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 BILASPUR CLUSTER

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Submitted
To

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1. Introduction

Medicinal and aromatic plants occupy an important position in the socio-cultural, socio-economic, health care and spiritual arena of rural people of India. Medicinal plants contributed significantly to the rural livelihoods. Globally, medicinal and aromatic plants (MAPs) constitute one of the integral parts of the biodiversity, ecosystem and biological heritage. Medicinal and aromatic plants are being used since ancient time for the treatment of many infectious diseases in traditional and recognized systems of healthcare and for therapeutic, fragrance and flavouring products in pharmaceutical and cosmetic industries besides as source of natural dye, fat, essential oil, bio-pesticide, resin, protein, vitamin, condiment, spice, timber, fibre and various other useful substances. The plants are also considered to be the prime source of drug and aroma molecules and their precursors in modern medicine.

2. Need and significance of the study

Medicinal plants are natural resources as they are unique, indispensable and an estimate of their availability is complex. Externalities occur during their extraction, processing and use, transaction costs exist due to irreversibility and extinction of species, with crucial equity inferences. With all these factors, medicinal plant becomes as one of the important group of natural resources. These provide a good source of income if cultivated aggressively and traded, as the demand is fast increasing. On the other hand 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 organizations are steering towards finding new paths of NTFPs for the poor people living in or around of the forests that will ultimately help to conserve the forest, improve the biodiversity and provide new income sources for their financial upliftment in their vicinity.

3. Study area

Keeping in mind the importance of NTFPs and their commercial potential an intensive survey of various village Panchayats of Distt. Bilapsur cluster was conducted to collect the information regarding NTFPs. Information was obtained through open interviews using semi-structured questionnaires. Different villages and Panchayats of Bilaspur district were visited during the course of investigation. The study focuses on, Bandla, Malaun, Pangwana, Janali, Sihra, Amarpur, Tarwar and Bulghar, Rohin, Malangan and Kutehla panchayat of Ghumarwin and Swarghat of Bilaspur district, HP. After listing the major plants available in the region their use, location and their processing facilities, eight important plant species were Amla, citrus, harar, tulsi, shatavari, arjuna, giloy and neem were selected after discussion with practitioners

in the field a redevelopment plan, conservation and sustainable management of these NTFPs, medicinal and aromatic plants have been prepared as given below:

Table: List of medicinal and aromatic plants of Bilaspur cluster

Sr.No.	Plant species	Common name	Traditional uses
1	*Azadirachta indica*	Neem	Leaves, stem, bark for treatment of diabetes, leprosy, asthma, inflammation and indigestion.
2	*Aegle marmelos*	Bael	Used in Jaundice, constipation, chronic diarrhoea, dysentery, stomachache, fever, asthma, mental illness and swelling tumors.
3	*Asparagus recemosus*	Satavatri	Galactogogue, anti-dysenteric, diuretic, nervine disorder, used in inflammation and liver diseases.
4	*Berberis aristata*	Daruhaldi	It is useful in treating swelling, jaundice, diarrhea and dyspepsia.
5	*Cascuta reflexa*	Amarbel	Seed used as carminative, plant used in jaundice and diuretic. Stem is useful in constipation and liver disorder.
6	*Curcuma longa*	Turmeric	Bulb, gel, leaves, roots, barks, peels etc. used as traditionally for the treatment of bacterial infections.
7	*Emblica officinalis*	Amla	Leaves used as anti-inflammatory and antipyretic agent
8	*Eucalyptus globules*	Blue gum	Treat cold and cough, lung infections, muscular aches etc.
9	*Ocimum sanctum*	Tulsi	Leaf as anti-inflammatory, anti-arthritic, anti-stress, antipyretic.
10	*Zanthoxylum armatum*	Tirmira	Fruits edible and used for Flavouring curries. Tender leaves used for making chutney
11	*Mentha spicata*	Pahari podina	Herb carminative. Leaves useful in fever, bronchitis
12	*Acacia catechu*	Khair	Medicinal (bark astringent)
13	*Aloe barbadnesis Mill.*	Kawarya	Medicinal (pulp useful in menstrual suppression, juice cooling)
14	*Vitex negundo*	Bana, Nirgundi	Antiarthritic, vermifuge, cardiac demulscent, lungs disease, expectorant
15	*Bauhinia variegate*	Karale	Root, bark and flowering buds. Bark useful in skin diseases. Dried buds used in dysentery, piles and expelling worms. Roots are antidote to snake poisoning. Flower buds used as vegetable
16	*Euphorbia heleoscopia*	Dudhi	Paste of the plant applied for healing wounds. 5-10 ml of leaf juice mixed with honey given for persistent cough.
17	*Achyranthes aspera*	Puth-kanda	Powdered roots mixed with honey used for cough and hemorrhoids. Root paste consumed to check bleeding after abortion. Leaf paste applied to heal bites of poisonous insects, wasp and bees.
18	*Adhatoda vasica*	Bansa, Basuti, Vasaka	Leaves and roots are useful in asthma, bronchitis, cough, rheumatism and as insecticide

19	*Mallotus philippensis*	Kamal	Mixed with mustard oil and applied topically on burns.
20	*Murraya koenigii*	Gandhelu	Luke warm decoction is applied topically on swelling of foot and legs.
21	*Terminalia bellirica*	Bahera	Roasted fruit for cough and cold.
22	*Terminalia chebula*	Harad	Rubbed with mother's milk & licked to infant as a laxative.
23	*Tinospora cordifolia*	Giloye	Decoction used orally in joint pains, jaundice, stomach ache
24	*Bombax ceiba*	Semul	Leucorrhoea, wounds, loose motions, burns and tumours
25	*Syzygium cumini*	Jamun , cherry	Used for the treatment of sore throat, bronchitis, asthma, thirst, biliousness, dysentery and ulcers
26	*Trianthema decandra*	Biskhapra	Roots of plants Used for treating hepatitis and asthma. Decoction of the plant used for treatment of fever, rheumatism, and as an antidote for alcohol poisoning
27	*Cymbopogon citratus*	Lemon grass	Used for treating digestive tract spasms, stomachache, high blood pressure, convulsions, pain, vomiting, coughs achy joints (rheumatism), fever, the common cold, and exhaustion. It is also used to kill germs and as a mild astringent
28	*Santalum album*	Chandan dhoop	Used in folk medicine for treatment of common colds, bronchitis, skin disorders, heart ailments, general weakness, fever, infection of the urinary tract, inflammation of the mouth and pharynx, liver and gallbladder complaints and other maladies
29	*Terminalia arjuna*	Arjun	Used for heart ailments including heart failure and chest pain
30	*Elettaria cardamomum*	Elaichi	Used to cure indigestion, nausea, vomiting and used to expel out phlegm out of body, beneficial in congestion of lungs and other pulmonary diseases
31	*Sapindus mukorossi*	Reetha	Useful in treatment of skin problems like eczema and psoriasis. Soapnut powder is a very good antibacterial and antifungal agent. It is mostly used in the cosmetic and contraceptive creams
32	*Citrus sinensis*	Orange	Excellent source of vitamin C, prevents skin damage, keeps blood pressure under control, lowers cholesterol, controls blood sugar level, lowers the risk of cancer.
33	*Citrus* sinensis	*Kinoo*	Excellent source of vitamin C, prevents skin damage, keeps blood pressure under control, lowers cholesterol, controls blood sugar level, lowers the risk of cancer.
34	*Citrus limon*	(Nimboo)	Excellent source of vitamin C, prevents skin damage, keeps blood pressure under control, lowers cholesterol, controls blood sugar level, lowers the risk of cancer.

Table: Selected Gram Panchayats of Bilaspur district

S. No.	Name of Gram Panchayats	Range	Cluster
1.	Bandla	Sadar	Swarghat & Ghumarwin
2.	Sihra		
3.	Amarpur	Ghumarwin	
4.	Rohin		
5.	Bulghar	Jhandutta	
6.	Malangan		
7.	Kuthela	Swarghat	
8.	Tarwar		

Based on field survey of study area and open interviews with traditional healers the following species have been selected in this clusters for cultivation.

4. Amla (*Emblica officinalis*)

It is commonly known as the Indian gooseberry, medicinally important plant used in manufacturing medicines for hair care, improve immunity, eye care, improve mental function etc. Amla fruit is rich in nutritional fibre which helps to improve the digestion process. It is also used in Ayurveda, Siddha and Unani system of medicine for production of hair oil and skin care formulations. Amla has been called the first-class of the Ayurvedic rejuvenating herb, considering by way of the usual stability of tastes (sweet, sour, pungent, bitter and astringent) multifunction fruit and is well identified for its dietary characteristics, fruit is the richest source of vitamin C.

