CONSERVATION AND PROMOTION OF ENDANGERED MEDICINAL PLANT SPECIES FROM WESTERN GHATS OF INDIA

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BY

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EXECUTIVE SUMMARY

Biological resources are viewed as 'resource capital' of a nation. Among the 34 global biodiversity hot spots, Western Ghats of India occupies the fifth position according to the economic potential of its biological resources. It is also one of the highly endemic areas of the world and houses over 4000 plant species that have medicinal uses. Of the 960 traded medicinal plant species from India, 178 species are consumed in volumes exceeding 100 Metric Tonnes per year, with their consolidated consumption accounting for about 80% of the total industrial demand of all botanicals in the country (Ved and Goreya, 1997). India with a rich repository of medicinal plant species (1/4th of the world) meets health care needs of more than 80 % of the population of this country (Ravikumar and Ved, 2000).

Several plant species that are threatened and endemic to Western Ghats, are becoming globally important as they yield high value metabolites such as Embelin (from *Embelia ribes, E. basaal* - used against diabetes), Camptothecin (from *Nothapodytes nimmoniana* – used against cancer) to name a few . Overexploitation of such resources is leading to over harvests, threatening global health care and local livelihoods. Unsustainable harvesting in large volumes by forest contractors through local tribal peoples was found to be one of the reasons for the depletion of genetic resources. Though reducing harvest pressure on wild population and promoting viable commercial cultivation with the community and government participation is a good option, it offers a huge challenge. With this background present study ***focuses on mass propagation, conservation and promotion of selected plant species that are 'red listed' and in high demand (trade > 100 tonnes/yr) was initiated.*** Project activities were conducted at **two main centers**. RANWA (Pune) lead the overall project with cultivation and promotional studies whereas College of Forestry (Sirsi) assisted in standardizing and developing mass multiplication protocols.

12 threatened medicinal plant species were **'prioritized'** for further studies. Short listing was done using (i) threat status (ii) trade potential / utility value (iii) harvest method and (iv) endemic status.

Key achievements:

(a) Development of propagation techniques of RET species - A standard protocol for mass multiplication of these short-listed species was developed through experimentation and interaction with experts and local knowledgeable individuals (Table 3 and 4).

(b) Successful 'reintroduction' of a rarest species in the wild - *C. strictum* (*Raldhoop* or Black dammer) is presently known from only three locations from entire northern Western Ghats of Maharashtra with serious population bottle-neck as we recorded only 14 reproductive / mature individuals. Predation of fruits and seeds and very low germination success further complicates its revival. To revive the severely depleted population, saplings (n=20) of black dammer were **successfully reintroduced** in the wild (*'Amba' Ghat r*eserve forest - 16° 56' 22.4 N and 73° 47' 47.4'' E) with the help of State Forest Department's participation. All the saplings were exhibiting good growth and 100% survival after one year of reintroduction (Refer section 3.2).

(c) Cultivation of RET species - A nursery of Medicinal Plants has been raised with the help of local people. Pilot-scale plantation plots of *N. nimmoniana* (EN), *S. asoca* (EN), *E. basaal* (VU) and *S. chinensis* were established on farmlands in different agro-climatic zones with the help of farmers and Self Help Groups. (Refer section 4.6)

(d) Linking commerce with conservation – (i) Local people were involved in data collection. They were trained in the development of *'nursery techniques'* and *'monitoring'* of cultivation plots and were rewarded for the same. Local farmers could generate ***'revolving funds'*** through sell of saplings worth 200 GBP. (ii) Support was given to 10 farmers/ families in terms of supply of nursery material manure etc. **Thus peoples' participation ensured incentive and benefit based conservation.**

(e) Capacity building – (i) Forest guards and community personnel were given training about monitoring of various growth parameters such as measurement of collar diameter, no. of flushes and height measurements etc. (ii) Two Masters' dissertations were submitted to University of Pune as a partial fulfillment of the Masters' in Biodiversity degree. (iii) During the project period, 10 student volunteers were imparted hands-on training in various aspects of field level studies.

(f) Outreach – (i) A farmer's seedling distribution '*mela*' (event) was organized at Sirsi center where farmers were given more than 500 saplings of various RET species for cultivation. Till date about 2000 saplings was distributed to 35 farmers and individual cultivators. (ii) A series of talks and presentations were given in workshops related to 'Prospects and Challenges in Medicinal Plant Cultivation'. Awareness generation sessions were conducted in 5 different schools (iii) About 10 articles were published in various local media and magazines dedicated to Medicinal Plants.

Stakeholder interest :

Maharashtra State Forest Department (SFD) and Maharashtra State Horticultural and Medicinal Plant Board (MSHMPB) exhibited keen interest in availing and utilizing the findings of the study.

Looking ahead...

We intend to publicize the results as a 'Methodology Manual' (especially regarding development of nursery techniques), as a post-project activity. The inputs will be given to State Medicinal Plant Board (SMPB), SFD, Academicians and farmers alike, besides contributing articles in local media, Agro-daily etc.

Making available ***Quality Planting Material*** **(QPM)** of ***'red listed'*** species is a big challenge. Besides, developing **'package of practices'** (collection, cultivation, agronomy etc.), evolving **'sustainable harvest strategies'** will form the future action plan. Efforts are needed to explore promotion of these species under various Government Schemes say **'contractual farming schemes'** where community / farmers are involved. Linkages with the industry need to be explored for '**scale-up**' of plantation of these species so that supply of good quality raw material can be assured and possibility of buyback can be explored.

OPENING REMARKS….

Present study looks into the conservation and promotion strategy road map of ***'red listed' medicinal plant*** species that are in high demand for their pharmaceutical properties. Various aspects of domestication such as mass propagation of species, experimental plantation plots, and their growth in different agro-climatic zones are tackled and discussed in the present work.

The present work is divided into following sections; (1) Introduction (2) Materials and Methods (3) Conservation initiatives (4) Promotion strategy and (5) Discussion and looking ahead. Section 1 briefly documents current status of short listed species with notes on its trade potential. Section 2 deals with descriptions of study sites and gives standard protocol for mass propagation. Efforts pertaining to conservation of species such as 'nursery development', 'reintroduction' etc. is dealt in Section 3. Section 4 gives an account of various steps in domestication of species such as awareness generation, training to local community and farmers regarding multiplication of the species, field trials and interaction with stakeholders like State Forest Department (SFD), State Medicinal Plant Board (SMPB) etc. Follow up of the activities and impact / highlights of the current study are dealt in the discussion section (Section 5).

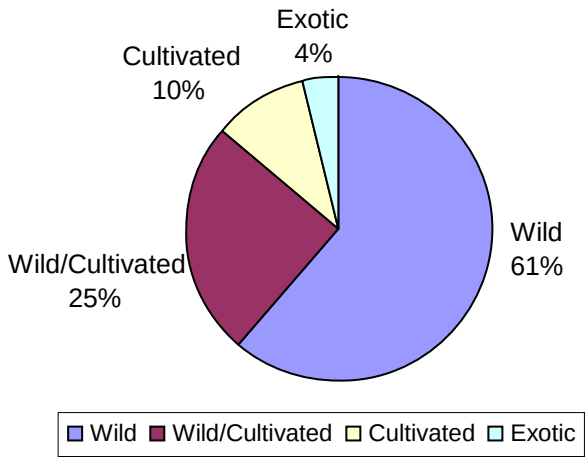
SECTION - 1

INTRODUCTION

1.1 Background :

Western Ghats, one of the global biodiversity hot-spots, supports an array of tropical forest types ranging from wet evergreen to scrub formations, harbors tropical humid forests, known to be amongst the most diverse, most productive and most threatened biological communities of the World (Daniels *et.al*., 1995). It is also one of the highly endemic areas of the world and houses over 4000 plant species that have medicinal uses. There is 50% population decline of medicinal plants in RET (Rare, Endangered and Threatened) category in the last decade from Western Ghats in particular. Modern medicine is exploiting some of these resources as major raw material and that has threatened traditional health care practices. This has led to their indiscriminate harvest from the wild and hence their very existence is under severe threat. It would be apt to mention here that till date bulk supply of Medicinal and Aromatic Plants (MAPs) is still dominated by produce of forest origin rather than farm origin (Fig. 1). Systematic cultivation is in nascent stages and rough estimates on the basis of existing market information indicate that not more than 10 per cent of the current demand is met by farm produce. Lack of availability of Qality Planting Material (QPM: seeds and seedling) is one of the major constraints for non availability of assured supply of raw material. The primary reason for this is, for majority of the medicinal species propagation techniques are not known and standardized. Destructive and premature harvesting further complicates the conservation of these species.

Figure 1. Share of Wild collected and Cultivated origin of MAPs in trade



The northern ranges of the Western Ghats, referred as northern Western Ghats (NWG), lie in the Maharashtra State make about one third of the total length of Western Ghats. Forests in this region are generally stunted, species poor and are fragmented as compared to the southern parts of Western Ghats. Especially in NWG, rapid industrialization has had serious impact on this biodiversity. Many species have become endangered as a result of road and

building construction on agricultural and forest land. Besides, more than half of the natural habitat from NWG has now been cleared (WWF, 2007). As a result, highly fragmented, scattered natural populations of species (such as *Nothapodytes nimmoniana, Saraca asoca, Symplocos racemosa, Embelia ribes, Dysoxylum binectariferum etc*.) exist in remnant forest patches or informally protected forest landscapes such as 'sacred groves'). However, because of their high industrial demand collections from wild populations are continuing. The population is declining due to harvest of a part (bark) that damages the plant and immature harvest time. Further, constraints to reproduction have resulted in poor natural regeneration, threatening the very survival of the species. Thus, developing mass propagation techniques and inducting these species into agro-forestry systems can reduce the harvest pressure on the wild population, allowing them to naturally regenerate.

1.2 Objectives :

1. To develop mass multiplication protocols of selected 'red listed' medicinal plant species that are in high demand
2. To involve local people in conservation and train those in raising quality planting stock enumerate threatened medicinal plant resources, their population levels and structure.
3. To promote cultivation of selected 'red listed' species in existing farming systems to prepare thematic maps (richness, density and geographic distribution) of prioritized threatened (RET) medicinal species of immediate conservation concern using GIS-RS technique.
4. To carry out enrichment planting of selected species in the areas where the population is depleting

1.3 Geographical focus of the study :

The patches of semi-evergreen forests in the northern Western Ghats of Pune, Satara and Kolhapur Districts form the focus of research and conservation action.

