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From the
Director's Desk

The current issue of the ENVIS Newsletter *VAN VIGYAN* carries information about the tropical tree *Dalbergia sissoo* in the 'Know Your Trees' section. Commonly known as Indian Rosewood or Sissoo, the species is a slow-growing hardy deciduous tree native to the Indian Sub-continent. Information about various aspects of the tree such as distribution, reproduction, silviculture, yield, utility, etc. has been included in the article. Cataloguing the existing Forest Genetic Resources (FGR) is one of the major tasks in conservation and subsequent utilization of FGR. Another article published in this issue gives a detailed account on the inventorization of *Pterocarpus marsupium* along the eastern and western slopes of south Western Ghats. This is the first field exploration carried out to identify various potential populations of this prospective multipurpose tree in southern India. In addition, the newsletter includes regular updates such as recent literature related to FGR and important ENVIS activities of the quarter. We welcome your comments and suggestions for the improvement of the newsletter.

R.S. Prashanth
Director

In this issue

Know Your Trees – *Dalbergia sissoo* Roxb.

Distribution

Dalbergia sissoo Roxb. is a wind-dispersed tropical deciduous tree native to the Indian Sub-continent. Its pure natural distribution is along the foothills of Himalayas in the sub-Himalayan tract extending from eastern Afghanistan through Pakistan to India, Nepal, Bangladesh, Bhutan and Malaysia (Troup, 1921; Sagta and Nautiyal, 2001). Being regarded as one of the most preferred timber tree of South Asia, the species is not only widely planted throughout its natural distribution, but also introduced and cultivated in various parts of the world as an exotic. The list of other countries in which *D. sissoo* has established as exotic species include Cameroon, Ethiopia, Ghana, Indonesia, Israel, Kenya, Mauritius, Nigeria, Sudan, Tanzania, Thailand, Togo, USA and Zimbabwe.

Habitat

The Sissoo can be considered as a tree of plains, however, it occurs naturally in the sub-Himalayan tract up to 900 m, at some occasions it climbs to 1500 m. In its natural distribution, the tree grows typically on sandy and gravel to rich alluvial soil particularly of riverbanks. The tree avoids stiff clay, preferring porous soil of sand, pebbles and boulders. The tree is also capable of anchoring in poor soils, on cliffs by means of root-suckers. The tree species exhibits stunted growth in poorly aerated sites. The optimum pH for growth is 5 to 7.7. *D. sissoo* is adapted to a seasonal monsoon climate and a dry season of up to 6 months. The absolute maximum and minimum temperature varies from 39 to 49ºC and 4 to 6ºC respectively. The rainfall in Sissoo growing areas varies from 500-4500 mm. Hence it is obvious that the tree can withstand extreme temperature and rainfall. In forest types, the species occurs either as mixed or pure stands. The prominent associated species of *D. sissoo* in moist deciduous forests are *Adina cordifolia*, *Terminalia alata, Acacia catechu* and in case of dry deciduous forests it occurs along with *Diospyros cordifolia*, *Holoptelea integrifolia*, *Bombax ceiba*, *Shorea, Terminalia* and *Lagerstroemia* spp.

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Botanical description

D. sissoo is a medium to large-sized deciduous tree that can reach a height of 30 m with GBH of 80 cm under favoured environmental conditions. However, the species generally exhibits a stunted and crooked form. Clean and straight boles are comparatively rare, even on average sites. The tree generally has a sparse crown. Leaves are imparipinnate; leaflets 3-5, alternate, 2.5-3.6 cm in diameter, broad ovate, acuminate, glabrescent, rachis 5-10 cm long and petioles are 3-5 mm long. Bark is thin, grey, longitudinally furrowed and exfoliating in narrow strips.