Table: Features of amla tree

Family	Phyllanthaceae
Scientific name	*Emblica officinalis*
Origin	Subtropical South Asian countries
Optimum temperature for growth	0℃-46℃
Suitable soil	well-drained loamy soil
Optimum pH	6.5-9.5
Varieties	Banarasi, Chakaiya, Francis, NA-4 (Krishna), NA-5 (Kanchan), NA-6, NA-7, NA-10.

4.1 Climate and soil

E. officinalis require a 630-800 mm annual rainfall and thrive up to 46°C, since the warm climate is quite beneficial during the beginning of its fruit growth. *E. officinalis* can be grown in a broad range of soil from sandy loam to clay and arid to semi-arid regions.

4.2 Seed propagation

E. officinalis mature fruits can be collected in the month of November-December. The collected fruits are usually sun-dried, so that seeds can be pulled out with gentle pressure. The best sowing time for *E. officinalis* seed is between April and June. The seeds can be sown in

small polybags at the depth of 5 cm. For highest percentage of germination and to attain seedling with good seed health, vitality, seed should be soaked in GA_3 200 ppm solution for 12 h.

4.3 In vitro propagation

In vitro propagation ensures the speedy multiplication of plantlets from plant cells and tissue on nutrient media under aseptic conditions. *E. officinalis* is propagated through seeds and asexually by budding and grafting. Propagation through seeds is not beneficial since seeds possess dormancy and do not produce true-type plants owing to cross-pollination and seed-derived plants bear inferior quality fruits. To overcome this issue, micro propagation techniques can be employed to produce large-scale true-type and disease-free plants.

4.4 Budding

In case of *E. officinalis* patch budding and shield budding are the best commercial method of vegetative propagation among all other modes. In general one year old seedlings with 1 cm thickness should be shield budded in early July with healthy and plump buds from new growth.

4.5 Grafting

Grafting is also one of the most significant practices for raising good propagules. Soft wood grafting has been attempted with 70 % success rate at the site of terminal shoot of the rootstock raised in situ. It would be suitable to raise seedling rootstocks in situ and graft them with superior types of scion predominantly in dry areas where mortality of budded plants is usually high. In addition, veneer and cleft grafting has also been attempted successfully.

4.6 Nursery preparation

Seed bed preparation is a pre requisite for raising seedlings. Usually, nursery beds should be raised with 10-15 cm, using farmyard manure (FYM) under fractional light. Limited shade is required for nursery bed. During spring or rainy season, pre-soaked seeds in water for 48 h can be sown at 2-3 cm depth and 2-3 seeds, keeping a space of 15 cm (row-row). For rootstock preparation, 6-12 month-old seedlings are usually considered. Ripen fruits harvested in the months of November-December used to extract the seeds in April to raise the nursery bed.

4.7 Rootstock

Six months to one year old seedling raised from ‘Desi’ amla seed can be used as rootstock. Propagation of amla in polybag, Polytube or in situ orchards establishment has also been standardized and commercialized.

4.8 Orchard establishment

A grafted amla tree starts bearing after 3-4 years and achieves commercial production after 10-12 years which may continue up to 60 to 70 years. The performance of orchard depends on its management which includes water and nutrient management, selection of right cultivars, planting system and maintenance of young and bearing trees, stature and canopy management of plants.

4.8.1 Selection of site

Selection of site for the establishment of any amla orchard is vital for optimal production. During fruit growth warm weather and dry period during flowering and humidity should be considered ideal for successful cultivation.

4.8.2 Land preparation and layout

Before land-dwelling preparation, the land should be cleared of bushes, weedy vegetation, levelled and ploughed deeply. For improving the fertility of the soil, organic matter should be added and green manure crop such as dhaincha (*Sesbania aculeata*) or sunhemp (*Crotolaria juncea*) should be grown which will improve moisture holding capability and physical condition of the soil.

4.9 Planting

Amla should be planted during rainy season which provides optimal soil moisture and better atmospheric humidity for better survival of plants. Hence, north Indian conditions, planting should be done from mid to end of August.

4.9.1 Planting System

E. officinalis is an evergreen, spreading plant which attains the height of about 8-10 meters at its full grown stage. Before planting, the field should be laid out and marked according to system of planting to be followed. The pit of 1x1x1 size should be dug at marked place during summer season in the month of April-May and kept open for 15 days. The pit should be filled with top soil mixed with about 3-5 baskets (15-20kg) of well decomposed FYM/compost, 1kg neem/karanj cake, 500g bone meal/single super phosphate, 200-300g muriate of potash, 50g Heptachlor per 20g, Furadan 3G/20g just before the onset of monsoon. Then the soil allowed settling properly during first few rains and gets levelled properly. At the time of planting, a hole of the ball size of the earth should be made in the centre of the pit at the marked point and planting should be done. After proper fixing of the plant, watering should be done immediately for proper establishment of plant. Plants should be regularly irrigated till they are properly established.

4.10 Orchard management

The orchard management includes the management of canopy architecture, nutrient, water, field sanitation and plant protection. Management practices like weeding, hoeing, cleaning of plant basins, plant protection and water management etc. should be done from time to time to facilitate better growth. Therefore, proper training and pruning is needed. Therefore dead, broken and week branches should be removed.

4.11 Nutrient management

The combination of organic and inorganic nutrients increase fruit production and quality. The physical, biological and chemical properties of soil are influenced by the source of nutrients. Dosage of manure and fertilizers based on soil fertility, age of the plant and frequency of fruiting. Usually, 10kg FYM, 100g nitrogen, 50g phosphorus and 100g potassium should be given to one-year-old plant. Annual increment of dose should be assured up to 10 year. The complete dose of FYM, phosphorus, half of the nitrogen and MoP should be applied around tree basins during December-January remaining half is applied in August.

Table: Systemic schedule of manure and fertilizer

Plant age (Year)	Manure and fertilizer per plant				
	FYM (kg)	Neem/Karanj Cake (kg)	N (g)	P (g)	K (g)
At plant	10	1	100	50	100
1	10	1	100	50	100
2	20	2	200	100	200
3	30	3	300	150	300
4	40	4	400	200	400
5	50	5	500	250	500
6	60	6	600	300	600
7	70	7	700	350	700
8	80	8	800	400	800
9	90	9	900	450	900
10	100	10	1000	500	100

4.12 Water management

Only after manure and fertilizer application (during January-February) in the fruit-bearing plant, irrigation should be done from time to time. Basin system of irrigation is best suited for *E. officinalis* and drip irrigation is also a promising practice and in water scarcity areas, pitcher irrigation is usually recommended for orchard establishment.

4.13 Cropping system

The tree canopy of *E. officinalis* with sparse foliage facilitates abundant incoming daylight and assists intercropping within available spaces even under full-grown trees and thus during initial 3-4 years of planting. Vegetables like bottle gourd, okra, coriander, cauliflower,

pea, turmeric and flowers like gladiolus and marigold have been found well suited for intercropping. Tuber crops should be grown even under the dense shade of orchard.

4.14 Plant protection

4.14.1 Physiological disorders and their management

Major physiological sicknesses that affect the quality of *E. officinalis* fruits are chilling injury, necrosis, pink spots and white specks.

- **Chilling injury**: Results in the splitting of peel and sporadic ripening of fruits that eventually leads to decay.

  Control: To avoid such harm, storage temperature should be optimized around 12°C.
- **Necrosis and pink spots:** During the hardening of endocarp, browning of innermost mesocarpic tissues along with epicarp results in the blackened fruit surface in the form of necrosis. In addition, owing to the deficiency of boron, random pink spots appeared on *E. officinalis* fruits that eventually deteriorate the fruit quality.

  Control: To control, spraying of borax (0.6%) thrice at two-week intervals (September-October) is useful.
- **White specks** White specks are the other major disorder that causes poor appearance and spongy texture of fruit at the curing and pickling stage.

  Control: The frequency of white specks can be minimalized via preservation of fruit in 0.04% $K_2S_2O_5$ and 10% NaCl solution, followed by salting and dehydrating with 0.02% $K_2S_2O_5$ and 10% NaCl after four weeks of storage.

4.14.2 Pathological disorders and their management

Major pathological diseases of *E. officinalis* are rust, anthracnose, fruit rots, blue mold rots etc. among which, rust is economically most important.