1.4 Prioritization of species :

Species has been selected on the basis of extensive literature review and interaction with academicians, researchers, traders, and State Medicinal Plant Board and State Forest Department. Following criteria were used for species prioritization. Table 1 gives detailed

account of the species of interest, whereas table 2 gives research / conservation recommendations as per CAMP (2001).

(i) Threat status : IUCN red data lists (2007), CAMP for Maharashtra (Conservation Assessment and Management Plan, 2001), FRLHT threat list (Foundation for Revitalization of Local Health Traditions), ADMA (Ayurvedic Drug Manufacturers Association) priority list of plants were referred to identify species for study as well as conservation priority.

(ii) Harvesting practice : Different parts of plants like leaves, fruits, root bark, stem bark, seeds are used for medicinal purpose. Root bark and stem bark are harvested in case of *Oroxylum indicum* (*Tetu*) and *Symplocos racemosa* (Lodhra) respectively. Such species with destructive harvest techniques will have high conservation value.

(iii) Trade potential : Species like *Nothapodytes nimmoniana* (Narkya) and *Saraca asoca* (Sita ashok) possess high trade potential and their demand in the local market is in the tune of > 100 tonnes/yr. Such species are in short supply and will thus bear higher conservation significance.

(iv) Endemic status : Endemic status if any was assigned to species as per Ramesh and Pascal (1997).

Table1. Short listed species

[#] *As per CAMP* (2001) and IUCN RED List (2007) , [¶] *Reported trade as per ADMA* (Tonnes /Year)

Sr. No	Species	Local Name	Habit	Threat Status [#]	Part used	Uses / Properties	Harvest Method	Trade [¶]
1	*Cannarium strictum*	Raldhup	Tree	VU	Wood	Against rheumatism, Anti-pyretic, chronic skin diseases	Harvest of wood	>100
2	*Dysoxylum binectariferum*	-	Tree	DD	Bark	Anti-inflammatory, Anticancerous	Harvest of bark	-
3	*Embelia basaal*	Vavding	Shrub	VU	Fruit	Seeds used as adulterant with *E. ribes*	Harvest of Fruit	>10
4	*Embelia ribes*	Vavding	Climber	DD	Entire plant	Anti-helminthic, Anti-diabetic Contraceptive, Skin diseases, Antibacterial	Harvest of entire plant	> 20
5	*Mammea suriga*	Surangi	Tree	VU	Seed, Flower bud	Against leprosy, eczema and other skin diseases.	Oil extracted from seed	-
6	*Nothapodytes nimmoniana*	Narakya	Tree	EN	Bark, Seeds, Roots	Anticancerous activity	CPT extracted from roots, bark	> 500 (source : SFD)
7	*Oroxylum indicum*	Tetu	Small Tree	VU	Entire plant	Stomach disorders, Anti-mutagenicity	Whole tree is cut	> 6.5
8	*Pterocarpus marsupium*	Bija, Bivla	Tree	VU	Root, stems	Anti-diabetic, Anti-pyretic	Root, stems	> 6.5
9	*Rubia cordifolia*	Manjistha	Climber	VU	Roots, shoots	Skin diseases, Anti-diabetic, Rheumatoid arthritis, Gastro-intestinal disorders	Roots, shoots	
10	*Salacia chinensis*	Saptarangi	Straggler	VU	Fruit, Roots	Normalizing menstruation and invigorating circulation	Harvest of Fruit and roots	-
11	*Saraca asoca*	Sita ashok	Tree	EN	Bark, Flower	Astringent in gynecological problems.	Harvest of Bark, Flowers	> 170
12	*Symplocos racemosa*	Lodhra	Tree	VU	Bark	Against fever	Removal of bark	> 20

Table 2. Species recommendations as per CAMP (2001) & other relevant literature

Species	Research / Management recommendations	Planting need
Canarium strictum	Cultivation	Conservation and production in and ex-situ, Cultivation difficult
Dysoxylum binectariferum	Cultivation	Conservation and production *in* and *ex-situ*
Embelia basaal	Monitoring; Taxonomic studies required to determine the status of the species	Conservation and production *in* and *ex-sit*u
Embelia ribes	Taxonomic studies required to determine the status of the species	Conservation and production *in* and *ex-situ*, Cultivation difficult
Mammea suriga	Development of nursery techniques	Conservation and production *in* and *ex-situ*
Nothapodytes nimmoniana	Non destructive harvesting, suitability for different agro-climatic zones for integration into Agro-forestry systems	Conservation and production *in* and *ex-situ*
Oroxylum indicum	Cultivation	Conservation and production *in* and *ex-situ*
Pterocarpus marsupium	Habitat management, Cultivation related studies	Conservation and production *in-situ*
Rubia cordifolia	Development of nursery techniques	Conservation and production *in* and *ex-situ*. Cultivation difficult
Salacia chinensis	Cultivation	Conservation and production *in* and *ex-situ*
Saraca asoca	Prioritized for cultivation	Conservation and production *in* and *ex-situ*
Symplocos racemosa	Development of nursery techniques	Conservation and production *in* and *ex-situ*

SECTION - 2

MATERIALS AND METHODS

MATERIALS AND METHODS

2.1 Northern Western Ghats :

The northern ranges of the Western Ghats, popularly known as *Sahyadri* (15º 30'- 20º 30' N Latitude, 73º-74º E Longitude), lie in the Maharashtra state. This zone represents gradual merger of WGs humid biota with dry zone biota widespread in rest of the country. The dry period length varies from 6-8 months. Precipitation is between 2140 mm – 5000 mm and mainly concentrated from June to September.

2.2 Propagation and pilot plantation studies :

Experimentation regarding nursery development was conducted at College of Forestry, Sirsi and at Jeur, a village situated in Purandar taluk. Experimental pilot plantation plots were established at Maval, Purandar and *'Velhe'* taluk of Pune district. Whereas Koyna WLS (Satara district) and *'Amba'* ghat reserve forest range (Kolhapur district) were chosen for assessment and reintroduction / recovery site respectively for *C. strictum.*

(i) Maval taluk (Fig. 3a) **:** Study area is situated towards north west of Pune in Maval taluk (18° 36'N, 73° 26' E) and is on the eastern slope of the Western Ghats at an elevation of about 700m above MSL. The average annual rainfall is approximately 4000 mm with 8-9 months of dry period length. The mean maximum temperature is 35°C and mean minimum temperature is 12°C. The forest type is mainly secondary moist deciduous with scrub patches in between.

(ii) Purandar taluk (Fig 3b) **:** Study site is located on the eastern side of Pune in Purandar taluk (18^0 25' N, 74^0 08' E) and the conditions are drier. Area mainly dominated by xerophytic plant species. The average annual rainfall is around 700 mm with 9-10 months of dry period length.

(iii) *'Velhe'* taluk (Fig. 3c) **:** Study site is located on the south western side of Pune in *'Velhe'* taluk (18° 17' 12.1'' N, 73° 33' 45.7'' E) at an elevation of about 750 m above MSL..and the conditions are moister. Area mainly dominated by moist deciduous forest species. The average annual rainfall is around 700 mm with 8-9 months of dry period length.

(iv) *'Amba'* ghat (Fig. 3d) **:** Study site is located along the Western Ghat crestline in Shahuwadi taluk (16° 56' 22.4'' N, 73° 47' 47.4'' E) at an elevation of about 709 m above MSL. Area supports tall semi evergreen, evergreen forest. The average annual rainfall is around more than 5000 mm with 7-8 months of dry period length.

Figure 3. Various study sites

(a) Maval taluk study site

(b) Purandar taluk study site

(c) Velhe taluk study site

(d) Amba study site

(e) Nursery at Purandar

(f) Nursery at Sirsi

2.3 Developing mass propagation protocols :

Developing nursery techniques play a vital role in conserving plants of threatened category. Raising seedlings from the plants with the poor germination capacity is the most vital part of the nursery techniques. Plants like *Oroxylum indicum*, *Rubia cordifolia, Dysoxylum binectariferum* and *Symplocos racemosa* are some of the threatened plants with poor regeneration capacity. This might be because of several natural factors. Studies were conducted to standardize the nursery techniques for prioritized species using following format. For selected species, information /data was being generated on following lines.

1. **Seed Collection and handling**
    - Seed collection
    - Time of collection
    - Seed grading
    - Seed storage
2. **Seed Germination**
    - Pre-Sowing seed treatment
    - Seed bed preparation
    - Sowing
    - Watering
3. **Transplanting to Nursery bags**
    - Potting Mixture preparation
    - Transplanting
    - Plant Protection
4. **Development in the nursery**
    - Nursery area
    - Land leveling
    - Providing Shade to the developing seedlings
5. **Seedling/ Sapling Growth and Nutrient Management**
    - Changing poly bags
    - Supply of nutrients
6. **Transplanting to the Field**
    - Area selection
    - Spacing
    - Land preparation
    - Field planting

2.4 Monitoring of growth parameters :

The parameters measured were,

1) Collar diameter
2) Shoot length
3) No. of flushes
4) % survival

The measurements were taken at every three months interval for ‘experimental plantation plots’ and ‘reintroduced’ saplings in the wild alike. Collar diameter was measured with digital Vernier Calliper (Company – Baker Gauges India Pvt. Ltd.)

SECTION - 3

CONSERVATION INITIATIVES

3.1 Seed collection and handling :

Seeds of short-listed prioritized species were collected from above mentioned sites in addition to Gaganbavda, Amboli, Rajmachi, Koyna, Raigad and Mulshi areas from NWG. Collection was primarily being done during summer months (Feb-May) and pre-monsoon season. Seeds were both handpicked directly from the plant and collected from the forest floor (Box 1). Handpicked seeds had an added advantage of avoiding fungal contamination and predation by ants and other insects if any when fallen on ground. This was mainly observed in *Symplocos racemosa*. *Saraca asoca* pods were mainly predated by monkeys and hence the seed set was very low in natural population, thereby hampering regeneration. In case of *Dysoxylum binectariferum* seeds sown without seed coat gave better results because seed coat was found to be predated by rats (perhaps because of the thick oil-rich seed coat). It is interesting to note here that seed coat removed seeds were not predated by them. Whenever required seeds were de-pulped immediately and either sun or shade dried. We also collected seedlings from the forest to avoid density dependent mortality. These seedlings were then transferred to 'root trainer' and then to polybags for further development.