The flowers are 5-8 mm long, exhibiting pale white to dull yellowish petals and borne on racemes measuring 2.5 to 3.7 cm in length, which in turn are arranged in short exillary panicles. The downy calyx measures almost half the length of a flower and possesses a standard long claw. Stamens are 9, fused to form a sheath with slit along the top. The ovary is pubescent; style much shorter than the

ovary with a larger stigma. The pods are strap-shaped, indehiscent, glabrous and appear pale brown when matured. Each pod is 5-7.5 cm long and 8-13 mm wide and is seeded from 1 to 4. Seeds are kidney-shaped, thin, flat and light brown in colour. Each seed is covered with a papery testa and measures about 6 to 8 mm in length and 4 to 5 mm in width.

Phenology and floral biology

The trees of *D. sissoo* growing in natural range begin to shed leaves during Oct.-Nov. Individuals remain leafless from this period until late Feb. to early March, the period which synchronize with leaf flushing. Leaf shedding was found to be very regular throughout the Sissoo-occurring forest and Sissoo woods in the riverine exhibit a typical bare grey appearance. Flowers start to bloom in the month of March with peak flowering during April. This is followed by the setting of young pods very rapidly, hanging in masses all over the tree. Pods reach their full size by July and can be harvested from December to early January, when they are completely matured.

The type of inflorescence found in *D. sissoo* is axillary panicle with short spikes bearing sessile or sub-sessile flowers (usually 7-14). The length of the inflorescence ranges from 3-8 cm. Flowers are yellowish white in colour and emit less fragrance. The typical papilionaceous corolla has five petals including 2 standard petals, 2 wing petals and a narrow keel petal. It has been noticed that the floral colour gets modified from yellowish white to orange once the pollination is completed. Androecium is composed of 9 stamens in monoadelphous condition grouped in two sizes, 5 in large stalk and 4 in smaller stalk. The hairy pistil

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has a narrow ovary at the base containing 5-6 ovules, a short style and a small stigma at the top. During the bud stages, the ovary is curved and found completely enclosed by anthers. Flowers start to unwind right from the morning and peak flowering could be observed between 11.30 – 12.30 hrs.

Reproduction

Studies pertaining to pollination biology and breeding system of the species is highly limited. However, scanty reports describing the pollination mode in the species reveal that the tree appears to be insect-pollinated and can also set seeds with both self and outcross pollen to varying degrees depending on local conditions (Bangarwa and Singh, 1994; Bangarwa, 1996). Earlier observations on the mode of pollination reveal that most birds and insects do visit the flowers, but not necessarily involved in pollination. It was also noticed that dehiscence of anthers takes place at the bud stage and the stigma too becomes receptive inside the bud. Due to these phenomena, self pollination recorded a pod set of 35%. However factors such as prolonged receptivity of stigma and extended pollen viability suggest that outcrossing cannot be ruled out in the species. Hence the exact breeding system can be ascertained only after conducting a detailed control pollination experiments in the species. Bangarwa and Singh (1994) conclude that the species is adapted to predominant selfing with chances favouring outcrossing.

Seed processing and nursery techniques

Fruits are available between December to March and it is often advised not to collect those fallen from trees as

Photo courtesy : davesgarden.com

they have a greater chance to get infected. Roughly, 1.25 kg of pod may yield 1 kg of seed. Later the collected pods are dried in sun and broken in to segments with one seed each. The broken segments are cleaned by winnowing to remove the pod debris. Seeds of *D. sissoo* are orthodox. If the seeds are properly dried and stored in airtight containers they remain viable up to several years even at room temperature, and further long period if stored at 5ºC. However, they can be infested by the pea beetle, *Bruchus pisorum* which may continue to breed during storage. The estimation of number of pods per kg is 16,000-18,000 and number of seeds per kg is 40,000-55,000 approximately.

Seeds do not possess any hard coat and hence scarification is not needed. Generally, the seeds exhibit a germination of 60-80% in 2-3 weeks after sowing. Prior soaking in cold water for 24-48 hrs enhances germination and they germinate well if planted along with their pod portion. Seeds are either sown in beds or in polybags in March-April. Care must be taken to avoid excess watering. As Sissoo fixes Nitrogen through a symbiotic relationship with Rhizobium bacteria, seedlings can also be inoculated in the nursery. When the seedling are about 5 cm tall, are transferred into containers. In case of stump production, the seedlings are to be maintained for 12-16 months in the nursery.