- Clean cultivation along with the removal of infected fruits and leaves (proper pruning) decreased infestation of the disease. Spraying 0.2% Zineb or 0.5% sulfur three times from the month of July at four week intervals proved to be very effective for rust management.
- During August-September, *Colletotrichum* state of *Glomerella cingulata* results in anthracnose of fruits and leaflets. Dried up leaves initially appear turn into dark brown stains with the red margin and yellow halos. In addition, 0.1% Carbendazim or 0.2% Difolatan spray should be given.
- Alternatively, pre-harvest dip of fruits at the rate of 4% borax or two sprays of 0.01% calcium nitrate with 0.1% Topsin M is efficient against fruit rot.
- Among the other pathological disorders, infestation of *Penicillium islandicum* causes blue mold rot brown patches with water-soaked areas. For this proper fruit handling and good

sanitary conditions during storage along with $NaCl_2$ and ozone gas treatment remains effective.

4.14.3 Insect pests and their management

There is an array of insect pests i.e. *Betousa stylophora* Swinhae, *Celepa celtis*, *Gracillaria acidula*, *Indarbela tetraonis* and *Virachola Isocrates*), Homoptera (*Oxyrhachis tarandus*, *Nipaecoccus vastator*, and *Ceciaphis emblica*) and Cleoptera (*Myllocerus discolor*). Juvenile fruits are affected by fruit borers that feed on the developing seeds after laying of eggs and the subsequent emergence of caterpillars. During July-August, Endosulphan (0.05%) spray is effective against fruit borers, apart from the collection and destruction of affected fruits. Caterpillar is 'bark-eating' type causes up to 80% damage to the whole plant, feed on the bark under silken ribbon-shaped webs. Reduction of overcrowded branches and clean cultivation can manage with an increasing infestation Furadan or Endrin spray (0.03%) during February-March or September-October. During the rainy season, young caterpillars bore into tender shoots and feed in pits. The affected parts should be pruned and burnt to minimize the infestation.

4.15 Cost benefit ratio analysis

4.15.1 Assumptions in Amla Cultivation

Material (Fixed charges)	**Investment in Rs**
Fencing charges	10,000.00
Land preparation	2500.00
Pit preparation	3500.00
Cost of fertilizers and manure	4000.00
Plant material cost	1500.00
Planting and irrigation	2000.00
Total Investment	**23,500.00**

4.15.2 Amla production cost during the gestation period

Material	**Investment in Rs**
Human Labour	12000.00
Manure and fertilizers	2500.00
Irrigation charges	1500.00
Plant protection chemicals	4500.00
Total	**20,500.00**

4.15.3 Cost of Amla production during fruiting years

Material and Labour	**Investment in Rs per year (from 5 year onwards)**
Human labour charges	15000.00
Manure and fertilizers	5000.00
Irrigation	4000.00
Plan protection charges	3500.00
Other miscellaneous charges	7500.00
Total	**35,000.00**

4.16 Harvesting And Yield

Amla tree starts bearing from 3rd years of planting. The fruits are harvested during February when they become dull greenish yellow from light green. The mature fruits are hard and they do not fall at gentle touch and therefore vigorous shaking is required. Fruits can also be harvested using long bamboo poles attached with hooks. A mature tree of about 10 years will yield 50-70 kg of fruit. The average weight of the fruit is 60-70 g and 1 kg contains about 15-20 fruits. A well maintained tree yields up to an age of 70 years

4.16.1 Expected yieldper acre

Year of Planting	Yield/ Plant	Total Plants/ Acre	Rate/ Kg	Total Income
First Year	Nil	200	Rs. 15/Kg	Rs. 00/-
Second Year	Nil	200	Rs. 15/Kg	Rs. 00/-
Third Year	15 Kg	200	Rs. 15/Kg	Rs. 45,000/-
Fourth Year	30 Kg	200	Rs. 15/Kg	Rs. 90,000/-
Fifth Year	40 Kg	200	Rs. 15/Kg	Rs. 1,20,000/-
Sixth Year	60 Kg	200	Rs. 15/Kg	Rs. 1,80,000/-
Seventh Year	80 Kg	200	Rs. 15/Kg	Rs. 2,40,000/-
From 8th to 40 Year	Every year average 100 Kg	200	Rs. 15/Kg	Rs. 3,00,000/- Every Year

4.16.5 Cost benefit ratio

Total cost/Earning total benefits=79,000/60,000=1.31

5. Citrus

Citrus fruit belongs to the family Rutaceae, include oranges lemons, limes, pomelo and grape fruit. Being a native of tropical and subtropical region of South East Asia, these have been under cultivation from time immemorial in South China, Malaya and sub-Himalayan parts of Assam, from here they spread to other tropical and subtropical parts of the world. All the edible fruits of citrus come under subgenus Eucitrus which can be divided into five horticultural groups. The plant was found to possess significant health benefits i.e. analgesic, antimicrobial, anti-inflammatory and antioxidant etc. The chemical compounds which are present in the plants are responsible for the pharmacological action.

Table: Features of citrus tree

Family	Rutaceae
Origin	South Asia, East Asia, Southeast Asia, Melanesia, and Australia
Optimum temperature for germination	31℃-33℃
Optimum temperature for growth	13℃-38℃
Suitable soil	Sandy loam or alluvial soils, acidic soil
Optimum Ph	5.5-8.5
Varieties	Orange, Kinnow, Mandarin, Tangerine, Lemon, Galgal etc.

5.2 Conventional Propagation

5.2.1 Soil and climate

Citrus needs deep, well-drained soil with pH 6.0-7.5. However, by means of modifying cultural practices it can grow well from 5.5 to 8.5 pH. Citrus is particularly sensitive to salt concentrations in the soil solution. It can be grown from hilly areas to semi-arid irrigated areas. If the soil pH is near 8.5 then EC of soil should be less than 0.5 mm for the success of citrus orchards. Citrus perform well in sub-tropical conditions and cultivated throughout India. Mandarins have adapted to sub-mountainous regions and are being cultivated in Himachal Pradesh. A rainfall of about 150 cm to 250 cm should be required for citrus fruit. The winter should be mild and there should be no strong or hot wind during summer.

5.2.2 Growth regulators

To increase the fruit retention spraying the trees at flowering and again at marble stage with 2, 4-D at 20 ppm or NAA 30 ppm.

5.3 Cultivation & Planting

Citrus trees are planted in rows in orchards. A typical tree can be required spacing of 6m between rows by 3m between trees, meaning that 555 trees per hectare. Once planted, trees take three or more years before bearing fruit that can be marketed. Thereafter, per tree and per hectare yields steadily increase to 40 to 70 t/ha depending on the variety after 4 to 7 years. The seedbeds are taken care of to be free from damping-off by drenching the soil with 1% Bordeaux mixture 3g/lit of water. In the case of acid lime and lemon lime rootstocks can be used.

5.3.1 Planting

Pits of 1 meter cube should be dug in square system at spacing of 6m for acid lime and 6-8m for sweet orange and filled with a mixture of tank silt, red earth and farmyard manure. Two or three kilos of bone meal or super phosphate per pit need to be applied. The plants selected should be free from viruses, pests and diseases. While planting care should be taken to see that the bud-joint does not get into the soil. The plants have to be staked immediately to avoid wind damage

5.3.2 Budding

When the seedlings become of pencil thickness then T- budding is done. The scion wood is taken from healthy true to type mother plants. T-budding should be performed in August- September and February-March when sufficient cell sap flow is there in seedlings. The rootstock seedlings can also be raised in poly bags of 12 cm x 30 cm size. Plants propagated in bags are easy to handle for transportation and planting. This limits the chance of earth ball breakage.

5.4 Nursery management

Primary nursery can be developed in raised bed or plastic tray by using sterilized potting mixture. Seeds should be sown in primary nursery just after extraction from the fruits to a depth of 1.5-2.0 cm and 10x5 cm distance. Sunlight, warm soil temperature and sufficient moisture should be required for rapid germination and seedling emergence. Seeds are covered with fine layer of wood ash or FYM mixture and mulched with dry leaves or paddy straw. Adequate watering should be given at regular interval as per need. Seedlings are ready for planting in main field after 12-18 months of growth.

5.5 Training and Pruning

The water shoots and rootstock sprouts should be periodically removed. Trees are trained to single stem with 4-6 well-spaced branches making the basic framework. Further no branches should be allowed from the trunk up to height of 45-50 cm from the ground level. An ideal mandarin tree should be low headed with dome like crown. Pruning of non-bearing trees can be done at any time of the year, but for bearing trees, the best time is after harvesting.

5.6 Irrigation

Young trees have to be regularly watered throughout the year during the dry season. The practice of smearing water close to the tree trunks should be avoided as it is conducive to the development of collar rot, gummosis and other fungal diseases. Double ring system of irrigation should be adopted for improvement. The basins may be enlarged from year to year so as to accommodate adequate irrigation water for growing tree. Depending on the climate citrus requires irrigation once in 7 to 15 days interval. But during the flowering and fruit maturity stage there must be sufficient moisture in the soil.