Box 1. Seed and sapling collection

Handpicking seeds of *S. chinensis*

Predated seeds of *S. racemosa*

Collecting seedlings from forest floor

Sun drying of seeds

Table 3. Species for which pre-sowing treatment is required

Species	*Seed Collection and Handling*		Germination					Transplanting to Nursery bags		Seedling Growth and Nutrient Management	
	Time of Collection	***Seed storage***	**Pre Sowing treatment**	**Seed bed preparation**	**Sowing and Watering**	**Germination Period**	**Germination type**	**Potting Mixture preparation and Transplanting**	**Plant Protection**	**Changing poly bags**	**Supply of nutrients**
R. cordifolia	Jan-Mar	Seeds dried and stored.	Seeds soaked in water and kept in air tight container for 2 days.	Shallow earthen pot containing coir pith-sand and moss-sand.	Little amount of water sprinkled.	30-45 days	Epigeal	Polythene bags of size 5" X 7", containing soil, sand and vermi-compost (1:1:1) Support for climbing.	-	After 90 days of planting.	Supply of 2 gm DAP per seedling
E. basaal	Aug-Oct	Seeds dried and stored.	H_2SO_4 ½ an hour+ GA_3 400 ppm and Accelerated aging treatment	Raised beds of 6'' height made out of 1:1:0.5 ratios of soil, sand and fertilizer	Spacing of 0.5''to 1". Judicious watering till seed germinate	after 4 months	Epigeal	polythene bags of 6''x8'' size filled with Farm yard manure, sand and forest soil(1:1:0.5)	Requires shade in the initial stages. Plant support require	Immediately after germination if sown in polybags	Spray of Capton (0.05%)
S. racemosa	May-Aug	Seeds dried and stored.	Treatment with cow dung slurry and shade dried.	Raised bed of 6" height using soil, sand and fertilizer (1:1:0.5)	Sowing with a spacing of 4"from each other. Watering daily	After 90 days.	Hypogeal	-	Shade nets used to provide shade and to protect from heavy winds and light	After 45 days of planting.	Spray of Capton
E. ribes	Jun-Aug	Stored in the ordinary conditions	Mature fruits in poly covers, under artificial light for 8 hrs/day, for 4-5 days. Followed by number of treatments	6''sunken or raised above the ground level made out of coir pith and perlite.	Spacing of 5 cm. Lightly covered with soil. Watering 2 times daily for 15 days till proper germination	2-3 months	Epigeal	polythene bags of 6''x8'' size filled with Farm yard manure, sand and forest soil(1:1:0.5)	Requires shade in the initial stages. Plant support require	four months of planting	Spray of Capton (0.05%)

S. chinensis	Apr-May	Seeds dried and stored.	peel out the fruit, soak in water and take out the seeds	Sand bed with at least 6” thickness	spacing of 4”	21-30 days	Hypo-geal	polythene bags of 6’’x8’’ size filled with Farm yard manure, sand and forest soil(1:1:0.5)	Requires shade in the initial stages. Plant support require	four months of planting	Supply of 5 g DAP per seedling
P. marsupium	Mar-May	Seeds dried and stored.	soaked in cow dung slurry for 48 hrs	Sand bed with at least 6” thickness prepared in large tray	spacing of 4”, Watering daily	7 days	Epigeal	poly bags of 8”×12” size filled with 1:1:0.5 combination of soil: sand: Farm Yard Manure	shading is necessary	after four months of planting	Supply of 5 g DAP per seedling
M. suriga	early June	Recalcitrant seeds can be stored for less than 1 month	Alternate wetting and drying of seeds in cow dung slurry for three days	Sand bed with at least 6” thickness prepared in large tray	spacing of 4”, Watering daily	45 days	Hypo-geal	poly bags of 8”×12” size filled with 1:1:0.5 combination of soil: sand: Farm Yard Manure	shading is necessary	after four months of planting	2g of DAP or 2g of Poultry / Pig manure per seedling
C. strictum	Jan - Mar	Seeds dried and stored.	Removal of the hard coat of the seed	raised or sunken beds of 6” height using soil, sand and fertilizer (1:1:0.5)	Seeds sown with a spacing of 4”with little exposure of seed surface Watering daily	20 days	Hypo-geal	poly bags of 8”×12” size filled with 1:1:0.5 combination of soil: sand: Farm Yard Manure	shading is necessary	after four months of planting	Supply of 5 g DAP per seedling

Note - Seed grading was done based on the sturdiness

Table 4. Species for which pre-sowing treatment is NOT required

Species	Seed Collection and Handling			Germination				Transplanting to Nursery bags		Seedling Growth and Nutrient Management	
	Time of Collect-ion	Seed Grading	*Seed storage*	Seed bed preparation	Sowing and Watering	Germin-ation Period	Germi nation type	Potting Mixture preparation and Transplanting	Plant Protection	Changing poly bags	Supply of nutrient/s
O. indicum	Mar-Apr	Filled seeds; Against light, can easily separate the filled and unfilled seeds.	At normal room temperature.	Sand bed with at least 6" thickness in a large tray.	Direct sowing and watering (season)	10 days for radicle initiation.	Epi-geal	Soil: sand: Farm Yard Manure (2:1:1). Transplanting after emergence of radicle.	Seedlings susceptible to fungal infection. Drenching of Capton (0.05%) or spray with a fungicide	After 45 days of planting.	Supplies of 2 gm DAP per seedling.
D. binectarife rum	Dec.	based upon the sturdiness	Up to 30-45 days (55% germination)	In polythene bags of 5" X 7" size filled with soil and sand (1:1)	Direct sowing and daily watering	15 days	Epi-geal	1:1:1 soil: sand: Farm Yard Manure. Transplanting after emergence of radicle.	Drenching of Capton (0.05%) or spray with a fungicide.	After 45 days of planting.	Supply of 2 gm DAP per seedling
S. asoca	May-Jul	-	Recalcitrant seeds can be stored for less than 1 month.	raised or sunken beds of 6" height using soil, sand and fertilizer in the ratio 1:1:0.5	Spacing of 4". Seeds placed over beds little exposure of surface. Watering daily.	30-35 days	Hypo-geal	Polythene bags of 8"×12" size. Potting mixture of soil, sand and fertilizer 1:1:0.5.	Shade nets to provide shade and to protect from heavy winds and light.	four months of planting	5 g DAP per seedling after one month of plumule emergenc e

Box 2 gives various steps in involved in handling of seeds of *E. basaal.* Similarly all other species were subjected to similar steps to develop mass multiplication protocols.

Box 2. Various steps involved in seed handling and germination

Mature seeds are hand-picked Pre-sowing treatment with acid Germination in seed trays

Propagation by stem cuttings Propagation by root cuttings Plantation in the field

Table 5. No. of saplings developed in various nurseries

Sr. No	Species	No. of saplings raised
1	*C. strictum*	75
2	*D. binectariferum*	50
3	*E. ribes*	125
4	*O. indicum*	400
5	*P. marsupium*	50
6	*R. cordifolia*	200
7	*S. asoca*	500
8	*S. racemosa*	125
9	*M. suriga*	275
10	*N. nimmoniana*	2000
11	*E. basaal*	250
12	*S. chinensis*	250

3.2 *In-situ* conservation of *C. strictum* (black dammer) OR Reintroduction and recovery of *C. strictum* (black dammer):

C. strictum yields resin with reported harvest >100 tonnes/yr from Western Ghats. The resin is used as an incense and air purifier. It is presently known from only two locations from entire northern Western Ghats of Maharashtra with serious population bottle-neck as reproductive individuals are hardly encountered and its survival is under severe threat. Fig. 4 from *Ozarde* catchment of Koyna WLS indicate that hardly 10% of saplings enter 'recruit' phase, middle aged individuals are absent. Altogether 14 mature individuals were recorded from Pune, Satara and Kolhapur districts. Predation of fruits and seeds and very low germination success further complicates its revival. To revive the severely depleted population, saplings of black dammer were successfully reintroduced in the *'Amba'* Ghat region in the wild. In the first phase, 20 saplings were planted in the climax evergreen forests with the help of State Forest Department's participation (Box 3). Forest guards were also given training about monitoring of various growth parameters such as measurement of collar diameter, no. of flushes and height measurements etc. Table 6 depicts growth in terms of collar diameter and shoot length after one year of reintroduction in the wild indicating successful establishment.

Figure 4. Population structure of *Canarium strictum* in natural habitat

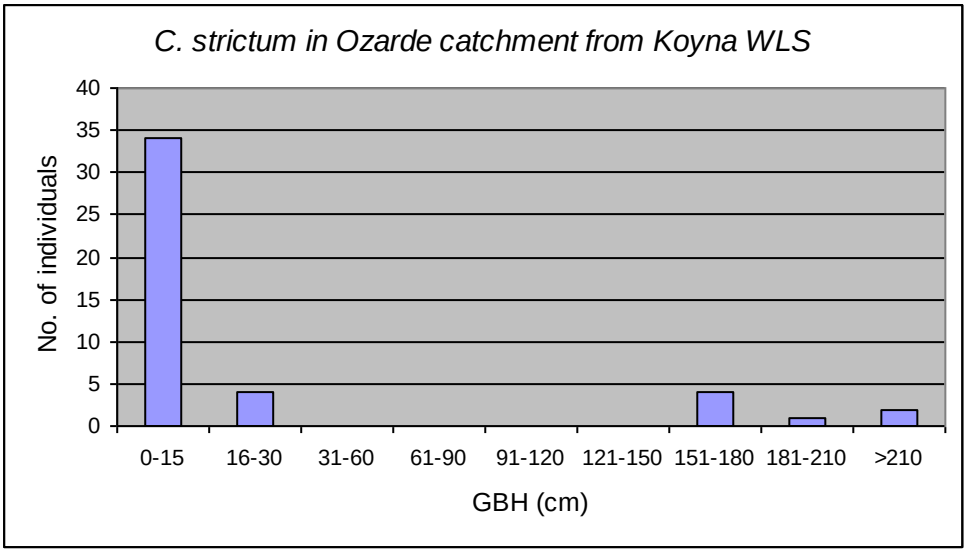


Table 6. Difference in collar diameter and shoot length in *C. strictum* saplings

