvest management

The herbage and fruits should be dried in shade. The fruits may be cut into pieces for drying and extracting seeds. Well-dried seeds are stored in damp-proof containers.

Relative economics of Tirmira

Analysis of economy of the plant can be undertaken from absolute economic behaviour in terms of the cost and income flows. Focus will be here to understand the process through which farmers will be benefited.

Table 9: Cost analysis during plantation period:

Material (fixed charges)	**Investment in Rs**
Fencing charges	6,000.00
Land preparation	1,500.00
Pit preparation	1500.00
Cost of fertilizers and manure	2,000.00
Plant material cost 20x150	10,00.00
Planting and irrigation	1,000.00
Total Investment (A)	**13000.00**

Table 10: Production cost during the gestation period:

Material	**Investment in Rs**
Human Labour	1400.00
Manure and fertilizers	1,000.00
Irrigation charges	1,200.00
Plant protection chemicals	200.00
Total (B)	**3800.00**

Table 11: Cost of production during fruiting years:

Material and Labour	Investment in Rs per year (from 4 year onwards)
Human labor charges	4,000.00
Manure and fertilizers	3,500.00
Irrigation	4,500.00
Planting protection charges	1,000.00
Other miscellaneous charges	2,000.00
Total (C)	**15,000.00**

The total yield from the farm is (50 kg) approximately

The cost of each kg is Rs 1500 per kg.

Total income from farm is: total yield x cost per each unit

(50 x 1 x 1500) = Rs 75000

Cost Benefit Ratio = Total cost/Earning total benefits= 31800/43200= 0.73

Profit from the farm is approximately around 43200 on the total investment structure.

5. Oroxylum indicum

Trade name : Sonapatha
Hindi name : Sonapatha, Arlu
Parts used : Root bark, stem bark, fruits, seeds, and leaves
Family : Bignoniaceae

5.1 Introduction

Root bark of sonapatha is an astringent, tonic, anti-diarrhoeal, diuretic, anodyne, and is used to cure dropsy. It is a medium-sized, soft-wooded tree attaining a height of 10-16 m. Inflorescence is generally situated at the apices of branches and its length is about 30 cm or more. Flowers are large, fleshy, violet coloured, and foul smelling with 2.5-cm-long pedicle. Calyx and corolla are about 2.5 cm and 6.5 cm in size, respectively. Stamens are slightly exerted and base of filaments is wooly. Fruit is a follicle, 30-90 cm long and 5-10 cm broad, strap/sword shaped, compressed, and two-valved. Seeds are flattened and winged. Flowering occurs from July to August, while fruiting occurs from December to March.

5.2 Distribution

The species is found throughout the tropical forests of India, that is, north-eastern, central, and southern India. It is more frequent in Vindhyas and southwards in mix-deciduous

forests, ascending to 1000 m altitude and naturally found in forests near rivers and streams. The species is generally absent in dry climate of western India.

5.3 Climate and soil

The plant prefers tropical areas that receive well-distributed rainfall, that is, between 85 cm and 130 cm per annum. Sandy-loam fertile soil is best suited for good growth and development of the species; but it can also grow well in medium to deep black soils to sandy loam soils.

5.4 Propagation material

Seed is the best propagation material and should be collected before splitting of pods during February-March. Seed germination percentage is 80%-90% without any pretreatment.

5.5 Nursery technique

5.5.1 Raising propagules

Before field preparation, a nursery of the plants is raised in polythene bags during second half of March for seedling establishment. The polybags should be filled with sandy-loam soil with good quality, well-decomposed FYM (farmyard manure) added to it in the ratio 2:1. After emergence of the seedlings, the plants are watered regularly to maintain optimum moisture level.

5.5.2 *Propagule rate and pretreatment*

In all, 250 g of seeds are sufficient to raise stock for plantation on 1 hectare of land. The seeds should be soaked in water for at least 12 hours before sowing to ensure good germination.

5.6 Planting in the field

5.5.1 Land preparation and fertilizer application

The land is tilled to make it porous, friable, and weed-free. Pits of appropriate size, preferably 60 cm × 60 cm × 60 cm, are dug in a square planting geometry (2 m × 2 m). Approximately, 10 kg FYM, 150 g of nitrogen, and 250 g of single super phosphate are mixed in the topsoil, and the pit is loosely filled back before planting.

5.5.2 Transplanting and optimum spacing

Transplanting in the main field is done in the first week of July (with the onset of monsoon in central India). A spacing of 2 m × 2 m is considered appropriate. An optimum crop stand of 2500 plants/hectare is achieved with this spacing. Gap filling is done in September.

5.5.3 Intercropping system

The plant can be grown as a sole crop as well as in a mixed cropping pattern. Short-term seasonal herbs can be grown in the inter-spaces after first year of growth.

5.5.4 Interculture and maintenance practices

About 20 kg of well-decomposed FYM, 150 g of nitrogen, and 250 g of super phosphate are required per plant in three split doses at intervals of six months for two years after transplanting. Potash is required only in potassium-deficient soils. Normally, two weedings along with hoeing are considered sufficient. However, the pit area around the plants may be given more frequent manual weeding, if required.

5.6 Irrigation practices

In the first year, irrigation should be done at least six to eight times but more frequent irrigation during the summer months (at an interval of 7-10 days) is desirable for maximum productivity. The check basin method is found best for irrigation.