5.7 Intercultural operation

Shallow ploughing can be taken up during monsoon season to avoid damage to fibrous root system. The soil in the basin is likely to become hard under continuous irrigation and therefore it should be given a light hand-digging with spade after every three irrigations so as to maintain porosity and tilt. Weeds should be removed time to time in the orchard for better production.

5.8 Control of fruit drop

Early and pre-harvest fruit drop is common in citrus fruits. To control this physiological condition, sprays of 2,4-D at 10 ppm (1g/100lit) should be given, one at the time of flowering and second the one month after fruit set and the third one month before harvest which is beneficial and increases the yield considerably minimizing the fruit drop.

5.9 Harvest and postharvest technique

Harvesting is done after full maturity of fruits only. During fully maturing stage there

is colour change and increasing in sweetness. Usually a fruit will take 8 to 9 months' time from flower to fruit measure stage in sweet orange. Where as in acid lime it takes 4.5 months. In sweet orange harvesting done once in change colour from green to yellow indicated, whereas the in acid lime harvesting is done, once the fruit reaches fully, size, green colour and kept in the storage till the fruit colour changes to yellow and send to the market. During the harvesting care in taken to avoid damage to the fruit skin.

5.10 Plant protection

Important insect-pests of citrus are citrus black fly and whitefly, citrus psylla, Citrus thrips, leaf miner, scale insects, bark eating caterpillar/trunk borer, fruit fly, fruit sucking moth, mites, etc. Other pests attacking citrus particularly mandarin orange, especially in humid climate are mealy bug, nematode, etc. Control measures of major pests indicated below:

- **Leaf miner:** Pest like leaf miner the leaves of young flush, showing glistening and zig zag mines on them. The affected leaves curl, deform and the plant appears sick.

  Control: Spraying of chemicals like fenvalerate 0.2 ml, 0.5 ml or profenophos 2 ml per litre of water immediately after the appearance of fresh foliage and 2nd spray after a week is recommended.

- **Bark and Stem borer**: The caterpillar bores into stems and branches and forms long galleries of silk overlaid with small fragments of wood. The larva comes out from this gallery and feeds on the barks.

  Control: The wooden particles, silk and bored holes plugged with excreta should be cleaned and poured with Malathion or Kerosene or Petrol using an ink pillar. Then the hole is sealed with clay so that the larva dies within the tunnel.

- **Green mites (*Olygony chuscitri, Tetramychus* spp.):** Infested leaves from upper side become stippled and later on turn grey on yellow. Infested fruits remain often small in size and drop.

  Control: Spraying of water soluble Sulphur 3g or propargite 2ml or Dicofol 3.5 ml/lt of water 2 times in 10 days interval should be recommended for mite control.

- **Fruits sucking moths (*Othreis maternal, O. fullonica, Achoeajanata, O. ancilla*):** These species pierce the ripening fruits and suck juice cause rotting and dropping of fruits. The moths will be active during dusk. The larvae develop on the weeds.

  Control: Rotten and fallen fruits attract the adult moths. So affected dropped fruits should be collected and destroyed. Moths get attracted to light. During fruit ripening period light traps along with basins containing fruit juice+% sugar Malathion or kerosene bait solution should be sprayed. Before the ripening period bagging of fruits either with 300 gauge polythene bags or palm leaf bags helps to reduce the pest attack.

- **Fungal diseases**
- **Leaf fall and Fruit rot:** Water soaked lesions develop on leaves and fruits, resulting in their drop. Two sprays of 0.1% Bordeaux mixture, once before the beginning of monsoon and the other at the end of the monsoon should be applied.
- **Powdery mildew:** White powdery growth is formed on the surface of the leaves. Spraying of Karathane 0.1% or wettable Sulphur 0.2% twice at 15 days interval reduces the disease incidence.
- **Bacterial diseases**
- **Canker and Greening:** are the two main bacterial diseases of citrus fruit. Canker (*Xanthomonas auxonopodis*) Corky out growths develop on the leaves, fruits and twigs. The disease is serious in acid lime.

  Control: Spray Streptocycline (1g) + Copper oxychloride (30g) in 10lt of water, twice on young flushes in rainy season at 20 days interval should be given. To prevent canker on fruits, spray the above chemicals on small fruits twice at monthly interval should cover entire fruits.

Table: Requirement of FYM and various nutrient

FYM	**I Yr**	**ll Yr**	**lll Yr**	**lV Yr**	**V Yr**	**Vl Yr**	**Vll Yr**
Kg/plant	20	10	15	20	25	30	40
Year wise requirement of various nutrients (g/plant/year)							
Nutrients	**I Yr**	**ll Yr**	**lll Yr**	**lV Yr**	**V Yr**	**Vl Yr**	**VlI Yr**
Nitrogen	100	200	300	400	450	500	550
Phosphorus	50	100	150	200	200	250	300
Potash	25	50	75	200	200	250	300
Zinc sulphate	25	25	50	50	100	150	200
Ferrous sulphate	25	25	50	50	100	150	200

5.11 Cost benefit ratio analysis

5.11.1 Assumptions in Citrus 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	**24,500.00**

5.11.2 Citrus 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**

5.11.3 Cost of Citrus production during fruiting years

Material and Labour	Investment in Rs per year (from 5 year onwards)
Human labour charges	15000.00
Manure and fertilizers	4500.00
Irrigation	4000.00
Planting protection charges	4500.00
Other miscellaneous charges	4500.00
Total	**32,500.00**

5.12 Harvest and yield

Year	5	6	7	8	9	10	11	12
Yield(Kg/Plant)	10	30	60	70	80	80	80	80
Yield(Kg/acre)	1100	3300	5500	6600	7700	8800	8800	8800
Income	65000	264000	440000	528000	616000	704000	704000	704000

5.13.5 Cost benefit ratio

Total cost/Earning total benefits = 70,500/65,000 =1.08

6. Harar (*Terminalia chebula*)

The fruit of *Terminalia chebula* is antiseptic, diuretic, astringent, cardiotonic and febrifuge in action. It is a safe and effective purgative, laxative, and alterative an important ingredient of "triphala", an Ayurvedic formulation used in the treatment of constipation, kidney dysfunctions, eye diseases and sore throat. Unripe fruits are more purgative and the ripe ones are astringent. Flowers are yellowish-white and emit a strong offensive odour. Flowering occurs in May-June, while fruiting occurs in winter. The species is found mostly in mixed dry deciduous forests and is frequent in tropical and subtropical zones, mostly in hilly tracks. The plant prefers tropical environment, ascending in the sub-Himalayas zones up to an elevation of 1500 m.

Table: Features of *Terminalia chebula*

Common name	Harar
Botanical name	*Terminalia chebula*
Parts used	Dried immature fruits, generally the fruit rind
Origin	Sub-Himalayan region of Nepal and northern India to Sri Lanka, Myanmar, Thailand, Indo-China and southern China.

6.1 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.

6.2 Propagation

Seed is the most appropriate material for this plant propagation. Fruit of this tree can be collected 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.

6.3 Nursery management

The seedlings are raised from seeds in a nursery in July with the onset of monsoon season. Seeds should be sown in prepared beds or polybags. Germination is slow, but may be improved by pre-treating 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. The nursery should be partially shaded against the sun. 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.

6.4 Land preparation and fertilizer application

The land is tilled and levelled properly to make it porous and friable. Pits of size 60 cm × 60 cm × 60 cm can 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.

6.5 Intercultural 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 @3kg per plant is mixed in soil. The weeds may be check with the help of scythes or tractor-operated cutters.

6.6. Irrigation and pest control

Irrigation in pit areas is required in the initial three to four years, depending on the season and moisture of the soil. The plants may be irrigated at least once a week in summers. Anti-termite treatment with chlorpyriphos 20% EC should be given in termite-prone areas.

6.7 Harvest management

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.

6.8 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.

6.9 Expected Yield and cost of cultivation

Approximately 40-50 kg of dry fruits are obtained per tree per year after it attains six years of age. This gives an average yield of about 12.6 quintals/hectare.

6.10 Cost benefit ratio analysis

6.10.1 Assumptions in Harar Cultivation

Material (Fixed charges)	**Investment in Rs**
Fencing charges	10,000.00
Land preparation	4000.00
Pit preparation	2000.00
Cost of fertilizers and manure	3000.00
Plant material cost	1800.00
Planting and irrigation	4000.00
Total Investment	**24,800.00**

6.10.2 Harar Production cost during the gestation period

Material	**Investment in Rs**
Human Labour	7000.00
Manure and fertilizers	5000.00
Irrigation charges	4500.00
Plant protection chemicals	3000.00
Total Investment	**19,500.00**

6.10.3 Cost of Harar production during fruiting years

Material and Labour	**Investment in Rs per year (from 5 year onwards)**
Human labour charges	4500.00
Manure and fertilizers	2000.00
Irrigation	3000.00
Plan protection charges	2500.00
Other miscellaneous charges	5000.00
Total Investment	**17000.00**

6.10.4 Total Investment for farming is

The total yield from the farm is (1350 kg) approximately

The total cost of each kg of Harar fruit is Rs. 42/kg.