Sapling No.	Collar diameter (mm)		Shoot length (cm)	
	After three months of reintroduction (25.12.2010)	After one year of survival in the wild (25.9.2010)	After three months of reintroduction (25.12.2010)	After one year of survival in the wild (25.9.2010)
1	9.94	10.06	110	108
2	8.9	9.22	106	102
3	Dead	Dead	Dead	Dead
4	8.45	10.72	104	112
5	7.1	7.53	57	51
6	7.06	7.73	84.5	43
7	8.88	8.83	105	108
8	10.66	10.52	69	54.5
9	9.36	9.8	94.5	96
10	10.31	10.01	98.5	99
11	9.75	9.74	97	99
12	7.43	7.41	106.5	111
13	6.46	6.29	71.5	73.5
14	7.76	8.03	90.5	112
15	8.21	7.45	91.5	93
16	7.9	8.22	113.5	116
17	8.45	10.72	104	112
18	Dead	Dead	Dead	Dead
19	9.51	9.51	122	122
20	9.51	10.36	104	106

	Tot. no. of saplings planted	% survival	Mean increase in collar dia (mm)	Max. increase in collar dia (mm)	Mean increase in shoot length (cm)	Max. increase in shoot length (cm)
C. strictum	20	90%	0.24	2.27	-1.1	21.5

** Note : Reintroduction was done on 22.10.2009. However, saplings were regularly monitored further after three months of reintroduction as we intend to ensure that they have established themselves in wild. These readings were then considered as control. In some saplings, shoot length showed decrease owing to breaking of apical portion*

Box 3. Various steps involved in reintroduction and monitoring of *C. strictum*

Raising of saplings in the nursery and transportation to the field site
Date : 20.09.2009

Reintroduction in the wild with the help of local community and State Forest Department
Date : 21.09.2009

Monitoring of growth parameters
Date : 27.03.2010

New flushes indicating successful establishment Date :25.09.2010

SECTION - 4

PROMOTION OF MEDICINAL PLANTS

This section gives account of various steps in domestication of a species. Conscious and directed efforts were taken to reach various stakeholders of the medicinal plants promotion chain. The activities conducted were at different scales, ranging from grass root (farmers, Self Help Groups) to policy level. This involves training to local community and farmers regarding multiplication of the species, awareness generation and capacity building, cultivation trials and interaction with stakeholders like state forest department (SFD), medicinal plant board (SMPB) etc.

4.1 Seedling distribution '*mela*' : A farmer's seedling distribution *'mela'* was organized at the College of Forestry, Sirsi. Hon'ble minister of Higher Education Mr. Vishshweshwara Hegde Kageri, Hon'ble Vice Chancellor of University of Agricultural Sciences, Dharwad, and Dr. J.H. Kulkarni attended the function. About 50 farmers attended the meet. About 500 seedlings of the following species were distributed; (i) *D. binectreriferum* (ii) *M. suriga* and (iii) *D. malabaricum.* Besides, more than 1000 saplings of *N. nimmoniana* were given to various farmers for cultivation throughout the year.

4.2 A workshop on **' Prospects and Challenges in Medicinal Plants Cultivation'** was organized (Box 4) for creating awareness amongst stakeholders. Literature regarding propagation and cultivation of the species was designed and distributed to the participants

Box 4. Workshop on 'Prospects and challenges in medicinal plants cultivation'

This was attended by almost every stakeholder group. Major participation was by the farmers. Social forestry officials, ayurvedic practitioners, nursery developers and academicians were also represented.

4.3 Discussion with government officials : Series of focused and targeted interactions with State Forest Department (SFD) and State Medicinal and Horticultural Plant board were conducted. Visits were made to the potential cultivation sites in Ajra, Kolhapur taluk along with the agricultural extension officer in the area. Local farmers and private cultivators who intended to develop 'commercial plantations' participated in the discussion and explored possibility of subsidy for cultivation of *N. nimmoniana* and other medicinal plants identified by medicinal plant board for promotion in that agro-climatic cluster.

Box 5. Interaction with various key stakeholders

(i) Interaction with SFD officials

(b) Discussion with Mr. Jangte, CEO, State Medicinal Plant Board

Visit to plantation sites with Agricultural Extension Officer and interaction with farmers

4.4 Peoples' participation in conservation : Local people were involved in data collection (Box 6). Training pertaining to identification of important medicinal plants, propagation and cultivation trials (Box 6,7 & Fig. 7) were given to folk healers, bare-foot botanists, farmers and women self help groups (SHGs).

Box 6. Community Participation

(i) Field visit with villagers

(ii) Discussion with villagers'

(iii) Interaction with folk healers' and bare-foot botanists

Box 7. Nursery of short-listed medicinal plants established at different sites involving farmers and women self Help Groups

Locality: (a) Chambali

Locality: (b) Amboli (c) Sirsi

Box 8. Training to student volunteers

Figure 6. Nursery of Medicinal Plants at *Jeur, Purandar* taluk, Pune District

Discussion with academicians and forest officers

4.5 Information dissemination : As a promotion strategy, efforts were also made to reach to the grass roots, farmers and cultivators through local print media / agro-daily and magazines dedicated to this field. (*Annex*. 1*A*-*E*).

4.6 Field cultivation of RET medicinal plant species :

Cultivation plots of *N. nimmoniana* (EN), *S. asoca* (EN), *E. basaal* (VU) and *S. chinensis* were established on farmlands in different agro-climatic zones with the help of farmers. Schematic representation of these plots is given in Chart 1-3. Medicinal plants were cultivated as 'block plantation' as well as 'intercrop' to check whether it has got some allelopathic effects. In some cases medicinal plants were cultivated with traditional crops and fruit crops such as 'brinjal' and 'papaya' and with other medicinal species as well. Experimental plantation plots were established on hill slopes (*'Velhe'* taluk- Fig. 7) and in farmlands (in Maval and Purandar taluk – Fig. 8, 9). Biological fencing of thorny shrubs was done for protection. Periodic monitoring was done and systematic records of various growth parameters (mentioned above) were kept.

Chart 1. Field layout of plantation of various RET species at *'Shilim'*

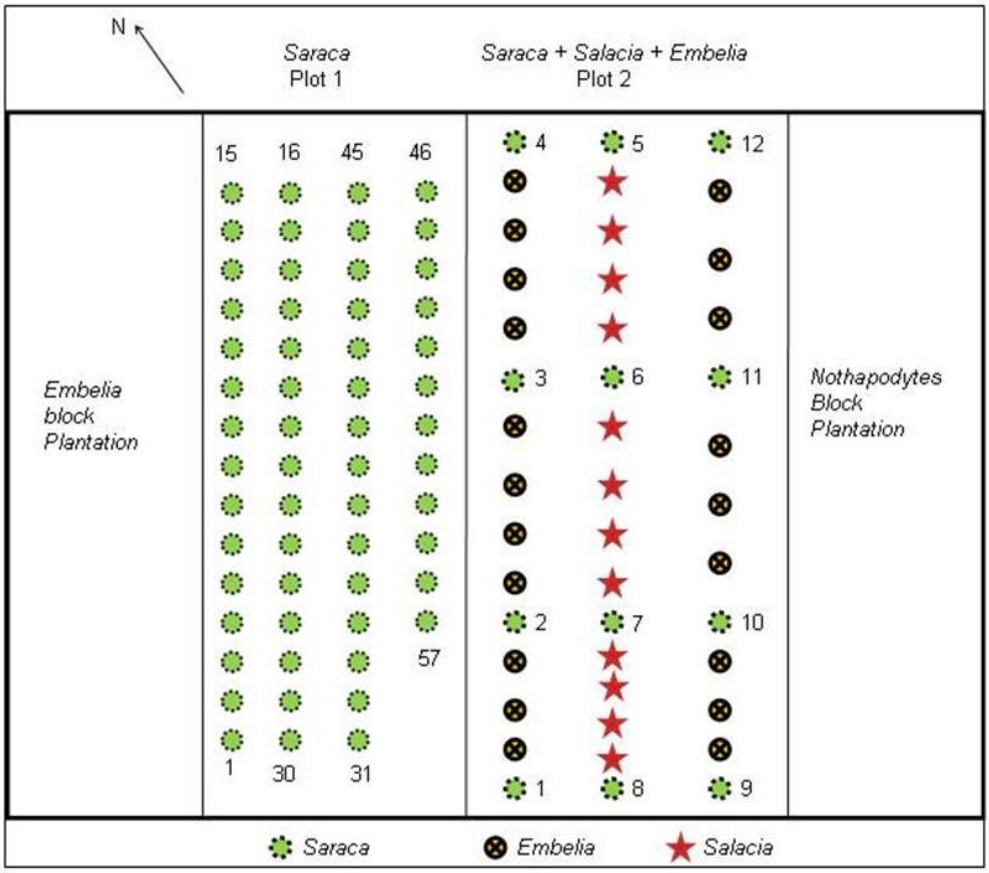


Figure 8. Field site at *'Shilim'*

Species	No. of saplings planted	% survival after one year of plantation
Saraca asoka	70	68
Nothapodytes nimmoniana	83	70

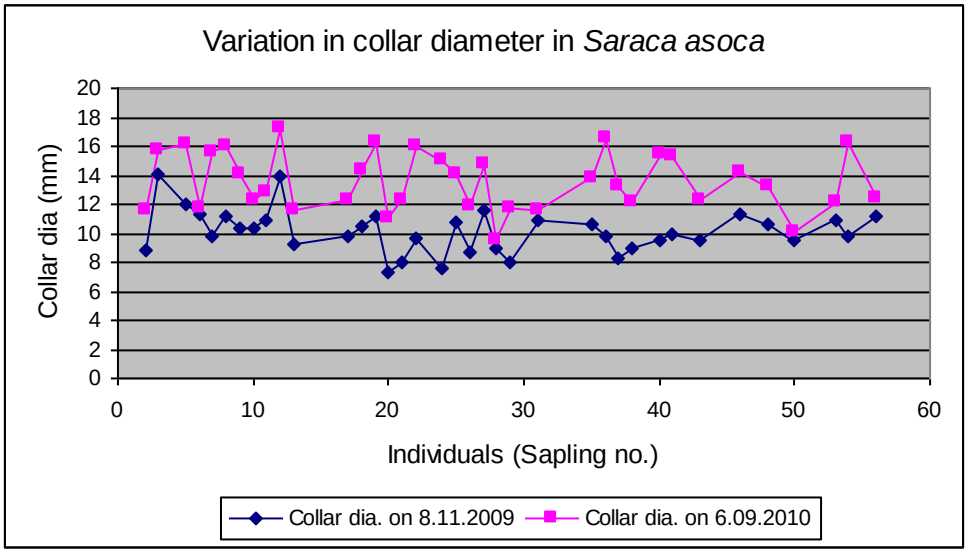
Figure 9. Plantation activities at *'Shilim'*