5.7 Disease and pest control

No diseases and nematode attacks have been reported. However, leaf-eating caterpillars like Bihar hairy caterpillar *(Diacrisia obliqua)* and grasshoppers damage leaves during rainy season. Besides, termite attack causes serious damage to root bark in crops grown on drier lands. These insects can be controlled by applying Endosulphan 30 EC spray @ 0.03% in water solution twice at 15-day interval as soon as the termites attack the plants.

5.6 Harvest management

5.6.1 Crop maturity and harvesting

The tree starts flowering and fruiting after three years, and forms viable seeds even in first fruiting. It takes about three to five months for fruits to attain maturity. The plants are uprooted for harvesting of root bark only after six to eight years, October– December.

5.6.2 Post-harvest management

A pit is dug around the tree and filled with water to facilitate uprooting. After uprooting, the roots are thoroughly cleaned. Thereafter, the bark is peeled off and the root is cut into small pieces, which are shade-dried to reduce their moisture level to less than 12%. The dried material is stored in moisture-proof bags.

5.7 Relative economics of *Oroxylum indicum*

Analysis of economy of the plant can be undertaken from absolute economic behaviour in terms of the cost and income flows. Focus will be here to understand the process through which farmers will be benefited.

Table 12: Cost analysis during plantation period:

Material (fixed charges)	**Investment in Rs**
Fencing charges	10,000.00
Land preparation	1,500.00
Pit preparation	1500.00
Cost of fertilizers and manure	2,000.00
Plant material cost 20x150	10,00.00
Planting and irrigation	1,000.00
Total Investment (A)	**17000.00**

Table 13: Production cost during the gestation period:

Material	**Investment in Rs**
Human Labour	4600.00
Manure and fertilizers	1,000.00
Irrigation charges	1,200.00
Plant protection chemicals	200.00
Total (B)	**7000.00**

Table 14: Cost of production during yielding years:

Material and Labour	**Investment in Rs per year (from 4 year onwards)**
Human labor charges	10,000.00
Manure and fertilizers	3,500.00
Irrigation	4,500.00
Planting protection charges	1,000.00
Other miscellaneous charges	2,000.00
Total (C)	**21,000.00**

The total yield from the farm is (25 kg) approximately

The cost of each kg is Rs 4000 per kg.

Total income from farming is: total yield x cost per each unit

(50 x 1/2 x 4000) = Rs 100000

Cost Benefit Ratio = Total cost/Earning total benefits= 45000/55000= 0.81

Profit from the farm is approximately around 55000 on the total investment structure.

6. *Viola serpens*

Trade name : Banafsha

Hindi name : Banafsha

Parts used : Whole plant, preferably flower

Family : Violaceae

6.1 Introduction

Viola species is antipyretic, diaphioretic, diuretic, aperient, antipyretic, and febrifuge in action. It is useful in respiratory track congestion, asthma, sore throat, cold, coryza, and cancer of the throat. Banafsha is a small perennial herb with a short semi-subterranean fleshy stem (rootstock). The upper younger portion is marked with close circular scars of the leaves of the previous years, and gives off elongated, rather fleshy, leafless runners. Leaves are ovate and crenate–serrate. Flowers are borne on long, slender, axillary stalks (scapes) exceeding the leaves. Flowers are lilac, blue, white or purple in colour and borne on the main stem, the larger ones being 6-12 mm in diameter. The flowers from the axils of the cauline leaves are minute. Fruit is a few seeded, globose capsules. Flowering occurs during February–March, while fruiting occurs during April-May.

6.2 Distribution

It is found throughout the temperate Himalayas up to an altitude of 2000 meters. In Himachal Pradesh, it is found in Chamba, Kangra, Kinnaur, Kullu, Mandi, Sirmaur, Bilaspur, Shimla and Solan districts.

6.3 Climate and soil

The plant grows well in cool and moist climate but heavy and frequent rain is fatal during blooming. Sandy loam soil is best for its cultivation.

6.4 Propagation material

The plant is generally propagated through separation of the new plantlets that develop from the runners. As much as 50-60 new plantlets can be separated from a single mother plant. This crop is also propagated through seeds that show about 80% germination.

6.5 Nursery technique

6.5.1 Raising propagules

The planting stock can also be easily raised through division of mother plants, which are directly planted in the field. To raise the planting stock through seeds, they are sown in the nursery in March-April, 10-15 cm apart from line to line. About 80% seeds germinate within three weeks. Sowing of the seed directly in the field is not recommended, as the seed size is very small.

6.5.2 Propagule rate and pretreatment

About 110 000 plantlets are required for planting in 1 hectare of land. When seeds are used as propagation material, about 1-1.5 kg seeds per hectare are required. No seed treatment is required before raising the nursery, as the seed coat is not very hard.

6.6 Planting in the field

6.6.1 Land preparation and fertilizer application

Field should be well prepared through two to three ploughings, followed by planking to make the soil suitable for the transplanting of the plantlets. Bed should be raised or oriented in such a way that there is proper drainage and no water stagnation, especially due to heavy rains in the rainy season. Exposure to frequent and heavy rains is very damaging for the flowers. In places of water scarcity, sunken beds may be prepared to conserve moisture. Well-decomposed FYM (farmyard manure) @ 12 tonnes/hectare should be applied to the soil before transplantation of the seedlings to obtain maximum yield. The seedlings are planted at a spacing of 30 cm × 30 cm.