Total income from the farm is: total yield x cost per each unit (1350x42) = Rs 54,000/-

6.10.5 Cost benefit ratio

Total cost/Earning total benefits = 61,300/55,000 =1.11

7. Tulsi (*Ocimum sanctum*)

Tulsi (*Ocimum sanctum*) is used for treatment of common cold, cough, tonsillitis

asthma, diabetes, earache and various Ayurvedic formulations. The leaf oil is used in dental cream, mouth wash and toothpaste. It is also possess insecticidal, antibacterial and mosquito repellent properties. The plant contains mainly phenols, aldehydes, tannins, saponin and fats. The essential oil components are eugenol (71%), eugenol methyl ether (20%), carvacrol (3%), minor portions of nerol, caryophyllene, selinene, α-pinene, ß-pinene, camphor etc. Two types tulsi are available i.e. Sri tulsi (White type) and Krishna tulsi (Black type).

7. 1 Soil and climate

Sacred tulsi thrives well on a wide range of soils. Rich loam, poor laterite, saline and alkaline to moderately acidic soils are well suited for its cultivation. Well drained soil helps in better vegetative growth. Water logged conditions can cause root-rot and results in stunted growth. It flourishes well under fairly high rainfall and humid conditions. Long days and high temperatures have been found favourable for plant growth and oil production and can grow up to an altitude of 900 m. The plant is moderately tolerant to drought and frost. The plant can be grown under partially shaded conditions but with low oil contents.

7.2 Propagation

Tulsi is propagated through seeds and seeds will get deteriorated over generations, due to its cross-pollination. Therefore, for fresh plantings, the growers have to take fresh seeds from the pedigree stock.

7.3 Nursery management

Nursery should be raised in the month of February. Seed beds of 15 × 4 × 9 ft. size should be thoroughly prepared and well manure by the addition of farm yard manure 10 kg per bed. About 200-300g seeds are enough to raise the seedlings for transplanting in one hectare of land. The seeds are very small and hence it should be mixed with sand and sown to a depth of 2 cm. After sowing, the seeds, a mixture of farm yard manure and soil should be spread in a thin layer over the seeds and irrigate with sprinkler tube. For getting healthy seedlings for transplanting spray of 2% urea solution on the nursery plants at 15-20 days before transplanting should be given.

7.4 Land preparation

The land is brought to fine pit and laid out into plots of suitable sizes. It is preferable to add 15 t/ha of farm yard manure and recommended fertilizers as basal dose during the preparation of land and should be mixed well in the soil.

7.5 Transplanting

Seedlings of six weeks old and having 4-5 leaves transplanted at a spacing of 40x40 cm, 40x50 cm and 50x30 cm to get high herbage and oil yield. The plots are irrigated immediately after transplanting. The seedlings will establish by the time of second irrigation.

At this stage gap filling and replacement of the poor plants are also done so that uniform plant stand is achieved.

7.6 Manures and fertilizer

Tulsi is full-grown for its herbage, it is necessary to frequently replenish the soil. Farm yard manure is to be applied at 10t/ha before planting. Do not use compost made from city waste and human excreta. Do not apply fresh manure for plant nutrition. Optimum fertilizer dose recommended for this plant is 120 kg N, 60 kg of P_2O_5 and K_2O per hectare. Half dosage of N and the entire dose should be given as a basal dose, whereas the remaining N is applied in two split doses after first and second cuttings.

7.7 Irrigation

Irrigation of crop depends upon the season and moisture content of soil. In summer season twice week irrigations are necessary whereas, during winter it should be irrigated one week intervals. Apply mulch to conserve soil moisture, before harvesting, irrigation should be discontinued.

7.8 Weeding

Weeds have to be managed before they start competing with the main crop for nutrients and light. First weeding is done one month after planting and the second four weeks later. After this, no further weeding is required as the plants become bushy thereby suppress the weeds. One weeding and earthing up operation is required at two months after planting. Use mulch to maintain soil moisture and inhibit growth of weeds. Do not use chemical herbicides to eradicate weeds and do not keep weeds till flowering as this will increase weed pressure in coming years. Do not let the soil to dry up due to excessive weeding.

7.9 Harvesting

Care should be taken while harvesting tulsi to avoid any type of contamination. Clean the entire surface that comes into contact with the plant during and after harvest. The crop is to be harvested at full bloom stage to obtain maximum essential oil yield. The first harvest is obtained at 90-95 days after planting. Thereafter, it may be harvested at every 65-75 days interval. Harvesting should be done on bright sunny days for good quality oil. It is not necessary to harvest the crop if there was a rain in the previous day. The crop should be cut at 15-20 cm above the ground level.

7.10 Processing

The collected crop may be allowed to wilt in the field for 4-5 hours so as to reduce the moisture content and also the bulkiness. However oil quality and its yield do not reduce up to 6-8 hours after harvest, but further delay may cause substantial loss in yield and quality of oil. Steam distillation is found to be greater to hydro distillation and hydro cum steam distillation.

The distillation unit should be clean, rust free and free of any other aroma. The oil obtained is then decanted and filtered and distilled oil is treated with anhydrous solution of sodium sulphate or common salt at the rate of 20 g per litre to remove the moisture. The oil should be stored in sealed amber coloured glass bottles or ampules made of stainless steel, galvanised tanks, aluminium containers and stored in a cool and dry place and all processing activities should be recorded.

Table: Cultivation details

Major activity	Month	Activity details
Nursery management	Mid February	200 - 300 g seeds / ha are mixed with sand and sown in raised nursery beds in lines of 10 cm apart to a depth of 2 cm
Land preparation	February-March	2-3 deep ploughing and harrowing
Manure and fertilizer application	February – March	Application of FYM 10 t/ha and basal dose of fertilizers i.e. ½ N and full P_2O_5 and K_2O. (The recommended dose of fertiliser is 120 kg N, 60 kg each of P_2O_5 Pand K_2O/ha)
Irrigation	April	One irrigation immediately after transplanting and thereafter 3 irrigations per month during summer months

7.11 Expected Yield

About 5 tonnes per hectare can be obtained by two to three harvests in a year. The oil yield varies with type, season, climate, chemical compounds and place of origin. The whole herb contains 0.1-0.23% essential oil and an oil yield of 10-23 kg can be obtained per hectare.

7.12 Cost benefit analysis

7.12.1 Assumptions in Tulsi Cultivation

Material (Fixed charges)	Investment in Rs
Fencing charges	10,000.00
Land preparation	2000.00
Pit preparation	1500.00
Cost of fertilizers and manure	4000.00
Plant material cost	2000.00
Planting and irrigation	2500.00
Total Investment	**22, 000.00**

7.12.2 Production cost during the gestation period

Material	Investment in Rs
Human Labour	2000.00
Manure and fertilizers	3000.00
Irrigation charges	4500.00
Plant protection chemicals	5000.00
Total Investment	**14, 500.00**

7.12.3 Cost of Tulsi production during fruiting years

Material and Labour	Investment in Rs per year (from 5 year onwards)
Human labour charges	3000.00
Manure and fertilizers	2500.00
Irrigation	4200.00
Plan protection charges	3500.00
Other miscellaneous charges	9500.00
Total Investment	**22,700.00**

7.12. 4 Total Investment for farming is

The total yield from the farm is (700 kg) approximately

The total cost of each h kg of tulsi is Rs. 75/kg.

Total income from the farm is: total yield x cost per each unit (20x35x75) = Rs 52,500/-

Cost benefit ratio = Total cost/Earning total benefits=59,200/52,500=1.12

8. *Tinospora cordifolia* (Giloy)

Tinospora cordifolia is a glabrous, succulent and climbing shrub native to India, also found in Burma and Sri Lanka. The reference of medicinal use of *Tinospora cordifolia* to treat diseases like, vatarakta (gouty arthritis) and daha (burning sensation) is found in various Ayurvedic texts. It has been traditionally used in various formulations for the treatment of rheumatoid arthritis. *T. cordifolia*, very important plant used by the local herbal practitioners/Vaidya's successfully. The plant occurs throughout tropical regions of India extending from Kumaon to Assam and Myanmar, Bihar, Konkan to Sri Lanka. It is a large climber which grows over the highest trees in the forests and throws out aerial roots which reach the length of 10 metres, though not thicker than pack-thread.