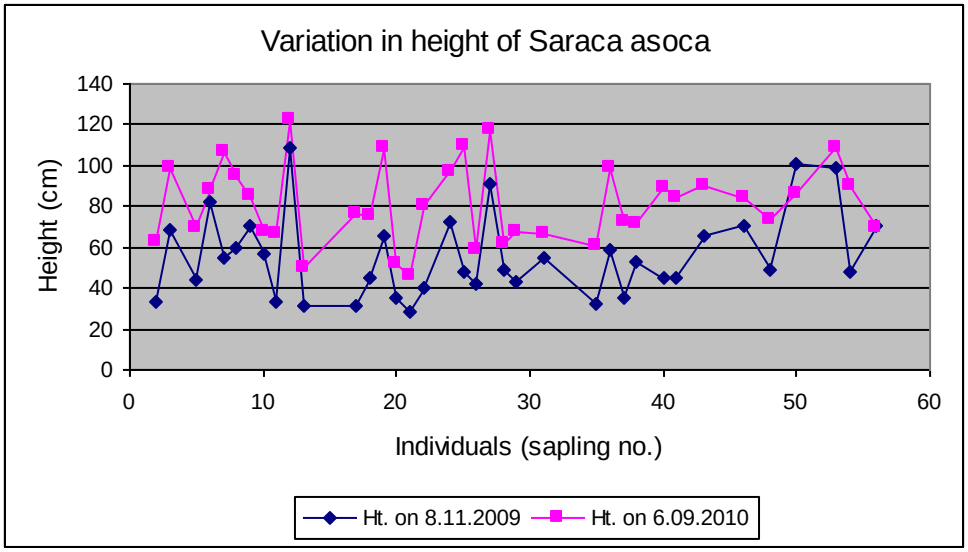
Saraca asoca : Block Plantation

Nothapodytes nimmoniana : Block Plantation

Aftercare and protection given during summer

Figure 10: Difference in growth parameters in *Saraca asoca* at *'Shilim'*

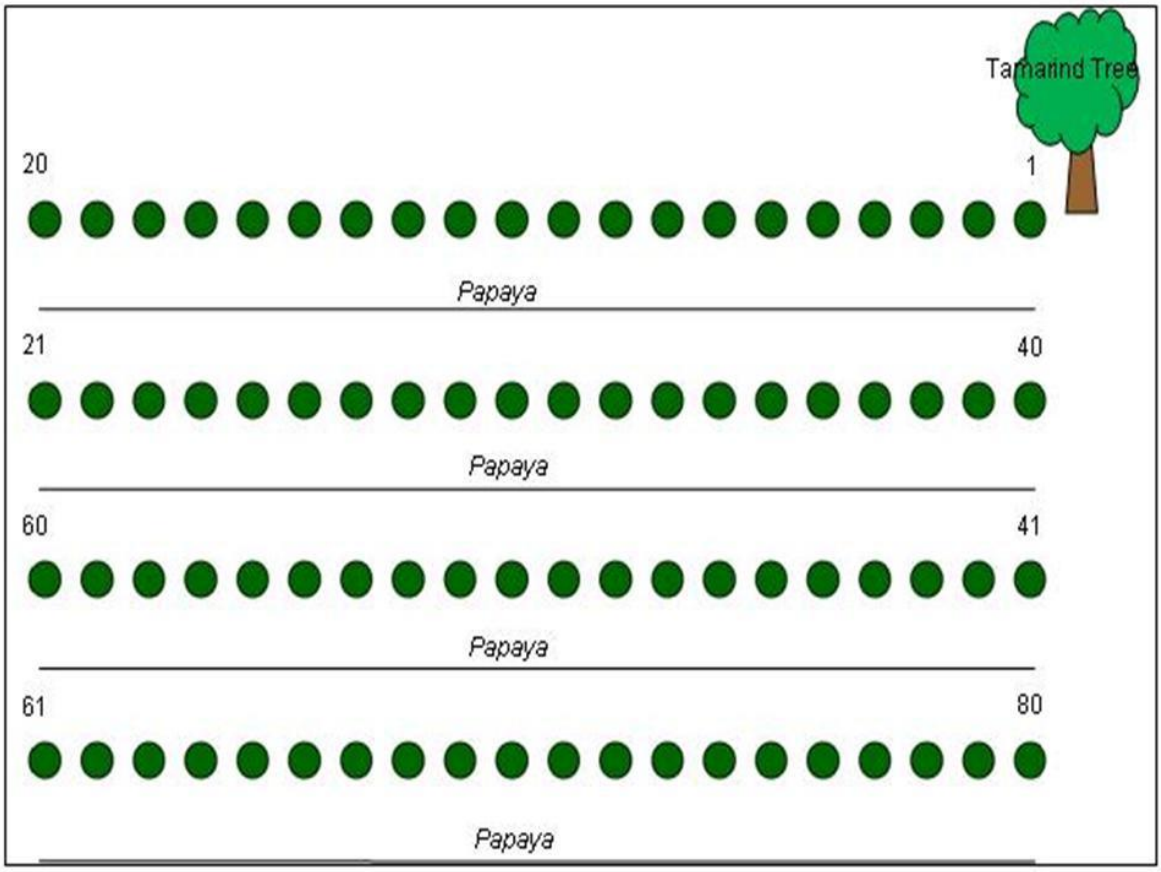




* *Note* – Some individuals show decrease in height because they were browsed upon by the cattle

	Mean ± SD Increase in collar dia (mm)	Mean ± SD Increase in shoot length (cm)	Increase in collar dia (Min – Max) in (mm)	Increase in shoot length (Min – Max) in (cm)
S. asoca	3.45 ± 1.86	25.42 ± 15.37	0.5 – 7.44	5.45 – 61.7
N. nimmoniana	0.73 ± 0.82	7.04 ± 4.77	0.1 – 2.86	1-18

Chart 2. Field layout of plantation of *N. nimmoniana* at 'Waghapur'



	Tot. no. of saplings planted	% survival	collar dia* (mm)	shoot length* (cm)	collar dia (Min – Max) (mm)	shoot length (Min – Max) (cm)
N. nimmoniana	80	88 %	0.75±0.72	3.8±5.02	0.02 – 3.96	0.1 – 24.8

** Mean ± SD*

Chart 3. Field layout of plantation of various RET species at *'Velhe'*

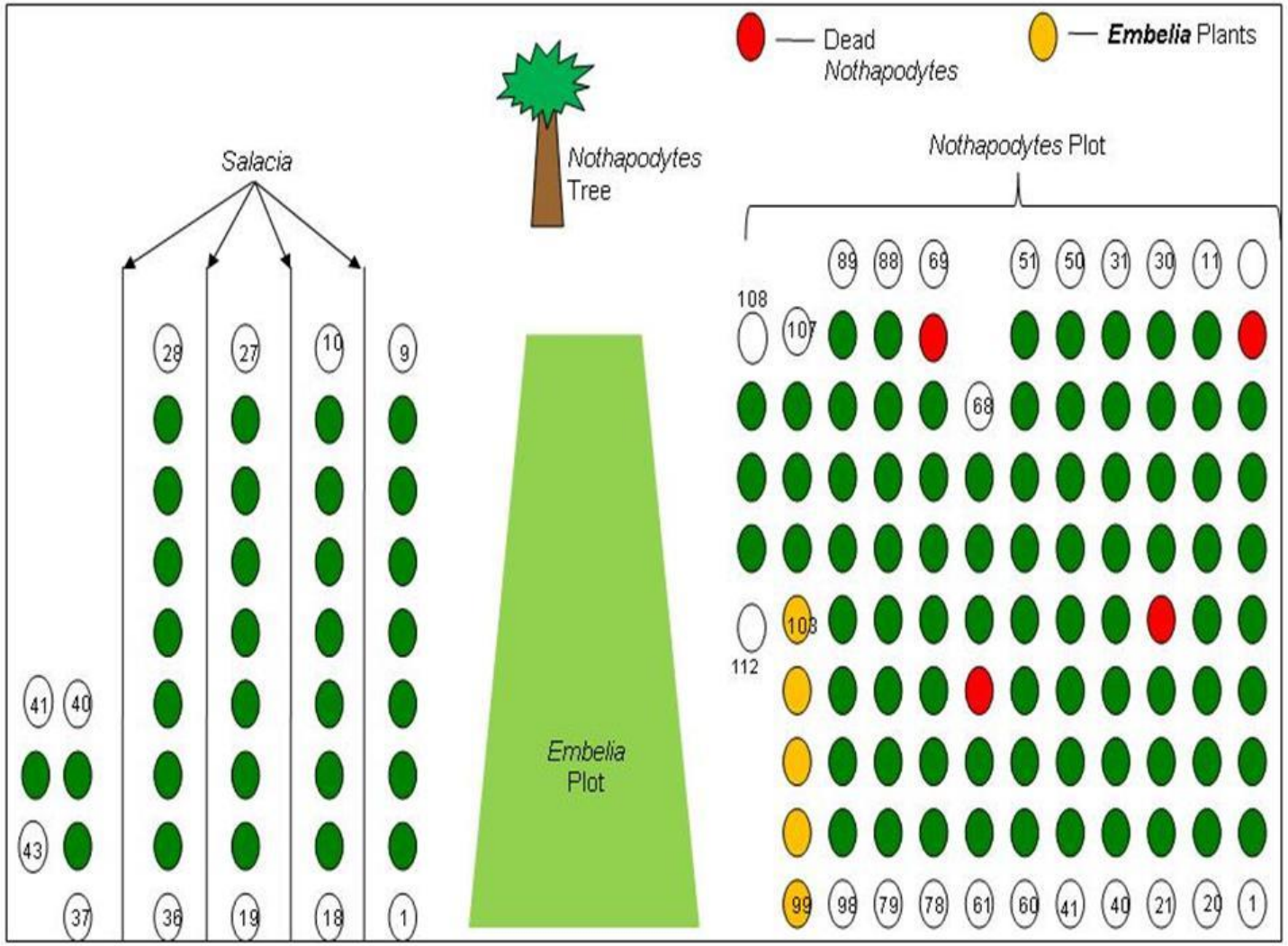


Figure 11. Plantation activities at *'Velhe'*

Date of plantation: 29th June 2009

Date of plantation: 29th June 2009

Site visit: 16th Aug 2009

Site visit: 22nd Oct 2009

Box 9. Various steps involved in plantation of *E. basaal* and *Salacia chinensis*

Making root cuttings and transfer to the plantation site (Date: 30.06.2009)

Established Salacia chinensis (Date: 15.08.2010)

Root cuttings showing multiple sprouts and excellent growth when visited after one year plantation (Date: 15.8.2010)

Table 7. Increase in collar diameter & shoot length after one year of plantation

	Tot. no. of saplings planted	% survival	collar dia* (mm)	shoot length* (cm)	collar dia (Min – Max) (mm)	shoot length (Min – Max) (cm)
N. nimmoniana	161	79	1.66±1.35	5.77±4.64	0.05-7.42	0.138 – 24.72
E. basaal	60	72	-	-	-	-
S. chinensis	36	86	-	-	-	-

** Mean ± SD*

Box 10. Various steps involved in plantation of *N. nimmoniana*

Saplings being transported to the field site and actual plantation (Date: 30.06.2009)

Established Nothapodytes plantation (Date: 15.08.2010)

Notapodytes sapling (a) in Aug 2009 (b) Aug 2010

Site visit : 22nd Oct 2009

Figure 12: Plantation activities at *'Velhe'*

View of site before plantation (Summer 2009)

View of site (Summer 2010)

Site visit: after one year of plantation : 16.08.2010

4.7 Benefit based conservation : One of the unique features of the project was incentive based participatory conservation. Community people were involved and rewarded in data collection. Table 8 gives details of various incentives that were given to farmers, local people in form of provision of soil, shade net, land preparation cost etc. Thus peoples' participation ensured benefit based conservation.