6.6.2 Transplanting and optimum spacing

The crop is grown in Kharif season during May-June, with the onset of pre-monsoon rains. This is the best period for establishment of plantlets in the field. When the crop is propagated through division of the mother plants, the separated plantlets can be planted directly in the main field in May-June. About one-month-old seedlings can be transplanted in the main field, at an optimum spacing of 30 cm × 30 cm.

6.6.3 Intercropping system

The crops can be grown in orchards where partial shade conditions prevail, provided no waterlogging takes place.

6.6.4 Interculture and maintenance practices

Only organic manure @12 tonnes/hectare is recommended as a basal dose. The field should be free from weeds, especially at the initial stages of plant establishment. Field should be drained well by digging channels across the field, especially during the rainy season. Irrigation should be provided as and when required during hot weather. For promoting the growth of the plants, 50 PPM (parts per million) solution of GA3 (gibberellic acid) may be sprayed at an interval of one month from September to May. Manual hoeing and weeding once in a month are recommended to control the weeds.

6.7 Disease and pest control

Browning and blotching of the leaves with dead areas having distinct black margins may occur during rains. These infected leaves should be collected and either burnt or buried deep in the soil to check the further spread of the disease. Pesticides or fungicides should never be used.

6.8 Harvest management

6.8.1 Crop maturity and harvesting

Leaves can be harvested after two months of establishment of the crop and subsequent harvesting may be done at an interval of one month till December. The plant starts flowering after 9-10 months of growth during February-March, corresponding with the increase in temperature. Fruits can be harvested in April and May. Flowers and seeds should be harvested either in February- March or April-May, depending on the climatic conditions of the area.

6.8.2 Post-harvest management

Flowers and seeds should be air-dried in shade and packed in polythene bags. The flowers should be packed in airtight polythene bags and stored in dark place at room temperature. The seeds retain viability for long periods when stored in airtight containers.

6.9 Relative economics of *Viola serpens*

Analysis of economy of the plant can be undertaken from absolute economic behaviour in terms of the cost and income flows. Focus will be here to understand the process through which farmers will be benefited.

Table 15: Cost analysis during plantation period:

Material (fixed charges)	**Investment in Rs**
Land preparation	1,500.00
Cost of fertilizers and manure	2,000.00
Plant material cost 20x150	10,00.00
Planting and irrigation	1,000.00
Total Investment (A)	**3700.00**

Table16: Production cost during the gestation period:

Material	**Investment in Rs**
Human Labour	1000.00
Manure and fertilizers	1,000.00
Irrigation charges	1,200.00
Plant protection chemicals	200.00
Total (B)	**3400.00**

Table 17: Cost of production during yielding years

Material and Labour	**Investment in Rs per year (from 4 year onwards)**
Human labor charges	1000.00
Manure and fertilizers	3,500.00
Irrigation	2,500.00
Planting protection charges	1,000.00
Total (C)	**8,000.00**

The total yield from the farm is (2 kg) approximately

The cost of each kg is Rs 12000.

Total income from the farming is: total yield x cost per each unit

(2 x 12000) = Rs 24000

Cost Benefit Ratio = Total cost/Earning total benefits= 15100/8900= 1.69

Profit from the farm is approximately around 8900 on the total investment structure.

7. *Terminalia chebula*

Trade name **:** Harar, Chebulic
Hindi name **:** Harar, Harra, Harad myrobalan
Parts used **:** Dried immature fruits, generally the fruit rind
Family **:** Combretaceae

7.1 Introduction

The harar fruit is antiseptic, diuretic, astringent and cardiotonic properties. It is an important ingredient of 'triphala', an Ayurvedic formulation used in the treatment of constipation, colic pain and kidney dysfunctions, eye diseases, and sore throat. It is a large tree with umbrella-shaped crown and crowded branches, growing up to 25 m in height. The species is identified by dark brown bark exfoliating in irregular woody scales and by the presence of a pair of large glands at the top of the petiole. Flowers are yellowish-white and emit a strong offensive odour. Fruit (drupe) is yellowish-green, obovoid or ellipsoid, hard, and five to six ribbed when dry. Flowering occurs in May–June, while fruiting occurs in winter (November–March).

7.2 Distribution

The tree is found in the outer Himalayas ascending up to 1600 m from Himachal Pradesh to Bengal and then throughout Central and South India. In North Western Himalayas, it is distributed between the altitude of 500-1100m in states of Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana and Uttrakhand. Trees found growing naturally on the bunds of farmer's fields and village common lands popularly known as ghasnis

7.3 Climate and soil

In the natural habitat of the species, temperature ranges between 36 °C and 45 °C, and rainfall ranges from 1200 mm to 3000 mm per annum. It is capable of growing on different

types of soils, but attains best development on loose well-drained soils, such as sandy loam as well as clayey loam. It grows in open areas in the forest, forming top to middle canopy.

7.4 Propagation material

Seed is the most appropriate material for this plant's propagation. Fruit is collected in summer in May–June. Generally, two good years are followed by one or two poor ones. Fruits are collected when they turn yellow. The seeds can be collected as soon as they fall on the ground, and are dried under shade. The seeds can be stored in gunny bags for one year, but fresh seeds germinate quicker.

7.5 Nursery technique

7.5.1 Raising propagules

The saplings are raised from seeds in a nursery in July with the onset of monsoon season. Seeds may be sown in prepared beds or polybags. Germination is slow, but may be improved by pretreating the seeds. The soil in beds and polybags should have sufficient proportion of organic manure, at least in the ratio of 2:1. Sometimes, pre-germinated seeds are used for sowing to get better survival rate. Generally, large-sized polybags, at least 35 cm × 22 cm, are used, since the root growth is comparatively faster and the seedlings are required to be kept in the nursery for at least one year. However, the growth of the seedlings is quite slow. The nursery should be partially shaded against the sun.