Table: Features of *Tinospora cordifolia*

Common name	Giloy
Botanical name	*Tinospora cordifolia*
Family	Menispermaceae
Soil	Light medium sandy loam soil
Origin	Tropical areas of the Indian subcontinent

8.1 Soil and climate

Giloy requires warm climate for its growth and the plant can be grown in Light medium sandy loam soil rich in organic matter, and with adequate drainage. The plant cannot survive in high rainfall and waterlogged conditions.

8.2 Nursery raising and planting

8.2.1 Raising propagules

The stem cuttings are sown directly in the field. Cuttings can be obtained from older stems with nodes. Cuttings should be sown within 24 hours of their removal from the mother plant. Meanwhile, they should be half-dipped in water vertically.

8.2.2 Propagules rate and pretreatment

About 2500 cuttings are required for plantation in 1 hectare of land. No specific treatment is required before sowing.

8.3 Manures, fertilisers and pesticides

The medicinal plants have to be grown without chemical fertilizers and use of pesticides. Organic manures like, Farm Yard Manure (FYM), Vermi-Compost, Green Manure etc. should be used as per requirement of the species. To prevent diseases, bio-pesticides could be prepared (either single or mixture) from Neem (kernel, seeds & leaves), Chitrakmool, Dhatura, Cow's urine etc.

8.4 Irrigation

The crop is grown under rain-fed conditions. However, occasional irrigation during extremes of cold and hot weather may help the crop survive in adverse conditions

8.5 Harvest management

8.5.1 Crop maturity and harvesting

The stem is harvested during autumn when it develops to a diameter of more than 2.5 cm. Basal part is left for further growth.

8.5.2 Post-harvest management

The stem of mature *T. cordifolia* should be cut into small pieces and dried in shade. It can be stored in gunny bags, and kept in cool and airy storage god owns. Stem bark peels off even by touch, thus stem should be cut very cautiously as peeled stem decays very soon.

8.6 Cost benefit ratio analysis

8.6.1 Assumptions in *T. cordifolia* cultivation

Material (Fixed charges)	**Investment in Rs**
Land preparation	2000.00
Pit preparation	4500.00
Cost of fertilizers and manure	4000.00
Plant material cost	1200.00
Planting and irrigation	2500.00
Total Investment	**14,200.00**

8.6.2 Giloy production cost during the gestation period

Material	**Investment in Rs**
Human Labour	13000.00
Manure and fertilizers	2500.00
Irrigation charges	3000.00
Plant protection chemicals	3000.00
Total	**21,500.00**

8.6.3 Cost of Giloy production during fruiting years

Material and Labour	Investment in Rs per year
Human labour charges	12000.00
Manure and fertilizers	1500.00
Irrigation	4000.00
Plan protection charges	3500.00
Other miscellaneous charges	7500.00
Total	**28,500.00**

8.6.4 Total Investment for farming is:

The total yield from the farm is (1500 kg) approximately

The total cost of each kg of *T. cordifolia* stem is Rs. 70/kg.

Total income from the farm is: total yield x cost per each unit (25x45x55) = Rs 61,875/-

Cost benefit ratio = Total cost/Earning total benefits=64,200/61,875=1.03

9. *Terminalia arjuna*

Terminalia arjuna, commonly known as arjuna is a deciduous and evergreen tree distributed throughout India and found in Sri Lanka, Burma and Mauritius. The bark and leaves of this medicinally important plant have been used in indigenous system of medicine for curing several diseases. Bark is used in the treatment for angina, expectorant, antidysentric, purgative, laxative, leucoderma, anaemia, hyperhidrosis, asthama, tumors and other cardiovascular disorders and leaves of this plant is used as a remedy for the treatment of ear ache. This is one of the traditional Ayurvedic medicines which are used since ancient times. The medicine is sweet and cooling as this will mucilaginous as it increases the Kapha and reduces the Pitta dosha and acts as a stimulant and also ensure to boost the energy.

Table: Features of Arjuna tree

Common name	Arjuna
Botanical name	*Terminalia arjuna*
Family	Combretaceae
Soil	Alluvial loamy or black cotton soils
Part used	Stem and bark

9.1 Soil and climate requirements for Arjuna

This plant can be grown in all types of the soils. But the most preferred soil is humid, fertile and red lateritic soils. The soil should be capable of well-draining. The waterlogging should be avoided as it can lead to major loss of the crop. This plant can furnish in drought and also this is frost resistant crop. The maximum temperature, which is required for the plants, should range 38˚C-48˚C and the minimum temperature should be 0˚C-15˚C.

9.2 Land preparation and planting

All type of unwanted weeds, pebbles, stones and also the unwanted materials should be removed. Then the land should be ploughed for 2-3 times as it will attain the fine tilth and

smooth texture following by the ploughing, harrowing and levelling should be done. For a plot (land) we should use 5 kg each pit should be filled with a mixture of soil and manure. The pits of 60 cm x 60 cm x 60 cm should be dug at a spacing of 6 m x 6m.

9.3 Nursery preparation

The beds should be sown with seeds in a row of 1 foot each from and 2 inches of space between the seeds. The best time for sowing is February-March. After sowing the seeds regular irrigation of bed must be there. Germinated seeds may be transplanted in polybags with clay, manure, and sand in equal ratio.

9.4 Propagation method

The propagation of the Arjuna can be done through the seeds. When we store seeds in a sealed tin, they can be viable for a year. The fruit should be dried in the sunlight and can store the seed for 6-12 months. The seeds which are collected can be sown directly. Before sowing, they should be pre-treated by soaking them in water for 2 days. Alternatively, the seeds may be soaked in boiling water and allowed to cool. Then the seeds should be kept in polythene bag, the depth of pits should be about 1 inch. After 8-9 months seedling can be transplanted to the main field.

9.5 Manure and fertilization

At the time of the plantation we need to supply farmyard manure to the soil. We need to supply 5 kg of farmyard manure. This plant doesn't require any heavy fertilizers.

9.6 Irrigation

The irrigation is one of the most important requirements for the germination, growth and also the development of seeds, seedlings and plants. During the summer, regular irrigation should be given. As per requirement, the seasonal irrigation plan should be arranged round the year. In the extreme hot month we should irrigate the plants in early morning and also in late evening hours.

9.7 Harvesting techniques

The harvesting should be done in the month of April-May as it will be dry season. The thick barks should be cut. The outer layer of the bark should be removed for the use, the middle and the inner layers should be left over for regeneration. If we leave the bark in equal portion then that can be harvested next year or next time.

9.8 Post harvesting

9.8.1 Drying

The bark of fully grown tree, which is collected should be cut into pieces. Then the bark should be dried under in a shaded region.

9.8.2 Packing

The ideal packing material for the Arjuna is airtight bags. These should be packed in poly or nylon bags to prevent them from moisture and also preventing the herb from getting into the moisture.

9.8.3 Storage

This harvested and dried material can be sorted for 6-12 months, cold storage is not preferred for storing the Arjuna.

9.9 Cost benefit ratio analysis

9.9.1 Assumptions in arjuna cultivation

Material (Fixed charges)	**Investment in Rs**
Fencing charges	10,000.00
Land preparation	1000.00
Pit preparation	1000.00
Cost of fertilizers and manure	1500.00
Plant material cost	1500.00
Planting and irrigation	2000.00
Total Investment	**17,000.00**

9.9.2 Arjuna production cost during the gestation period

Material	**Investment in Rs**
Human Labour	10000.00
Manure and fertilizers	1500.00
Irrigation charges	2000.00
Plant protection chemicals	3000.00
Total	**16,500.00**

9.9.3 Cost of arjuna production during fruiting years

Material and Labour	**Investment in Rs per year**
Human labour charges	12000.00
Manure and fertilizers	1500.00
Irrigation	1500.00
Plan protection charges	2500.00
Other miscellaneous charges	6000.00
Total	**23,500.00**

9.9.4 Total Investment for farming is:

The total yield from the farm is (500 kg) approximately

The total cost of each kg of *T. arjuna* bark is Rs. 75/kg.