Table 8. How individual farmers / cultivators / self-help groups have benefited from the project (includes both Pune and Sirsi center)

Name of the farmer	Support given in form of…	Saplings given for plantation	Manpower supported
1. Sharad Shinde	* Land preparation cost * Shade net * *Karvi* sticks for biological fencing * Local labor cost	300 (*Saraca, Nothapodytes and Embelia*)	Token honorarium given throughout the duration of the project
2. Ganesh Dhumal	* Soil * Humidity chambers for conducting germination trials * Shade net and Bamboo for development of nursery * Poly bags / Root trainers	Propagation trials were taken	Token honorarium given throughout the duration of the project
3. Babu Pawar	* Shade net * Bamboo * Soil * Poly bags	Propagation trials were taken	Honorarium given whenever required
4. Vinaykumar Puranik	* Land preparation cost * Manure * Transportation of saplings * Local labor cost	250 (*Nothapodytes, Embelia* and *Salacia*)	Support given during plantation and monitoring activities
5. Manju Pujari	* Soil and * FYM	250 *Nothapodytes* and 100 *Saraca*	Token honorarium given throughout the duration of the project
6. Shrikanth Mukri	* Soil * FYM * Poly bags	120 *Nothapodytes* and 50 *Saraca*	Token honorarium given throughout the duration of the project
7. Venkataramana	-	50 seedlings of *Embelia*	Token honorarium given throughout the duration of the project

The seedlings were exchanged with interested farmers around the village and were distributed in a Agri- fair. Some farmers could generate ***'revolving funds'*** through sell of saplings worth 200 GBP.

SECTION - 5

DISCUSSION AND LOOKING AHEAD….

DISCUSSION….

Species tackled here are red listed species that possess high trade potential. As indicated earlier, around 90 % of the species of medicinal plants are harvested directly from the wild. More than 600 species that are collected from forested landscapes do not have known / standardized propagation techniques. There is a difficult task ahead of all conservation biologists, as they have to find solutions to issues such that harvest pressure on wild population is reduced and at the same time commercial demand is also fulfilled. One way to address this is to standardize mass multiplication protocols and promote commercial cultivations, as they help in reducing the harvest pressure on the wild population (Ravikumar and Ved, 2000). Studies presented here have given promising results in achieving that goal. This project has shown good lessons regarding a) domestication of RET medicinal plants b) community involvement in conservation c) recovery of critically endangered plant species and d) lobbying for the conservation of RET medicinal plants. We have been successful enough to show the large potentiality of domesticating medicinal plants into the agro-ecological situations to bring down the pressure in natural systems. Further we have also demonstrated the potentiality of participatory nursery development as a tool for community empowerment for conservation. However we need to still demonstrate one complete cycle of planting to harvest some of the tree / shrub speices and assess the REAL economic empowerment of communities. This clearly requires a grand plan and large programme, which we are already contemplating.

There are various conservation related programmes on priority agenda of the nation and one of them is **'species recovery and bioprospecting'**. The methodology adopted for 'recovery and reintroduction' can be followed / modified and insight be drawn from this study. It can be replicated to other areas/ regions and can assist in micro-planning.

FUTURE PLANS….

- Species such as *Embelia ribes, S. racemosa, S. chinensis, S. asoca, O. indicum* etc have been included in the **'priority species list'** for cultivation and promotion by State Medicinal Plant Board (Ref. letter MSHMPB/Tech-3/4776/08). There is need to develop 'package of practices' / 'agronomy techniques' for cultivation of these species.

- The present project has been developed in consultation with State Forest Department and State Medicinal Plant Board. In addition, with the publication of encouraging results

in the local news media (*Annex. 1 A-E*), farmers' cooperative, private cultivators and industry have approached us to find our supply extent. There is strong end user need to explore cultivation of these species through **'Contractual Farming Schemes'** of government through public-private partnership.

- With the development of mass multiplication protocols, now there is need to develop **Quality Planting Material stocks (QPM)** through scale-up of the nursery facilities. We intend to develop nursery that can become source of at least 150 medicinal plant species that are in regular use by ayurvedic practitioners and industry alike. **'Demonstration cultivation plots'** need to be developed so that cost-benefits of plantation can be worked out for further promotion.

- SMPB had already identified various 'clusters' for promotion of these species. Chemical profiling of active components from different populations of these species will be the next logical step as it will help in identifying suitable regions for cultivation and collection of these species. State Forest Department and State Medicinal Plant Board has expressed keen interest in developing further the **'conservation-cultivation-utilization'** model as one can work upon sustainable harvest techniques.

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Sr. No.	Title of the article	Name of daily / Magazine	Date of publication
1	*N. nimmoniana* – Prospects of a future crop	Heritage Amruth	Feb 2010
2	Dhoop trees make a comeback in sahyadris	Sakaal Times	2.10.2009
3	Activists give new lease to endangered Black Dammar tree	Times of India	19.10.2009
4	*Paschim ghatat vadhtoy Raldhoop*	*Sakaal*	6.10.2009
5	50 % decline in rare medicinal plants	Times of India	9.09.2010
6	Efforts on to increase yield of cancer curing plant	Times of India	3.05.2010

Coverage received in Print Media towards the successful introduction of *C. strictum* (Black dammar – Dhoop)

:- (a) Article in Sakaal Times dtd 2.10.2009

DHOOP TREES MAKE A COMEBACK IN SAHYADRIS

Endeavouring to restore the waning glory of floral-rich Western Ghats, a group of city conservationists recently reintroduced black dammar trees - the main source for natural dhoop - on the slopes of Sahyadris. This is the first time that a concerted effort has been made towards standardising propagation technique for dhoop trees.

"Twenty dhoop saplings were planted in Amba ghat region in the first phase of the project, while a few more plants have successfully been grown in nurseries," Head of Bio-Diversity Department at Garware College Dr Ankur Patwardhan said. The plant rejuvenation venture is part of UK-based Rufford Foundation's Conservation and Promotion of Threatened Plants project.

"Black dammar - resin of this tree is used as incense and air purifier - is pushed on the verge on extinction," said Patwardhan, who is also a coordinator of Ranwa, a city-environmental research group. "We could find hardly five full-grown black dammar trees along the Sahyadris," he added.

Sakaal Times

GREEN SUCCESS: A group of students reintroducing a black dammer sapling on the slopes of Amba ghat

"Not much data is available on dammar trees though its resin has been greatly in demand." Patwardhan said, adding that one of the estimates keeps the annual demand for dammar tree resin around 20 tonnes.

"Natural dhoop therefore is a scarce commodity," he said.

"We carefully selected plantation sites providing the best possible natural conducive locations along the crest line of the Western Ghats," project officer Bhanudas Chavan told Sakaal Times. Plantations were done with the help of Range Forest Officer from Shahuwadi range Prakash Bagewadi, he said.

On rarity of dammar trees, Chavan maintained that re-germination is difficult for dammar fruits and seeds are often eaten by animals and birds. Immature or destructive harvesting for resin also makes them vulnerable, he added.

"Documentation of growth of the trees and standardisation of propagation technique are the most vital aspects of the project," Chavan said, adding the students-volunteers would be monitoring growth of the saplings.

Patwardhan and his colleagues have developed two nurseries, one in Jeur village near Neera and another in Welha, growing saplings of black dammar and 150-other medicinal and indigenous plant species. This project would help building propagation techniques besides fostering quality planting material, Patwardhan said.

REPORTER
reporters@sakaaltimes.com

(b) Times of India dtd 19.10.2009

Annexure 1 B

Activists give new lease of life to endangered Black Dammar tree

Prasad Kulkarni | TNN

Pune: As the lingering fragrance of incense pervades your home this Diwali, spare a prayer for the humble dhoop stick, for, the tree from which dhoop sticks are made is in danger of becoming extinct.

'At present, there are just five Black Dammar (canarium strictum) trees in the state," Ankur Patwardhan, head of the bio-diversity department, Garware College, told TOI. Asked the reason for this catastrophic decline in number, Patwardhan said, "The main reason is inhuman practices like cutting or burning of these trees, as these trees have good market value. Another reason is unsustainable harvesting."

Patwardhan is working on a project for the re-introduction of these trees in their natural habitat. According to him, the trees grow well only in crest line areas. The first phase of the plantation project was carried out at Amba Ghat near Shahuwadi, Kolhapur district, in September.

"Samplings of the tree were developed in a nursery at Jeur village, Pune. After two years, the trees were planted," he said, "Continuous monitoring of the growth of these trees will be carried out and we are considering using a Geographical Mapping System (GPS)."

The forest department and Ranva, a city-based group of nature-lovers, is behind the project. Data collection is being carried out by MSc students from Garware college.

According to Amruta Joglekar, a member of Ranva, the project began in 2006. An area of around 10,000 sq km in the western ghats has been searched for the Black Dammar and other endangered trees.

"Our work is purely voluntary. We involve the local people in the project and teach them about the survival of the trees and their reintroduction," she said.

Joglekar said that self-help groups and farmers have been encouraged to develop the nurseries. School students also participate in the project.