Silviculture

The tree is a strong light demander and needs overhead light during early developmental stages. In fact, in dense vegetation the species grows more vigorous so as to suppress the weaker saplings of its competitors. Being adapted to riverine conditions, the tree thrives well in adverse soil and moisture conditions. It also appears to be frost hardy at the early stages of growth but it is not resistant to fire. New plantlets are propagated either by seeds or root suckers. *D. sissoo* has a characteristic feature of dimorphic roots, one for the purpose of nutrition without buds that penetrate deep into the soil and the other long horizontal roots with buds which produce suckers. The tree can also be propagated by cuttings. For cuttings, twigs should be collected from one year old branches of 15-20 year old trees with a diameter range of 35-40 cm. Cuttings must be at least 23 cm long with a thickness of 10 mm and usually collected during January to February. Initially the twigs are treated with bleach for 15-30 minutes to disinfect any pest infestation. Later they are placed in polythene bags (20 X 10 cm) that contain silt as rooting medium and maintained in a condition of 30-40ºC temperature with 70-80% humidity. Proper watering and weeding should be done at regular intervals.

Alternatively, stumps are prepared from plants that are grown for 6 months to 1 year in sand beds. Usually each stump is preferred to have a 5-10 cm of stem portion and 20-25 cm of root portion. The root collar diameter should be 1 cm. An incision made near the base of the cuttings shall stimulate root growth. The preferred time of planting is June-July. Stumps are commonly used for establishment of plantation over rooted cuttings and direct seeding. It was observed that container-grown seedlings yielded a survival percent of 50%. Proper weeding should be carried out at regular intervals for the initial 3 years. Similarly a good irrigation is necessary, coupled with fertilizers. The application of phosphate would aid early growth promotion on poor soils. After 6 years of planting, the plantation might have formed a small canopy and during this time around 30-40% of the stems are thinned selectively to remove suppressed, diseased and crooked trees. Later thinning is recommended every 7-8 years where the rotation is 30-60 years. There is evidence that the stumps begin to lose vigour after 2 or 3 rotations when

managed as a coppice crop. The tree usually coppices vigorously up to 20 years of age.

The tree also suits well for agroforestry systems and intercropping with wheat, lentil, cow pea, etc. is commonly practiced in several places. This has a positive impact on soil organic matter, microbial biomass, basal respiration and dehydrogenase and alkaline phosphatase activities, which in turn lead to an improved organic matter status of the soil. However, tree spacing should be properly maintained to minimize the effects of shading on the intercrops. Farmers usually prefer both the bund and stand plantation depending upon land and labour availability. The major advantage of bund plantation is that it requires no additional land as seedlings can be planted along the bund of the cultivated field. Further, the establishment cost is lower when compared to stand and also the trees can use the manure and fertilizer applied for other major crops. In bund plantation the seedlings are planted in one meter gap, whereas in stand plantation different spacing such as 4 X 4, 3 X 3 or 2 X 2 is followed based on the various purposes. With key unique features such as early flowering and fruiting behaviour and N_2 fixing ability due to the presence of root nodules, the species can be well regarded as a pioneer species both in plantation forestry as well as in agroforestry systems.

Pests and diseases

The most serious insect pest of Sissoo is the defoliator *Plecoptera reflexa* which causes more damage to concentrated plantations. This insect has a shorter life cycle and is able to complete 10-11 generations within a year under favourable conditions. The first symptom of defoliation is generally visible in May-June with sufficient multiplication of the pests and later the defoliation becomes more pronounced. The coincidence of tender foliage with emergence of caterpillar stage makes a situation more suitable for the pest multiplication. Since chemical control measures were proven to be unsuccessful, silvicultural practices such as preference of stump planting and proper thinning and adequate irrigation can keep a check on this severe damage causing pest. Other less important insect pests of *D. sissoo* include the defoliator *Dichomeris eridantis*, leaf miner *Leucoptera sphenograpta*, leaf roller of northern India *Apodersus sissu*, sap suckers *Drosicha mangifera* and *Pulinaria maxima*.