Total income from the farm is: total yield x cost per each unit (20x25x75) = Rs 37,500.00/-

Cost benefit ratio = Total cost/Earning total benefits=57,000/37,500=1.52

10. *Asparagus recemosus*

The Shatavari is one of the popular herbs which are used in Ayurvedic medicines. Shatavari belongs to Asparagaceae family, commonly found in the Himalayas, India, Nepal, Africa, China and Sri Lanka. The Shatavari is popularly grown in Indian states like Arunachal Pradesh, Delhi, Assam, Chhattisgarh, Gujarat, Kerala, Punjab, Himachal Pradesh, Haryana,

and Jharkhand. In India, more than 500 tonnes are used and also are needed for the preparation of Ayurvedic medicines. Not only in Ayurvedic medicines also used in homeopathy and also in Siddha medicines. This Shatavari is also named asshatmuli, satavari, satawar, satavari, shatavali,

Table: Features of Shatavari

Common name	Shatavari
Botanical name	*Asparagus recemosus*
Parts used	Tubers and leaves
Soil	sandy-loam to clay-loam soil
pH	6-8

10.1 Soil and climate requirements

The plant mainly prefers annual average rainfall of 600-1000 mm or less. A well-drained fertile sandy-loam to clay-loam soil, with a pH of 6-8 is best suited for its cultivation with staking support. Shatavari can be grown in open land as well as under shade, but very high moisture levels result in rotting of root.

10.2 Land preparation

Before planting the grafted plants or planting the seedling prepare the land, remove the weeds and unwanted material from area under cultivations etc. Then land should be ploughed as the soil attains fine tilth and smooth texture. After the ploughing process gets completed the tailoring and levelling should be done. After this the land should be supplemented with farmyard manure. For planting the plant 40-45 cm broad ridges should be prepared and the levelling of 15-20 cm furrow spaces should be left for the channels of irrigation. Each seed should be 5 cm away from each other.

10.3 Propagation method

The propagation of Shatavari is done by using the seeds or by using the vegetative propagation.

10.3.1 Seed Propagation

The beds of 5 cm are raised in April then the seeds should be sown in the beds which are raised and should be facilitated with the decay of its hard coat by the time of monsoon. After the first irrigation, given to plant the germination starts and it takes 8-10 days for the germination. This course should be done in the month of June. On the edges the seedling should be transplanted at a distance of 60 cm x 60 cm and for the support of the plants need to provide the plants with bamboo etc. stakes at a height of 45 cm. Before planting, seeds should be treated by cow urine for 24 hours for higher germination.

10.3.2. Vegetative Propagation

The propagation of the plants can be done by taking the base and also the upper part of

the mature plant. After some days the grafted plant root produces 2-3 tuberous roots. After transplanting, the sprouting commences in 8-10 days of planting.

10.4 Manure and Fertilization

At the time of plant we need to use the farmyard manure, which is well decomposed. For an acre of land 52 kg of Urea and 200 kg of Super Sulphur Phosphate and also 66 kg of Muriate of Potash should be needed. The nutrient must for an acre of land is Nitrogen @ 24 kg, Phosphorus @ 32 kg and Potash@ 40 kg. Bio pesticides to prevent the soil from borne diseases like Dhatura, Cow's urine and Chitrakmool can also be used.

10.5 Irrigation methods

The requirement of the water for this plant is very low, as it can also survive without irrigation. Annual rainfall, required for the Shatavari plant is 800-1200 mm of well distributed rainfall. The first irrigation is given at the time of plantation and second at the time of seedling establishment. During winter, the irrigation can be given for every 30 days interval.

10.6 Intercultural methods

Weeding: The weeding should be done regularly or else these weeds will cause pests or diseases to the plant. The weeding can also be done manually or by using the chemicals like weedicides or herbicides. The unwanted materials like stems, leaves and dead twigs can be removed.

10.7 Harvesting techniques

After transplanting them from the nursery to the main field, it takes 20-30 months for the roots to get mature also depends on the soil and climatic conditions as they will be matured within 12-14 months. The harvesting is done in the month of March-May. The harvesting can be done by using the Kudali. For the preparation of formulations we need to take the fully ripen seeds.

10.8 Post harvesting techniques

10.8.1 Peeling

After harvesting the Shatavari, should be peeled in boiling conditions. Once, after they are peeled should be left in the air as they will dry. Should be dried in a temperature at 40˚C. The grading is done as per the colour and quantity. Then they should be packed in airtight bags/containers for storage and also for the transportation purposes.

10.9 Yield of Shatavari

- The roots come to maturity in about 20-24 months after planting.
- The average yield is reported to about 1500 kg dry roots after 24 months from one acre.

10.10 Cost benefit ratio analysis

10.10.1 Assumptions in *Asparagus recemosus* cultivation

Material (Fixed charges)	**Investment in Rs**
Fencing charges	15,000.00
Land preparation	2500.00
Pit preparation	3000.00
Cost of fertilizers and manure	1500.00
Plant material cost	1200.00
Planting and irrigation	2500.00
Total Investment	**25,700.00**

10.10.2 Shatavari production cost during the gestation period

Material	**Investment in Rs**
Human Labour	14000.00
Manure and fertilizers	2500.00
Irrigation charges	3000.00
Plant protection chemicals	2500.00
Total	**22,000.00**

10.10.3 Cost of Shatavari production during fruiting years

Material and Labour	**Investment in Rs per year**
Human labour charges	14000.00
Manure and fertilizers	3000.00
Irrigation	2000.00
Plan protection charges	3500.00
Other miscellaneous charges	7500.00
Total	**30,000.00**

10.10.4 Total Investment for farming is:

The total yield from the farm is (10,000 kg) approximately

The total cost of each kg of Shatavari roots is Rs per kg.

Total income from the farm is: total yield x cost per each unit (25x50x60) = Rs 75,000.00/-

10.10.5 Cost benefit ratio = Total cost/Earning total benefits=77,700/75,000=1.036 of total investment.

11. *Azadirachta indica*

Azadirachta indica is well known in India and its neighbouring countries as one of the most versatile medicinal plants having a wide spectrum of biological activity. *Azadirachta indica* (Neem) find extensive use in Ayurveda, Unani and Homeopathic medicine. Neem is a member of the Mahogany family and its leaves are used for the treatment for the various diseases. Recently it is reported as anti-cancer and used for hypolipidemic effects. For thousands of years, the beneficial properties of neem have been recognized in the Indian tradition.

Table: Features of Neem tree

Common name	Neem
Botanical name	*Azadirachta indica*
Parts used	Leaves,bark and seed
Soil	clayey, saline and alkaline soils, black cotton soil
pH	8.5

11.1 Soil and climate requirement

Neem trees flourishes well in all regions having average annual rainfall of 350 mm to 1200 mm. Neem tree can tolerate high temperatures even up to 50 to 52°C. Neem trees grow well in wide range of soils. However, black cotton soils are best for growing these trees. Neem can be grown in even in rocky soils where water availability is a major problem. Neem trees increase the soil fertility and helps in neutralising acidity in the soil.

11.2 Propagation

Propagation can be done by seeds. However, propagation with root cuttings is also possible.

11.3 Land preparation, planting, and spacing

Land/main field should be ploughed couple of times to remove any weeds and required pits should be dug. Neem seedlings can be raised on nursery beds and transplanted to field or can be sown directly in the field. For seed collection and planting, use fruits at the yellow green colour stage. Collected fruits should be depulped immediately. Germination of seeds depends on the storage. The chances of germination would be about 90% for fresh seeds. Neem seedlings should be transplanted when they are 8 to 10 cm tall with a tap root of 15 cm long. Neem seedlings 25-30 cm height should be transplanted (beginning of the rainy season) in pits of 30 cubic centimetres at a distance of 3 m x 3 m.

11.4 Irrigation

Neem trees require or survive with little water. However, the plant needs plenty of sunlight and sensitive to frost and extreme shade conditions. Avoid water logging conditions and poorly drained soils.

11.5 Manures and fertilizers in Neem cultivation

VAM fertilizer application of 50 g, 20 g of *Azhospirillum* and *Phospobacteria* should be applied on regular basis.

11.6 Intercultural Operations

Weed free filed always required for any cultivation. In case of Neem cultivation, normally 2 to 3 weeding should be carried out during the first year and one weeding during the

second year. Thinning should be done in case of transplanted seedlings in the field at the age of 4 to 5 years.

11.7 Harvesting

Neem tree starts bearing fruits after 4 to 5 years and comes to full bearing at the age of 10-11 years. The leaves and fruits can be manually harvested and should be dried in shade and after proper drying the material should be packed in air tight containers to ensure protection from moisture.

11.8 Yield in Neem

The yield depends on many factors such as tree age, cultivation practices, variety and climatic conditions. On an average one can obtain about 10-25 kg of seeds per tree during initial years. Once the trees attain maturity, yield will be increased to 35- 50 kg per tree.