Prakash Bagwadi, range forest officer of Shahuwadi, confirmed that there were just five Black Dammar trees left in the state, "Of these, two are in the Shahuwadi region and three are in the Koyna region," he said. "The new trees have been planted in my jurisdiction. The area is on a high altitude, which should be conducive to their growth."

Bagwadi said that the first phase would be used as a case study. The trees will be monitored and their growth and survival percentage will be studied every two months, he added.

LIFE ANEW: A sapling of the Black Dammar, before plantation in the Shahuwadi forest region

(c) Maharashtra Times and Sakaal dtd 6.10.2009

Annexure 1 C

गरवारे कॉलेज बायोडायव्हर्सिटी डिपार्टमेंटचा पुढाकार; १०० झाडांच्या लागवडीचे उद्दिष्ट

धूप झाडांच्या बचावासाठी युद्धपातळीवर प्रयत्न

» म. टा. प्रतिनिधी

राज्यात धुपाची संपूर्ण वाढलेली पाचच झाडे शिल्लक राहिल्याची धक्कादायक माहिती समोर आली आहे. या झाडांची संख्या वाढावी म्हणून रानवा संस्था आणि गरवारे कॉलेजचे बायोडायव्हर्सिटी डिपार्टमेंट एकत्रित प्रयत्न करत आहेत.

धुपाच्या झाडांची संख्या राज्यभरात कमी झाल्याचे एका सर्वेक्षणामुळे लक्षात आले. त्यामुळे या झाडांची संख्या वाढावी, यासाठी काय करता येईल, याचा विचार करायला सुरुवात केली, असे रानवा संस्थेच्या अमृता जोगळेकर यांनी नमूद केले.

राज्यात निरनिराळ्या ठिकाणी औषधी आणि इतर वनस्पती दुर्मिळ होत चालल्या आहेत. त्यातल्या अनेक वनस्पती नष्ट होण्याच्या मार्गावर असल्याचे डिपार्टमेंटचे प्रमुख अंकुर पटवर्धन यांनी सांगितले.

धूप, नरक्या, वावडिंग, सीता अशोक, ससरंगी, लोध, गुगुळ, मालकामणी, रक्तचंदन आदी औषधी वनस्पतींची संख्या सातत्याने कमी होते आहे. आतापासून प्रयत्न करायला सुरुवात केली तर प्रजाती वाचवण्यात काही प्रमाणात यश येईल. पश्चिम घाटातून दरवर्षी ८८० हून अधिक औषधी वनस्पतींचा प्रतिवर्षी एकूण सुमारे १०० टनांचा व्यापार केला जातो. यातल्या कितीतरी वनस्पतींची पुनर्लागवड होत नाही. धुपासारख्या झाडांची पूर्ण वाढ होण्यासाठी साधारण २५ वर्षे लागतात, अशी माहिती पटवर्धन यांनी दिली. यातल्या कितीतरी प्रजातींची लागवड कोणत्या पद्धतींनी करायची, याची माहितीही कुठे उपलब्ध नाही. यासंदर्भात संशोधन करून लागवड आणि संवर्धनासाठी प्रयत्न सुरू असून आंबा घाटात २५ धुपाच्या झाडांची लागवड या वर्षी केली आहे. पुढील वर्षी १०० झाडांची लागवड करणार असल्याचे त्यांनी सांगितले. धुपाबरोबरच नरक्या आणि औषधी वावडिंगाची लागवड केली आहे. या कामात वनाधिकार प्रकाश बागेवाडी यांनी खूप मदत केल्याचे त्यांनी आवर्जून सांगितले.

संख्या कमी झालेल्या झाडांची लागवड करण्यावर लक्ष केंद्रित केले असून निरनिराळ्या ठिकाणच्या शेतकऱ्यांना या वनस्पतींच्या लागवडीसाठी प्रशिक्षण देणार आहे. तसेच शहरी भागातून 'अर्बन हर्बल गार्डनिंग' अंतर्गत सोसायट्या किंवा ज्यांच्याकडे जागा उपलब्ध आहे, त्यांनाही या औषधी वनस्पतींची रोपे तयार करता येतील. रोपे आणि औषधी वनस्पतींच्या विक्रीसाठीही व्यासपीठ उपलब्ध करून देण्याचा उपक्रम असल्याचे ते म्हणाले.

पश्चिम घाटात वाढतोय राळ धूप

अंकुर पटवर्धन यांचा प्रकल्प; पहिल्या टप्प्यात वीस रोपे

पुणे, ता. ५ : महाराष्ट्राच्या पश्चिम घाटातून दुर्मिळ होत असलेल्या वनौषधींचे जतन आणि संवर्धन करण्याचा प्रकल्प गरवारे महाविद्यालयाच्या बायोडायव्हर्सिटी विभागाचे प्रमुख आणि रानवा संस्थेचे समन्वयक अंकुर पटवर्धन यांनी हाती घेतला आहे. संपूर्ण पश्चिम घाटात आढळणाऱ्या ८८० वनस्पतींना सर्वाधिक म्हणजे वर्षाला शंभर टनांहून अधिक मागणी आहे. दुर्दैवाने यातील ५६३ वनस्पतींच्या लागवडीचा अभ्यासच झालेला नाही. राळ धुपाचाही यात समावेश असून, महाराष्ट्रात केवळ पाच पूर्ण वाढ झालेली झाडे शिल्लक आहेत. प्रकल्पाच्या पहिल्या टप्प्यात संस्थेला राळ धुपाची वीस रोपे तयार करण्यात यश आले आहे.

या उपक्रमासाठी भानुदास चव्हाण पटवर्धन यांना सहकार्य करीत असून, ब्रिटन येथील रफर्ड फाउंडेशनने यासाठी अर्थसाह्य केले आहे. आंबा घाटात तेथील वनअधिकारी प्रकाश बागेवाडी यांच्या मदतीने [illegible] राळ धुपाची वीस झाडे लावण्यात आली आहेत. याशिवाय [illegible] पुराणिक यांच्या शेतात वावडिंग, सीता अशोक, ससंगी, नरक्या, दशमूळ, राळ धूप या झाडांची लागवड केली आहे. नीरजवळ जेऊर गावातही गणेश धुमाळ यांच्याकडे दोन्ही प्रकारच्या वनौषधींची रोपवाटिका आहे.

याबाबत पटवर्धन म्हणाले, "राळ धूप या वनस्पतीवर सध्या विशेष लक्ष केंद्रित केले असून यात मिळणाऱ्या नोंदीनुसार पुढे दिशा ठरवली जाईल. धूप ही सदाहरित जंगलात आढळणारी वनस्पती आहे. पश्चिम घाटात केवळ पाच पूर्ण वाढ झालेली झाडे शिल्लक आहेत. या झाडाच्या डिंकाचा धुपामध्ये वापर करतात. वर्षाला साधारणतः वीस टन मागणी आहे. त्यामुळे उत्तम प्रतीचे धूप सहसा उपलब्ध होत नाही.

वनौषधी जतन आणि संवर्धन या उपक्रमात सीता अशोक, वावडिंग, नरक्या, ससंगी, दशमूळ आणि राळ धूप या दुर्मिळ वनस्पतींची निवड केली असून, त्यांची मानवनिर्मित लागवड, फुटवे, वाढ, पुनर्निर्मिती याचा सविस्तर शास्त्रीय अभ्यास केला जात आहे. [illegible] लागवड केलेल्या रोपांच्या निरीक्षणाच्या नोंदी घेण्याचे काम सध्या सुरू आहे. याशिवाय आंबा घाटात वीस धुपाची झाडे लावली आहेत, अशी माहिती पटवर्धन यांनी दिली.

Coverage received in Print Media towards regarding the cultivation of various RET species :-

Annexure 1 D

(a) Article in Times of India dtd 9.09.2010

50% decline in rare medicinal plants

Dipannita Das | TNN

Pune: The last decade has seen a 50 per cent decline in medicinal plants in the rare, endangered and threatened (RET) category in the state. The decrease is more pronounced in the Western Ghats, a biodiversity hot-spot. The primary reason seems to be destructive and premature harvesting.

One of the reasons for quality planting material, like seeds and seedlings of medicinal plants, not being available is that propagation techniques have not been standardised for a majority of the medicinal species. There is a need to develop cultivation package for such species, say experts.

To address the situation, the Ruffords small grants programme, UK, and biodiversity expert Ankur Patwardhan have taken up a pilot plantation project of two medicinal plant species in Velhe, Pune district, with the help of local farmers.

The 'Embelia robusta' species taken up for field trials in Velhe

The two plant species taken up for field trials in the 'conservation and promotion of medicinal plants' project are 'Embelia robusta' (Vavding) and 'Salacia oblonga' (Saptarangi), both belong to the RET category. The plants are being cultivated on the land of Vinaykumar Puranik.

Speaking to TOI, Patwardhan said the idea was to look into the cultivation practice, generate studies on biomass, find suitable season for harvesting and standardising mass multiplication protocols.

According to him, no study has been done so far on where to grow, when to grow and how much quantity to harvest. The basic knowledge was missing. Thus, there was a need to develop a sustainable harvesting technique. The pilot project aims to bridge this gap, he added.

Patwardhan, who is also the head of the biodiversity department of Abasaheb Garware College, said land and resources were available, but good quality seeds and seedlings were not available. "Eighty per cent of the country's population depends on traditional medicine. Over 180 medicinal plants traded in the country are in the volume of more than 100 metric tonnes. And the demand for herbs, too, is increasing, leading to a huge gap between demand and supply," he said. Hence, the need for raising systematic plantations in various agro-climatic zones.

Explaining the decline in the plant population, Mandar Akkalkotkar, co-ordinator of the forthcoming International congress on Ayurveda, said that earlier medicinal plants were available in the wild in plenty. But now, with the increase in demand, the stocks have depleted. Besides, though being one of the most potential sectors, it is still unorganised.

According to him, there was enough scope for economic medicinal plants as under-shrubs and crops. But at present, the sector was unorganised as contractors either cut the plant or strip off the entire bark for extracting the medicinal value. Akkalkotkar pointed out that adulterated barks, gums and roots were coming to the market. It was difficult to identify the genuine material. So, the quality of medicines was also going down. To bridge the gap between demand and supply, concerted efforts and co-ordination between various departments of agriculture, forestry and research institutes were needed, he added.