7.5.2 Propagule rate and pretreatment

About 5 kg seeds are required for raising stock for planting in 1 hectare of land. The depulped seeds should be either treated by fermentation process for a period of 15–20 days, or the seeds may be clipped at their broad end and then soaked in water for a period of two days before sowing in the nursery beds. Alternatively, seeds may be mixed with cow dung slurry and kept in pits for one to two weeks.

7.6 Planting in the field

7.6.1 Land preparation and fertilizer application:

The land is tilled and leveled properly to make it porous and friable. Pits of size 60 cm × 60 cm × 60 cm are dug at a spacing of 6 m × 6 m. The soil of each pit is mixed with 15 kg FYM (farmyard manure) and a mixture of NPK (nitrogen, phosphorus, potassium) @ 75:30:30 g and refilled before transplanting of seedlings.

7.6.2 Transplanting and optimum spacing

Transplantation of one-year-old saplings is done in the next monsoon. A spacing of 6 m × 6 m enables a crop stand of 280–300 plants per hectare.

7.6.3. Intercropping system

Since this is a long-term crop, intercropping with short duration crops is preferable, particularly with climbers like Gudmar, Malkangni, Guduchi, Ratti, and so on as in *Terminalia arjuna*. *S*hade-loving crops like *Curcuma*, *Zingiber*, and *Alpinia galangal* may also be intercropped.

7.6.4. Interculture and maintenance practices

A small dose of organic manure may be added every year for the first three to four years to ensure good growth of young plants. Compact soil of pits is made porous by hoeing and well-decomposed FYM @ 3 kg per plant is mixed in soil. Only manual weed control is recommended. The weeds may be kept in check with the help of scythes or tractor-operated cutters.

7.7 Irrigation practices

Irrigation in pit areas is required in the initial three to four years, depending on the soil moisture and season. The plants may be irrigated at least once a week in summers.

7.8 Disease and pest control

The plants are able to survive attacks of seasonal insects and pests. Anti-termite treatment with Chlorpyriphos 20% EC should be given in termite-prone areas.

7.9 Harvest management:

7.9.1 Crop maturity and harvesting

Flowering and fruiting generally commence after 8–10 years of planting in the summer season. The tree starts yielding fruits at this time. The trees live for more than 50 years and continue to yield fruits every year.

7.9.2 Post-harvest management

The collected fruits are well dried in shade for a few days, with moisture content not more than 10%, and stored in well-ventilated containers/baskets in damp-proof, cool rooms.

7.10 Relative economics of *Terminelia chebula*

Analysis of economy of the plant can be undertaken from absolute economic behaviour in terms of the cost and income flows. Focus will be here to understand the process through which farmers will be benefited.

Table 18: Assumptions in *Terminalia chebula* Cultivation

Material (Fixed charges)	**Investment in Rs**
Fencing charges	10,000.00
Land preparation	3000.00
Pit preparation	3500.00
Cost of fertilizers and manure	2500.00
Plant material cost	1500.00
Planting and irrigation	4000.00
Total Investment	**21,000.00**

Table 19: Production cost during the gestation period

Material	**Investment in Rs**
Human Labour	3000.00
Manure and fertilizers	3500.00
Irrigation charges	4000.00
Plant protection chemicals	3000.00
Total	**13,500.00**

Table 20: Cost of production during fruiting years

Material and Labour	**Investment in Rs per year (from 5 year onwards)**
Human labour charges	15000.00
Manure and fertilizers	4000.00
Irrigation	3500.00
Planting protection charges	4500.00
Other miscellaneous charges	4000.00
Total	**31,000.00**

The total yield from the farm is (2800 kg) approximately

The cost of each kg is Rs 26.

Total income from the farming is: total yield x cost per each unit

(35 x 80 x 26) = Rs 72800

Cost Benefit Ratio = Total cost/Earning total benefits= 40000/32800= 1.2

Profit from the farm is approximately around 32800 on the total investment structure.

8. *Valeriana jatamansi* DC

Trade name : Mushkbala, Tagar

Hindi name : Mushkbala, Tagar

Parts used : Dried roots and rhizome

Family : Valerianaceae

8.1 Introduction

Rhizomes and roots of tagar have antipyretic and diuretic properties,and are used as hepatic and nervine tonic. They are cooling, stimulant, hypotensive, and sedative. They are useful in epilepsy, hysteria, hypochondriasis, nervous unrest, and skin diseases. *Valeriana* is an aromatic herb up to 50 cm high. Rootstock is thick, with 6-10 cm thick, long fibrous roots knotted by uneven circular ridges. The plant has several stems that are 15-45 cm long. Flowers are white or tinged with pink and occur in flat-topped corymbose clusters on erect, nearly leafless peduncles. Flowering and fruiting occur in March-April. Seeds ripen in April-May.

8.2 Distribution

The species is frequent in temperate Himalayas, from Kashmir to Bhutan and Khasi Hills. It grows naturally at altitudes of 1800-3000 m in northwestern Himalayas and between 1200 m and 1800 m in Assam and North-East India.