11.9 Cost benefit ratio analysis

11.9.1 Assumptions in neem cultivation

Material (Fixed charges)	**Investment in Rs**
Fencing charges	12,000.00
Land preparation	3000.00
Pit preparation	3500.00
Cost of fertilizers and manure	2500.00
Plant material cost	1400.00
Planting and irrigation	3000.00
Total Investment	**21,900.00**

11.9.2 Neem production cost during the gestation period

Material	**Investment in Rs**
Human Labour	12000.00
Manure and fertilizers	3000.00
Irrigation charges	3500.00
Plant protection chemicals	4000.00
Total	**22,500.00**

11.9.3 Cost of neem production during fruiting years

Material and Labour	**Investment in Rs per year**
Human labour charges	15000.00
Manure and fertilizers	3000.00
Irrigation	2000.00
Plan protection charges	3500.00
Other miscellaneous charges	5500.00
Total	**29,000.00**

11.9.4 Total Investment for farming is:

The total yield from the farm is (900 kg) approximately

The total cost of each kg of neen seed/leaves/bark is Rs. 65/kg.

Total income from the farm is: total yield x cost per each unit (30x30x65) = Rs 58,500.00/-

11.9.5 Cost benefit ratio = Total cost/Earning total benefits=73,400/58,500=1.25

12. Common conservation strategy for each selected prioritized species

Low income group people who are directly/indirectly engaged in the medicinal and aromatic plants domestication, cultivation and commercial production will be selected. Cultivation practice seems to be replaced the collection from wild by the local people for different purposes particularly in home. Nurseries for medicinal and aromatic plants should be developed i.e. Amla, citrus, harar, tulsi, arjuna, shatavari, giloy and neem through participatory approach for capacity building, demonstration and dissemination, germplasm conservation and seedlings distribution to the farmers. Promoting medicinal and aromatic plant species for cultivation is one of the feasible options for livelihood improvement of agricultural communities and conservation of these species in their natural habitat. A network of natural sites plays an important role for conservation and sustainable harvesting of MAPs by the farming communities. The management practice aims to mainstream conservation and sustainable use of MAPs by upgrading the capacity of the farmers. Sustainable cultivation practices can take place as enrichment planting under natural conditions. Strategies for Medicinal plant production following a sustainable program are growing specific species at small-scale in home gardens, growing specific species at small scale by herbalist (to cover locally demand) and cultivation by local people.

12.1 In-situ conservation

The establishment of certain areas for conservation of biological diversity helps in sustainability of the medicinal plant species growing in such protected areas are conserved in their natural habitats. These are the areas, which function as the resort of such valuable plant resources. The anthropogenic pressures, mainly in the form of human induced land use change and overexploitation of medicinal plants for commercial gains, have the largest effects on medicinal plants survival in the natural habitats including biodiversity. Therefore to minimize the impact of these disturbances, the idea of setting protected areas network has been brought. The need of conservation as well as the utilization of bio-resources the legal status of protected areas varies with national parks, sanctuaries, reserve forests and biosphere reserves. The legal provisions that do not allow harvesting medicinal plants from the national parks and also regulating their harvest from the sanctuaries mainly help in conservation of these important species. The Himalayan region have claimed that the population of medicinal plants was higher in the protected areas compared to the adjacent unprotected areas.

12.3 Natural reserves

The destruction of habitats is a major cause of the loss of important medicinal plant

resources. Natural assets are protected areas of important wild resources created to preserve and restore biodiversity. Around the world, more than 12,700 protected areas have been established, accounting for 13.2 million km^2, 8.81 % of the earth land surface. Conserving medicinal plants by protecting key natural habitats needs evaluating the contributions and ecosystem functions of individual habitats.

12.4 Wild nurseries

Wild nurseries are established for species-oriented cultivating and controlling of endangered medicinal plants in a protected area, natural habitat, place that is only a short distance from where the plants naturally grow. Although the populations of many wild species are under heavy pressure due to overexploitation, habitat degradation and invasive species. Wild nurseries can provide an effective approach for in situ conservation of medicinal plants that are endemic, endangered.

12.5 Ex situ conservation

The aim of ex situ conservation is to cultivate and naturalize threatened species to ensure their continued survival and sometimes to produce large quantities of plant material used in the creation of drugs, and it is often an immediate action taken to sustain medicinal plant resources. Many species of wild medicinal plants can not only retain high potency when grown in gardens far away from the habitats where they naturally occur, but can have their reproductive materials selected and stored in seed banks for upcoming replanting. Botanic gardens can play a role in medicinal plant conservation through the development of propagation and cultivation protocols and programs of domestication and variety breeding. Seed banks can also offer a better way of storing the genetic diversity of wild medicinal plants and help preserve the biological and genetic diversity of wild plant species.

12.6 Plantation/enrichment in the forest area

Enrichment planting is commonly used technique for increasing the density of desired tree species in secondary forests often characterized by occurrence of low commercial species. The enrichment planting trial was arranged in a randomized block design with replications. Survival, height and diameter were measured after planting and subjected to analysis of variance). Though, diameter and height growth was favoured more in gaps than in planting lines related to rapid canopy closure in both gaps and lines. Significant inter-species variation was detected for survival rate, height and diameter.

13. Sustainable harvesting of medicinal and aromatic plants

Non Timber Forest Products (NTFPs) particularly those of medicinal value, are among major produces contributing to the economic development. NTFPs play a major role in

upliftment, enhancement of cultural life style and healthcare of tribal and rural population. There is an urgent need to frame strategies for appropriate management of NTFPs growing under widely varying habitat conditions in the country or state to meet the local needs while maintaining the biodiversity. Sustainable harvesting can improve the livelihoods of people by ensuring continued supply of biomass and through supplementary income and employment. All this can be organised with active involvement of the local people with the cooperation of all relevant stakeholders of the sector. Developing sustainable harvest methodologies, such as local knowledge, tenure rights, empowerment to local institution, institutional capacity, political system affecting the equity and resource access, market policy, trade linkages, etc. need to be taken care through a well-developed and operationalized adaptive management strategy.

Good collection practice or sustainable collection practice pertains to the protocols of collection of NTFPs or wild resources from the forest area while maintaining the regenerative capacity of wild populations of the species and its associates. Applying sustainable collection practices in the wild is significant in conserving the resource and also in fulfilling the needs of forest dependents communities and other stakeholders who directly or indirectly benefit from collection of NTFPs/ medicinal plants.

14. Post-harvest management

The minimization of loss of NTFPs produce remains the vital goal of post-harvest management strategies. The post-harvest management has attained the central stage in the present situation of increasing population and shrinking of forest cover and other resources. Presently, the main global challenge is to utilise the natural resources in a sustainable manner safe to mankind and environment. Hence, there is need for understanding the ecosystem functions. The production of NTFPs have increased manifold during the recent years, but the development and adoption of post- harvest technology is lacking and resulting in huge post-harvest losses. The value chain in post-harvest management of medicinal and aromatic plants mainly comprise of pre-harvest factors, harvesting, market preparation, transportation, storage, value addition/processing and by-product waste management.

14.1 Marketing and retailing

Marketing is the last operation of post-harvest system. Although, produce can be marketed at different points in the market chain particularly from the growing place (orchard), stores, wholesale markets and retail markets. Excessive delays in marketing at wholesale markets during gluts lead to losses in quantity as well as quality. Thus, the duration between harvesting, storage and marketing should be as short as possible.

15. Socio-Economic Development

The Himalayan region occupies a vital place in the mountain biological systems of the world and as a supplier of life but they also harbour a rich variety of flora, fauna, human communities and cultural diversity. There is need to develop new model to restore balance between economic attentiveness and ecological imperatives with regards to sociocultural developments. For the socio-Economic development following advances should be taken.

- The organic farming is a basic approach for production of medicinal plants. Organic farming methods are based on natural production principle. Organically produced medicinal herbs are believed to love in harmony with the natural system by cooperating rather than competing.
- Most of the medicinal plants are collected from the wild but some of these are also grown particularly by small farmers to diversify their cropping system and to earn some additional income for their substance.
- The local people should be trained for collection, cultivation, processing, and marketing of medicinal plants.
- The Govt. should provide linkage of collector with market and dealers.

16. Strategies for conservation, resource development and sustainable management of NTFPs

- 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 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 to promote the agriculture/horticulture practices among villagers.
- Small scale green industries/processing units 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, tulsi, harar 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 to plant 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.

17. Conclusion

This report emphasized that both conservation strategies (in situ and ex situ conservation and cultivation practices) and resource management (e.g. sustainable use solutions) should be adequately taken into account for the sustainable use of medicinal plant resources. Additionally, breeding improvements can be carried out using molecular marker-based approaches applied at the genetic level, and the time required for breeding may be significantly shortened. Several information regarding many NTFPs including crops, fodder, fruits, vegetables, medicinal and aromatic plants as well as weeds have been recorded. 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 panchayats of this cluster 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, invasive plants, poor road connectivity, non-availability of good price and market facilities and lack of processing units for agricultural/horticulture and NTFPs produce are the major blockades for sustainable development of the villagers residing in the vicinity of forests.