(b) Article in Times of India dtd 3.05.2010

Annexure 1 E

Efforts on to increase yield of cancer-curing plant

Dipanvita Das | TNN

Pune: The Department of Biotechnology (DBT), New Delhi, will undertake a unique project in the biodiverse Western Ghat (Maharashtra and Karnataka) to optimise the yield of a plant which helps treat cancer. Besides, the DBT plans to explore the possibility of commercial cultivation of the medicinal plant in diverse climate conditions.

The plant, 'mapia foetida', contains camptothecin (CPT), which has anti-bacterial properties and is also useful in treating human immunodeficiency virus (HIV), besides the falciparum malaria. The bark and roots of 'mapia foetida' are the main source of CPT.

According to Ankur Patwardhan, head of biodiversity department at the Abasaheb Garware college, "The yield optimisation project is primarily aimed at narrowing the huge demand-supply mismatch. The existing supply of 'mapia foetida' is less than 50 per cent of the 700-odd metric tonne demand from pharmaceutical companies in the Indian market."

Patwardhan said, "Almost 80 per cent of the plant population is lost due to indiscriminate harvesting. Besides, there is an urgent need to find alternative sources of CPT, since it cannot be synthesised artificially. The effort entails field trials to establish whether 'mapia foetida' can be grown under varied agro-climatic conditions."

This project will look into the possibility of commercial cultivation of the plant which would result in consistent supply of high quality CPT to the industries, he added.

Vasudeva Ramesh, Department of Biotechnology's project coordinator, said, "Multi-location experimental plantations of 'mapia foetida' in different agro-climatic zones will start from the coming monsoon. The idea is to develop cultivation packages on a large scale over a period of next three years."

Saplings of 'mapia foetida' being planted at Velhe village in Western ghats

'Mapia foetida' contains Camptothecin which has anti-bacterial properties. The bark and roots of the plant are the main source of Camptothecin. Almost 80 per cent of the plant population, grown in Western Ghats, is lost to indiscriminate harvesting

"The field trials will cover Dapoli and other parts of the coastal Konkan region besides Gaganbavda which links Kolhapur and Konkan and is suited for mango cultivation; Purandar and Maval in Pune district; and north Karnataka and Shimoga district, which is suited for areca nut, coconut and coffee plantations," said Ramesh.

Apart from Abasaheb Garware college, the project also involves NGO Ranwa, the University of Agricultural Sciences, Bangalore and the College of Sirsi in Karnataka.

Ramesh said, "The thrust will be on increasing the biomass i.e. the mapia woodchips, screening and vegetative cloning of high yield varieties, collection practices, cost benefit analysis, land area, water requirement, rate of application of fertilizer and its benefits."

Article published in 'Heritage Amruth', a widely circulated magazine dedicated to traditional health care

Annexure 2

Prospects of a Future Crop

Nothapodytes nimmoniana - An Endangered Medicinal Tree

Ankur Patwardhan

Western Ghats in India are endowed with very rich and diverse varieties of plants and animals. Indian system of medicine traditionally makes use of a wide variety of medicines derived from plant / animal origin. However, increasing dependence on forests for sustenance and livelihood has left behind degraded and fragmented forests and has rendered many species rare, endangered and threatened. Many medicinal plant species have undergone destruction due to over-harvest for their clinical applications in modern medicine. One such medicinal plant is *Nothapodytes nimmoniana* also known as *Mappia foetida*. Studies conducted by FRLHT in CAMP workshop at Pune in 2001 placed this species into 'Endangered' category, since it was observed that there was a rapid decline in its population ranging from 50% to 80%.

Brief introduction on *Nothapodytes nimmoniana*

Nothapodytes nimmoniana is a small sized tree found as an under storey in evergreen to moist deciduous forest types. It prefers forest edges as habitat. It grows up to 15 metres height in undisturbed evergreen forests, but appears shrubby in secondary or disturbed forests. It sheds its leaves, become leafless and remains dormant in summer months, whereas new leaves arise with the advent of monsoon. It is popularly known as 'Narkya', 'Amruta', 'Chamera'and 'Darvasamemara' in vernacular languages.

Nothapodytes nimmoniana belongs to family Icacinaceae. The plant can be easily recognized when it flowers by the strong foetid smell hence the name 'foetida' (commonly referred to as stinking tree). Leaves are alternate and simple, broad, ovate, and acute at both ends. Inflorescences are terminal, many flowered, shorter than leaves. The species is polygamous in nature. It shows a wide array of breeding types with male (only male flowers), female (only female flowers), hermaphrodite (only bisexual flowers), andromonoecious (male flowers with few bisexual ones), gynomonoecious (female flowers with few bisexual ones), trimonoecious (mixture of male, female and bisexual flowers) at individual level.

Fruits are ovoid, purple and single seeded while the seeds are albuminous. Bark is rough, grey colored with peculiar lenticels (dot like markings on stem). The plant usually flowers during August and the fruits ripen till November, however flowering and fruiting periods vary in different regions. In the disturbed open forests of northern Western Ghats near Pune and Raigarh district, the fruits ripe in November-December, however, in the tall forests of Kolhapur and Sindhudurg district of Maharashtra, they can be harvested in January-February; indicating that rainfall might be playing a critical role. Birds such as Black

Bulbul, Red Whiskered Bulbul, Yellow Browed Bulbul, White Chicked Barber and mammals like giant squirrel etc. are known to eat and disperse the fruits of *Nothapodytes nimmoniana*.

Distribution

The species is native to warmer regions of South India. It is widely distributed in many parts of the Western Ghats from Konkan southwards to Nilgiris, Anamalais, and is common in Uttara Kannada. It is also found in some parts of Assam, the Himalayan foothills, Ceylon, Burma and Thailand. There is a controversy over its global distribution. Its original global distribution has been reported in Indo-Malayan region in CAMP (2001) whereas certain reports extend its limit to America.

Medicinal Uses

Being one of the most promising anticancer drug (Camptothecin - CPT alkaloid) yielding plants, *Nothapodytes nimmoniana* has gained an international importance in the pharmaceutical industry worldwide. Camptothecins (CPT) are lauded as one of the most important alkaloids of the 21st century because of their clinical applications against variety of tumors and HIV-I. Recently, they have been found active against parasitic trypanosomes, *Leishmania*, *falciparum* malaria and also known to exhibit antibacterial activity.

There are hardly any reports of *Nothapodytes nimmoniana* used in traditional medicines. Discussion with a person expert in Ayurveda medicines revealed that medicinal properties of *Nothapodytes nimmoniana* have not been mentioned in Ayurveda. However it has reported that the aqueous extracts of *Nothapodytes nimmoniana* have folkloric reputation for the treatment of a variety of ailments among the Toda tribes of Nilgiris.

Trade

Reported trade of *Nothapodytes nimmoniana* woodchips in the last decade from Maharashtra state was around 400 metric tons. In Indian market, the current demand for biomass of *Nothapodytes nimmoniana* is 500-700 metric tons with supply less than 50% of the current demand, thereby encouraging large scale transport of the raw material either in the form of wood chips or powder. To meet the ever increasing demand from pharma industries locally from Sonepat (Haryana), Kolkata (West Bengal), Hyderabad (Andhra Pradesh), Delhi and subsequently from Japan, USA and Spain, more and more plants are cut and dried and are exported in powder or gel form. This export business is completely managed by private sector. The collectors have trained the local tribal and rural laborers in identifying, cutting and drying processes. They are paid as per the rate of Rs. 15-20 per kg of dried stems. The drying is usually done in the sun. Then it is pulverized and powdered. The value added product in extract form can fetch a price as high as Rs. 1500 per kg.

In Maharashtra, trade of this plant, is being carried out by obtaining felling permission from the revenue authority only since species in not covered by Maharashtra felling of Trees Act, 1964 & material transported under valid transit pass etc. With the exhaustion of the supplies in the private areas, apparently emboldened by the trade, people started eyeing the invaluable resources availed in the forests and wild life protected areas.

Conservation Concern

Due to habitat fragmentation, over exploitation and clandestine trade for the CPT alkaloid, the population of *Nothapodytes nimmoniana* has declined drastically during the last decade. According to CAMP survey, this decline in population is up to 10-80 % in various parts of Maharashtra. Total loss has been recorded from certain areas. Currently the species population density is as low as 1-2 individuals /ha in some areas. However it extends up to 20-25 individuals/ha at some localities. This made the species endangered in the Maharashtra state with 50-80% population loss. However in Uttara Kannada region, where the exploitation and trade is relatively less, the species has got a threatened status.

Tradeoff between Trade and Destruction

The ever increasing world wide market of Irinotecan and Topotecan (semi synthetic CPT analogues) has currently reached one thousand million US dollars, which represents approximately 1 ton of CPT in the terms of raw material. To cater this demand, one needs around 1000 tons of *Nothapodytes nimmoniana* wood chips to get 1 ton of CPT in terms of raw material. Analysis of illicitly cut and stored stems of *Nothapodytes* revealed that about 90% of them were below 45 cms girth. This critically affects the seed set and has further constraints over germination. This gives an idea about the scale at which destruction is ongoing. Since the species is in high demand, the challenge is to domesticate it and standardize harvest practices. This also throws light on the extent of cultivation required to cater the commercial demand.

Annexure 3

Plantation Details at *Velhe** :

1. Pit Size : 2 x 2 x 2 feet
2. Centre to centre distance between two plants : 2 meters
3. Total no. of saplings planted: 250
4. Total Area under plantation : 0.10 hectare

Actual cost of plantation activity at *'Velhe'*

Sr. No.	Particulars	Unit cost (in Rs.)	Quantity	Total Cost (in Rs.)
1.	Saplings	Rs.15/ plant	250	3750/-
2.	Land Preparation (Pit digging)	Rs. 11/ pit	250	2750/-
3.	Labour cost	Rs. 70/day x 2 Days	8 persons x 2 Days	1120/-
4.	**Manure** Vermicompost Neem Cake Super Phosphate	 Rs.7/kg Rs.9/kg Rs.6/kg	 300 kg 50 kg 25 kg	 2100/- 450/- 150/-
5.	Transport of manure, Saplings	Rs. 7/km	150 km	1050/-
6.	Travel cost for plantation	Bus fare	Rs.120 x 8 people To and Fro journey	960/-
7.	Food and hospitality	8 lunch x Rs. 35 for 8 people	140 x 8	1120/-
	Total			**Rs. 13,450/-** (approx.195 GBP)

** Cost for Watch & ward, Watering etc. have been excluded.*
** Biological fencing of locally available thorny bushes was done*

On similar lines, the actual cost for pilot-scale plantation at *'Shilim'* was calculated. (Rs. 21,880/- i.e. approx. 320 GBP).