8.3 Climate and soil

The plant prefers a temperate climate. It grows well in moist loamy soils having partial shades of trees like deodar and banj oak on north-facing hillocks. It can grow over a wide range of soils, with slopes up to 20%, provided that it gets sufficient water and nitrogen nutrient. However, it thrives best in humus-rich, heavy loam soils, with adequate moisture and good drainage. To harvest roots in an easy and efficient manner, a relatively loose soil with low clay content is desirable. Water stagnation in the beds should be avoided, as the roots of the plant are sensitive to rotting.

8.3 Propagation material

Valeriana can be propagated through seeds or by using portions of the rootstock, preferably during rainy season. It is normally advisable to raise the crop through suckers because crop raised through seeds takes more time to mature. Seeds can be collected in April-May and sown immediately in nursery.

8.4 Nursery technique

8.4.1 Raising propagules

For raising the crop through rootsuckers, a separate mother nursery should be maintained. Fresh rooted suckers can be taken from the mother nursery and planted in the field. New suckers should be planted in the nursery in June or with the onset of monsoon. Rooted suckers taken from mother nursery are planted in the field in rows at a depth of 4-5 cm. If the crop is to be raised through seeds, then nursery is prepared separately in April-May. Seeds germinate in 15-20 days and are pricked into polybags for further growth. The seedlings are ready for planting in about three months' time.

8.4.2 Propagule rate and pretreatment

About 2.5-3 kg seeds are required to raise planting stock for 1 hectare of land. No specific treatment of seeds is required. However, rootstock is preferred as propagules.

8.5 Planting in the field

8.5.1 Land preparation and fertilizer application

In order to have optimum root yield, pulverization of the soil is necessary. A minimum of three ploughings are recommended. If the crop is to be raised through rhizomes/ rootsuckers, first ploughing is done with soil-turning plough in June. The field should be left fallow for 15-20 days so that crop residues buried in the soil get rotten and the soil also receives appropriate sunlight. Before second ploughing, well-decomposed FYM (farmyard manure) should be spread uniformly and properly mixed in the field. Second ploughing should be done in the end of June and third ploughing should be done with first showers of monsoon. Planking and harrowing should be done after second and third ploughing to break the clods and make the soil friable with good tilth. When the crop is raised through seeds, the preparation of land should be deferred by about one month. The crop requires fertile and humus-rich soil. A dose of 35-40 tonnes/hectare of FYM, applied in split doses, is found to be the best. The first dose of about 25-30 tonnes is applied at the time of field preparation and the rest is applied in the following months of June–July when earthing-up is done. The FYM dose is kept slightly higher because no inorganic fertilizer is applied to the crop.

8.5.2 *Transplanting and optimum spacing*

The rooted propagules are planted in the field in June-July, while seedlings are transplanted in August at higher elevations and in October at lower elevations. Seedlings should be transplanted when they attain a height of 8-10 cm and planted immediately after uprooting, so that they establish early and remain healthy. Planting in rows 40-50 cm apart and 20-30 cm spacing between plants in a row are recommended. Approximately, 75 000-85 000 plants are required for 1 hectare of plantation.

8.5.3 Intercropping system

Tagar can be raised as an intercrop in the fruit orchards. Experimental trials conducted on intercropping in a peach orchard show that the crop can yield about 12-15 quintals/hectare of fresh root mass in the second year, indicating that Valerian may act as a good supplementary crop in fruit plantations.

8.5.4 Interculture and maintenance practices

The crop requires fertile and humus-rich soil. A dose of 35-40 tonnes of FYM is found to be the best. No studies about the use of inorganic fertilizer are available. Manual

weeding is recommended at an interval of 25-30 days. Once established, the plant shows good resistance against weed invasion, and because of its vigorous upright growth and dense foliage, weeds are smothered under its canopy.

8.5.5 Irrigation practices

Irrespective of whether the crop is raised through seeds or rhizomatous suckers, fresh plantings need irrigation almost daily till they are established. Subsequently, depending upon the slope and water-holding capacity of the soil, irrigation interval may vary between one and two weeks.

8.6 Disease and pest control

The crop is relatively free from pests and diseases. But occasionally, rhizome rot has been observed for which drenching with 0.2% Dithane M-45 is recommended.

8.7 Harvest management

8.7.1 Crop maturity and harvesting

The crop may be kept in the field for one or two years. It can be harvested in the first as well as second year, but yield is much lower in the first year. Crop attains physiological maturity

in August but requires some more days for complete maturity. Digging and harvesting of roots are done in September-October.

8.7.2 Post-harvest management

The best method of drying should prevent enzymatic breakdown of the constituents. The harvest should be dried as rapidly as possible without overheating. The maximum preservation of the valepotriates is achieved when drying is done within the range of about 35-40 ^{o}C. Dried rhizomes are best stored in gunny bags/ bamboo baskets.

8.8 Relative economics of *Valeriana jatamansi*

Analysis of economy of the plant can be undertaken from absolute economic behaviour in terms of the cost and income flows. Focus will be here to understand the process through which farmers will be benefited.

Table 21: Cost analysis during plantation period:

Material (fixed charges)	**Investment in Rs**
Land preparation	1,500.00
Cost of fertilizers and manure	2,000.00
Plant material cost 20x150	10,00.00
Planting and irrigation	1,000.00
Total Investment (A)	**3700.00**

Table 22: *P*roduction cost during the gestation period:

Material	**Investment in Rs**
Human Labour	5000.00
Manure and fertilizers	1,000.00
Irrigation charges	1,200.00
Plant protection chemicals	200.00
Total (B)	**7400.00**

Table 23: Cost production during yielding years:

Material and Labour	**Investment in Rs per year (from 4 year onwards)**
Human labor charges	5000.00
Manure and fertilizers	3,500.00
Irrigation	2,500.00
Planting protection charges	1,000.00
Total (C)	**12,000.00**

The total yield from the farm is (20 kg) approximately

The total cost of each kg of roots is Rs 3990.