D. sissoo growing in natural forests and plantations is also affected by a number of fungal pathogens. The notable one is the leaf wilt disease caused by *Fusarium solani*, mostly during the late sapling and pole stages. Ganoderma lucidum is the fungus responsible for root disease of Sissoo that occurs in almost all parts of India. *Polyporus giluas* is another devastating fungus causing tree die-back, a condition in which the affected trees do not die immediately but continue to live for few years/months and when their roots are decayed slowly, they are blown over string winds. Other notable fungal infections of Sissoo include powdery mildew caused by *Phyllactinia corylea*, leaf spot by *Cercospora sissoo*, leaf blight and leaf wilt caused by *Colletotrichum sissoo* and *Fusarium solani* respectively. The wood pathogens recorded in the species include fungi *Daedalea flavida* responsible for wood rot and *Fomes durissimus* responsible for stump rot.

Growth statistics

The tree species exhibits a rapid growth rate under favourable conditions when grown in natural forests, plantations or in coppices. The favourable conditions here mean the edaphic factors such as presence of sandy or sandy loam soil, growth atmosphere free from the interventions of weeds or climbers during early establishment and proper thinning at regular intervals. Earlier records state that *D. sissoo* growing under natural conditions reaches a height of 18.3 m in 30 years and 30.5 m in 60 years with a girth of 22.4 cm and 46. 2 cm respectively (Howard, 1925). The growth rate of individuals in plantations at Doab in Uttarpradesh was claimed to be 10.4 m height with a girth of 14.2 cm after 6 years of planting. Significant variations in growth parameters were observed between plantations grown in various geographical locations. According to De (1940), in Assam plantation raised from 2 years old stumps reached a height of up to 6.7 m over a period of 3 years. Similarly the radial growth of trees growing on roadsides was higher than those under canopy. Another earlier estimation reveals that the ratio of crown diameter (feet) to GBH (inches) was 1.8±0.01, a calculation which included data from more than 2000 individuals.

Uses

D. sissoo yields one the fine quality woods of India and hence highly sought for furniture and cabinet making. The golden to deep brown heartwood (with dark streaks) can be clearly distinguished from the yellowish white to pale brown sapwood. The heartwood can resist termites and borer attacks. The wood with a specific gravity of 0.63 – 0.83 is hard and moderately heavy. It possesses straight to shallowly interlocked grains with a medium to coarse texture. The timber is hard, strong and tough with high durability. It is ready to saw unless the grain is extremely interlocked. The heartwood yields light brown viscous non-drying oil that can be used as a lubricant for heavy machinery (Troup, 1921).

The tree has the potential to be used as an intercrop in agroforestry systems. The tree produces moderate root nodules and heavy litter fall decomposes to enrich soil with nitrogen, phosphorus and organic carbon. Further, its characteristic feature of developing root suckers and runners makes it useful for soil erosion control. With a dry-matter content of 32.46% and crude protein of 2.7-24.1%, the young branches and foliage of Sissoo can serve as excellent alternate fodder sources in case of emergency. In total, the tree provides, fuelwood, fodder, green manure and other wood products on a regular basis as well as timber at the end of 25-25 year rotation.

The tree has many reputed medicinal properties and has been traditionally employed to cure a variety of ailments including skin diseases, blood diseases, syphilis, stomach problems, dysentry, nausea, eye and nose disorders, aphrodisiac, expectorant, among others. A compound made by boiling the leaves is used to treat gonorrhoea. Bark and wood extracts are used to alleviate vomiting, thrust and burning sensations.