Total income from the farm is: total yield x cost per each unit

(20 x 3990) = Rs 79,800

Cost Benefit Ratio = Total cost/Earning total benefits= 23100/56700= 0.40

Profit from the farm is approximately around 56700 on the total investment structure.

9. *Hedychium spicatum*

Trade name : Kapoor kachri
Hindi name : Kapoor kachri
Parts used : Rhizomes
Family : Zingiberaceae

9.1 Introduction

Rhizome of *Hedychium* is aromatic, acidic, bitter, pungent, carminative, stomachic, stimulant, expectorant, anti-asthmatic, antiseptic, and anti-inflammatory. It is useful in asthma, bronchitis, vomiting, dyspepsia, and inflammations. It has insect repellent properties, and is also used as a dye and perfume for making 'abir' powder used in 'Holi'. Kapoor kachri is a rhizomatous, fragrant leafy herb with robust stem, and is up to 1.5 m tall. Rhizomes have

strong aromatic odour and bitter camphoraceous taste. They are white, starchy, and fragrant within. Bark is rough, reddish-brown with few deep-seated fibrous rootlets. Leaves are up to 30 cm long, lanceolate, with green, obtuse bracts and leaf sheath clasping the stem. Flowers are fragrant, white with orange-red base, present in a dense, terminal, 15-25 cm long spike. Floral bracts are prominent, green with solitary flower in axil. Calyx is papery and three-lobed. Petals are linear and spreading; tip is white with two elliptic lobes and orange base. Corolla tube is about 5–6.5 cm long. Fruit is a spheroid, three-valved capsule with orange-red lining. Seeds are black with a red aril. Flowering occurs in August and fruits ripen in October.

9.2 Distribution

The species occurs in subtropical and sub-temperate Himalayan region in oak (*Quercus* spp.) and deodar (*Cedrus deodara*) forests on slopes between 1500 m and 2500 m altitudes.

9.3 Climate and soil

Kapoor kachri is sciophytic in nature and prefers shady slopes. Water logging in the soil is fatal due to rotting of rhizomes. Moderate temperature and well-spread rainfall are suitable for better growth. Sub-temperate to temperate climate with annual precipitation of 1000–1500 mm, and well-drained, deep sandy loam, and humus-rich soil with good moisture retaining capacity are most suitable for its cultivation. Soil with 40%-50% of sand gives better yield.

9.4 Propagation material

Both seeds and rhizomes may be used as propagation material, but when crops are raised through seeds, rhizomes may require three to four years to mature. Propagation by rhizome is preferred due to less time involved (about two years) in crop maturity.

9.5 Nursery technique

Raising propagules It is not advisable to raise the crop through seeds; rhizome pieces with apical buds are buried in 10 cm × 20 cm polybags containing soil, sand, and FYM (farmyard manure) in equal amounts and irrigated intermittently. Rhizomes may also be planted in mother beds in the nursery and uprooted for planting in the field. Nursery is raised in April when the weather is little warmer. Propagules sprout between 25 and 30 days. Rhizomes may also be planted directly in the field.

9.5.1 Propagule rate and pretreatment

About 25 quintals of healthy rhizomes, segregated into pieces with one bud in each and weighing about 40–50 g, are required for raising plantlets in 1 hectare of land. Though

rhizome rot is not a serious problem, high rainfall and waterlogging may cause damage to propagules. Therefore, rhizomes should be dipped in 0.01% bavistin solution for 25-30 minutes, followed by shade drying for six to eight hours before planting.

9.6 Planting in the field

9.6.1 Land preparation and fertilizer application

First ploughing with soilturning plough is done in the first week of March in montane ranges and in last week of March on higher hills. This makes the soil free from weeds and buries the previous crop residues. The field is left fallow for 15–20 days for solar treatment, aeration, and to facilitate decay of crop residues. With second ploughing, well-decomposed FYM at the rate of 20 tonnes per hectare should be spread well and thoroughly mixed. Planking should be done after second and third ploughing to make the soil friable and turn it into a fine tilth.

9.6.2 Transplanting and optimum spacing

Propagules are transplanted in April in middle zones and in May in high ranges of hills. The rhizomes are planted in furrows at a depth of 10–12 cm, at an optimum spacing of 45 cm × 30 cm. At this spacing, about 64 000 propagules per hectare will be required. Saplings should be taken for transplantation when they attain a height of 12–15 cm. These saplings should immediately be planted after uprooting them from the nursery bed.

9.7 Intercropping system

Hedychium is preferred as an intercrop in fruit orchards. Experiments of intercropping in apple orchards have given better results perhaps due to the availability of congenial environment

for better growth. The yield is about 60-65 quintals per hectare. In an apple orchard, only about 44 000 propagules/hectare may be required.

9.7.1 Interculture and maintenance practices

The quantity of FYM recommended is about 30-35 tonnes/hectare. It should be applied in three split doses: the first one at the time of land preparation (20 tonnes/hectare) and the other two doses (5-8 tonnes/hectare each) should be applied well before the onset of monsoon in the first and second year of cropping. Interculture operations mainly comprise weeding, earthing-up (hoeing), and timely watering. First hoeing is done at the time of top dressing, that is, 45-50 days after transplanting, and the second hoeing can be done just after rainy season to loosen the soil. If

required, inorganic fertilizer, such as NPK (nitrogen, phosphorus, potassium), may be applied at the rate of 100:120:60 kg/hectare in three split doses. The entire amount of phosphorus and

potassium along with one-third of nitrogen should be applied in furrows at the time of land preparation. The remaining nitrogen should be applied in two equal split doses: first after two months of planting and the second in the next rainy season after new sprouting.

9.8 Irrigation practices

Since the crop is grown in areas with well spreadout rainfall, it requires no irrigation, except in the case of rainfall deficiency or during long spells of no rain. During winter, light irrigationmat an interval of 15-20 days is sufficient. Sufficient moisture should always be available, but there should be no waterlogging.

9.9 Weed control

Manual weeding is recommended for the crop. Three weedings are sufficient. First weeding is done 15-20 days after completion of sprouting. Second and third weedings are done with the first and second hoeing operations.

9.10 Disease and pest control

In rhizome rot, leaves of the affected plant become pale and the affected rhizomes become soft and pulpy, and ultimately rotten. Rhizome rot can be controlled by dipping the rhizomes in 0.01% bavistin solution for 25-30 minutes followed by shade-drying before planting. In leaf spot disease, spots appear over leaf lamina; control measures involve spraying with 4:4:50 bordeaux mixture.

9.11 Harvest management

9.11.1 Crop maturity and harvesting

The crop is biennial when planted through rhizomes, and hence, matures in second season during October-November, depending upon the elevation. Dried leaves and stalks are removed after they turn yellow, while rhizomes are left in soil for about 20-25 days for ripening before being dug out.

9.11.2 Post-harvest management

Rhizomes should be properly cleaned in water to remove soil particles. Small roots and rootlets are also removed. The produce is then dried in shade and stored in containers in damp proof stores. Healthy rhizomes should be selected before drying as future propagules and treated with 0.01% bavistin solution to prevent rotting and then buried with pits in sandy soil till next sowing period.

9.12 Relative economics of *Hedychium spicatum*

Analysis of economy of the plant can be undertaken from absolute economic behaviour in terms of the cost and income flows. Focus will be here to understand the process through which farmers will be benefited.

Table 24: Cost analysis during plantation period:

Material (fixed charges)	**Investment in Rs**
Land preparation	1,500.00
Cost of fertilizers and manure	2,000.00
Plant material cost 20x150	10,00.00
Planting and irrigation	1,000.00
Total Investment (A)	**3700.00**

Table 25: *P*roduction cost during the gestation period:

Material	**Investment in Rs**
Human Labour	5000.00
Manure and fertilizers	1,000.00
Irrigation charges	1,200.00
Plant protection chemicals	200.00
Total (B)	**7400.00**

Table 26: Cost production during yielding years:

Material and Labour	**Investment in Rs per year (from 4 year onwards)**
Human labor charges	5000.00
Manure and fertilizers	3,500.00
Irrigation	2,500.00
Planting protection charges	1,000.00
Total (C)	**12,000.00**

The total yield from the farm is (20 kg) approximately

The total cost of each kg of roots is Rs 3990.

Total income from the farm is: total yield x cost per each unit

(20 x 3990) = Rs 79,800

Cost Benefit Ratio = Total cost/Earning total benefits= 23100/56700= 0.40

Profit from the farm is approximately around 56700 on the total investment structure.

10. Importance of medicinal crops in the cluster

Medicinal and aromatic crops occupy an important position in the socio cultural, spiritual and health aspects of Indian rural population. Many important and useful plant species are found in Himalayan region. Medicinal plants have also been identified as one of the thrust areas by the forest department and different programmes have been initiated for their conservation in the forests and protected areas. The selected plants are cultivated as regular seasonal crops. If these species acquire the status of crops then this transition can make a significant difference in the economy of medicinal crops.

11. Problems in cultivation

- Farmers pointed out the problem of water scarcity and damage to crops by wild animals (monkeys, stray cattle, wild cocks, pigs, barking deer) and wild birds (boar, peacocks, wild, jungle fowl).
- Additionally, the residents of the area has pointed out the issues of wild weeds and have suggested that extensive uprooting of wild weeds or some eco-friendly selective spray may reduce the effects of the same.
- Farmers have also suggested the concept of solar fencing to combat the issues of wild animal and stray cattle.
- All the agricultural productivity in most of areas in Himachal Pradesh depends upon rain to fulfil waster requirements. People suggested harvesting raw water to use for irrigation by uplifting water from local khads and construct high volume tanks.
- Transport problems, shortage of proper food processing units and cold store.

12. Conservation of MAP's

Conservation of high value medicinal plant is very important especially, threatened medicinal plants for the conservation of biodiversity and for the health of the people as they are also very important source of highly valuable products. It also serves as habitat for fauna. Keeping in view the importance and value of biodiversity, its conservation is very important and following measures can be undertaken for its conservation:

- The commercial harvesting of threatened medicinal plants should be banned and cultivation should be promoted. As due to unsustainable harvesting, over harvesting, deforestation and uncontrolled grazing, medicinal plant diversity has come under threat of extinction.
- Biotechnological methodologies such as germplasm conservation, micro-propagation etc. can be used to culture and micro-propagate the commercially and medicinally important species. Genetic manipulation of the endangered and threatened species can be the effective tool for maintaining biodiversity.
- The local communities need to be sensitized to the sustainable use and conservation of these species. Therefore feasible conservation strategy and action plan should be formulated and implemented effectively in order to save these high value declining resources.
- The cultivation of these species should be promoted on priority basis as situation is more alarming in absence of any cultivation practices.