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Population structure of *Pterocarpus marsupium* in South Western Ghats

The first field exploratory work to identify genetic resources was carried out at Institute of Forest Genetics and Tree Breeding, Coimbatore on *Pterocarpus marsupium*. The distribution of the species in the Western Ghats was studied using the "Forest map of South India" prepared by the French Institute at Puducherry. The *Anogeissus latifolia - P. marsupium, Terminalia* spp forest type (>600 MSL) under dry deciduous forests along Eastern aspect of Western Ghats (Tamil Nadu) and moist deciduous forests along Western aspect of Western Ghats (Kerala) were located up to range level in field using the forest map. Based on physical barriers separating the distribution of *Pterocarpus marsupium,* 17 distinct populations on Eastern aspect of Western Ghats (Tamil Nadu) were short listed for field studies while in Western aspect of Western Ghats (Kerala), 9 locations were shortlisted and details of the identified sites of given in Tables 1 & 2 and in Figure 1 & 2.

Table 1. Details of shortlisted sites in Eastern Aspect of Western Ghats (Tamil Nadu)

S.No.	Location	Forest Range	Forest Division	GPS	
				Latitude	Longitude
1	Tekkumalai West	Bhutapandi Range	Kanyakumari	08°50" N	077°31" E
2	Singampatti	Mundanthurai Range	KMTR	08°35" N	077°25" E
3	Kuttralam	Cuttralam Range	Tirunelveli	08°91" N	077°25" E
4	Chokkampatti	Cuttralam Range	Tirunelveli	08°91" N	077°26" E
5	Sivagiri	Sankaran Kovil Range	Tirunelveli	09°41" N	077°35" E
6	Erasakkanayakannur	Cumbam Range	Theni	09°45" N	077°26" E
7	Gandamanur	Gandamanur Range	Madurai	09°52" N	077°33" E
8	Agamalai	Theni Range	Theni	10°07" N	077°26."E
9	Amaravathi	Udumalaipettai Range	IGWLS	10°21" N	077°11" E
10	Siruvattukadu	Kannivadi Range	Dindigul	10°23" N	077°43" E
11	Bolampatti	Coimbatore Range	Coimbatore	10°57" N	076°41" E
12	Anaikatty	Bolampatti Range	Coimbatore	11°03" N	076°46" E
13	Hiriya Shige	Kunda Range	Nilgiri South	11°25 " N	076°65" E
14	South Bargur	Andhiyur Range	Erode	11°57" N	077°59" E
15	Thalamalai	Thalamalai Range	Sathyamangalam	11°60" N	077°06" E
16	Nilgiri Eastern Slope	Kotagiri Range	Nilgiri North	11°54" N	076°89" E
17	Kalmalai	Shivery north Range	Mudumalai	11°59" N	076°58" E

Table 2. Details of shortlisted sites in Western aspect of Western Ghats (Kerala)

S.No.	Location	Forest Range	Forest Division	GPS	
				Latitude	Longitude
1	Kalmalai	Neyyar Range	Neyyar WLS	08°35" N	077°09" E
2	Kottur	Agasthiavanam Bio-park Range	Peppara WLS	08°33" N	077°09" E
3	Achankovil	Pathnapuram Range	Punalur Division	09°04" N	076°57" E
4	Kumaran Perur	Konni Range	Ranni Division	09°12" N	076°53" E
5	Thodupuzha	Kaliyar & Mullirungadu Range	Kothamangalam Division	10°02" N	076°45" E
6	Malayattur	Kuttampuzha Range	Malayattur Division	10°05" N	076°36" E
7	Ladysmith	Thamarassery Forest Range	Kozhikode Division	10°75" N	076°24" E
8	Allatur	Meppady Forest Range	Wyanad Division	10°95" N	076°17" E
9	Kinnanur	Kanhangad Range	Kannur Division	10°99" N	076°13" E

Fig. 1. Map showing study sites in the Eastern aspect of Western Ghats (Tamil Nadu)