- The abundance and scarcity of commercially important rare and threatened medicinal and aromatic plant species should be enlisted that is important for their conservation.

13. Strategies for conservation, resource development and sustainable management of NTFPs in the cluster

- Necessary financial and technical assistance should be provided to the farmers of the area for construction of rain water harvesting structures and water shed management so as to ensure supply of water for irrigation purposes.
- Construction of shelters (Gaushalas) for stray cattle should be ensured at each panchayat to minimize the risk of grazing of standing crops by stray cattle and to employ the local unemployed youth for management of these shelters (gaushalas) for economic purposes.
- Solar fencing should be installed at the boundary of agricultural land of the village/panchayat to reduce the risk of damage to crops by wild animals as well as stray cattle
- A large number of fruit-bearing plants should be planted in the forest areas of the panchayat so as to minimize the movement of wild animals specifically monkeys towards the agricultural land of the villages in search of food.
- Natural habitat of wild animals like monkeys, wild boar, nilgai, barasingha, rabbits, porcupines, pig and peafowl etc. should be protected by way of afforestation of the barren/waste lands of the area and through implementation of strict rules by the forest department as well as local administration for protection of forests.
- Extensive program for uprooting of wild weeds and invasive plants should be started at panchayat level so as to save the fertility of agricultural/forest land and to minimize the health issues arising from such wild weeds.
- Good price and appropriate market of agricultural produce should be ensured by way of developing good infrastructure of roads and other necessary facilities at the door of the farmers.
- Small scale industries should be set up in the village area in relation to the production of value added products from fruits and vegetables (fruits selected in this study i.e. amla, citrus fruits, wild pomegranate, papaya, pomegranate, and mango etc. can be processed into a variety of products such as juices and concentrates, pulp, canned and dehydrated products, jams and jellies, pickles and chutneys etc.) and raw material from wild date palm (khajur) leaves, *Murraya Koenigii* (curry tree) leaves and Gossypium (cotton) plant etc. so as to increase the livelihood/income of the farmers of the area and employment of unemployed youths and women.

- There is an earnest need of preparing a data base of native aromatic and medicinal plants and a concrete plan for rejuvenation/regeneration of these species at the earliest. To plant the native species of the aromatic/medicinal plants in the forest area at large and to deploy trained persons for harvesting of the NTFPs/MAPs in the forest by including the local villagers.

14. Socio-Economic Development

- Medicinal plants and their products are important resources for sustainable economic development of IHR.
- Planned marketing and trade of medicinal plants and products can provide collector with good sum of money for the collection.
- The outcomes of present study is a useful tool to botanists, pharmacologists, phyto-chemists, practitioner of herbal medicine, foresters, planners and administrators for the preparation of action and development plans for the conservation of this natural wealth.
- Also development of herbal drug industry in the tribal tracts can provide self-employment opportunities and will improve and uplift the life, economy and social status of the tribal and rural populations.
- Establishment and maintenance of potential medicinal plant species through cultivation will not only help to meet their requirement for curing diseases, but will also help in generating income.
- The initiatives at government level such as deciding minimum support price for the medicinal plants like agricultural crops can avoid the involvement of middleman.

15. *In-situ* conservation

a. Conservation of a given species in its natural habitat or in the area where it grows naturally is known as *in-situ* conservation.
b. It includes Gene bank / Gene sanction, Biosphere reserves, national parks, sacred sites, Sacred grooves etc.
c. It is only in nature that plant diversity at the genetic, species and eco-system level can be conserved on long-term basis
d. It is necessary to conserve in distinct, representative biogeographic zones inter and intra-specific genetic variation.

It is cost-effective way of protecting the existing biological and genetic diversity is the 'in-situ' or on the site conservation wherein a wild species or stock of a biological community is protected and preserved in its natural habitat. The prospect of such an 'ecocentric', rather than a species centred approach is that it should prevent species from becoming endangered by

human activities and reduce the need for human intervention to prevent premature extinctions. Establishment of biosphere reserves, national parks, wild life sanctuaries, sacred groves and other protected areas forms examples of *'in-situ'* methods of conservation. The idea of establishing protected area network has taken a central place in all policy decision process related to biodiversity conservation at national, international and global level.

16. Conclusion

The present study was conducted in Mandi district to accumulate information regarding potential NTFPs/MAPs of eight selected Panchayats. Survey questionnaire, participatory observations and field visits were conducted to illicit information. Several information regarding many NTFPs including crops, fodder, fruits, vegetables, medicinal and aromatic plants as well as weeds have been recorded during the present investigation. In addition, issues in the conservation and management of various NTFPs / MAPs were recorded by interviewing the people of studied Panchayats. During the course of the study and field visits, it has been observed that farmers of all the aforementioned panchayats are facing the issues of water scarcity for irrigation purposes, damage to crops by wild animals, feeding of standing crops by stray cattle, extensive covering of irrigated/forest/grass land by wild weeds and invasive plants, poor road and market facilities for agricultural produce and non-availability of good price for the crops.