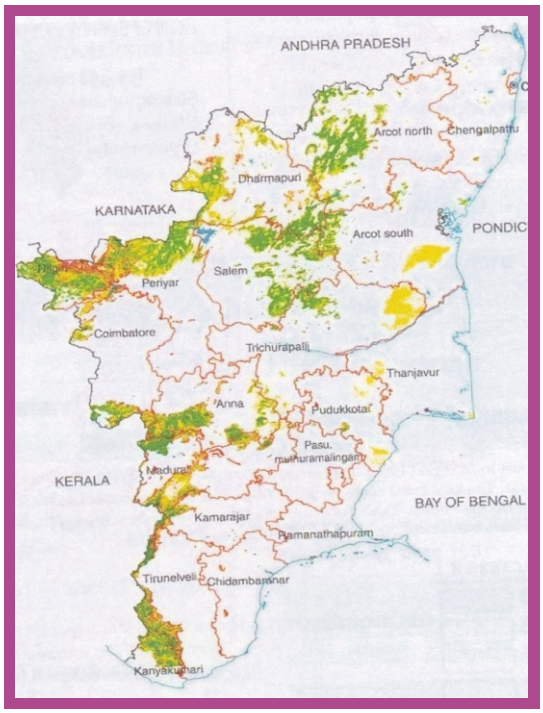


Fig. 2. Map showing study sites in the Western aspect of Western Ghats (Kerala)

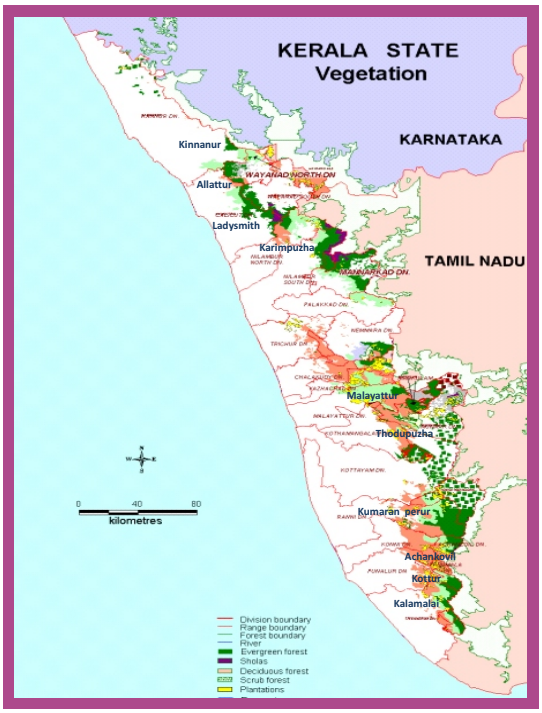


Image analyser studies on seeds

From the 17 shortlisted sites in Tamilnadu, good quality fresh seeds were collected from 82 trees spread over of study sites and subjected to image analyser studies. Seed parameters viz., weight of 25 seeds (g), area of seed(cm), length breadth (cm) perimeter, roundness, aspect and fullness ratio were recorded and results are given in Table 3. For each site 25 seeds per replication, selected randomly were studied under Image analyzer. Average weight of 25 seeds ranged from 12 to 18.499 g with mean weight across 7 study sites being 15.77 g. Average area of seed ranged from 1.34 to 9.02 cm^2 with mean area for seeds collected across 7 sites being 4.66 cm^2.

Table 3. Results of image analyser studies for 7 locations in Eastern aspect of Western Ghats

S.No.	Location	Number of trees studied	Weight of 25 seeds (gms)	Area (cm^2)	Length (cm)	Breadth (cm)	Perimeter	Roundness	Aspect ratio	Full ratio
1	Tekkumalai West	1	12.000	5.060	2.755	2.471	10.610	1.783	1.117	0.962
2	Kuttralam	9	14.525	3.440	2.470	1.956	9.560	1.963	1.269	0.938
3	Agamalai	9	18.499	4.390	2.690	2.227	9.753	1.743	1.212	0.948
4	Amaravathi	10	18.366	9.017	3.978	3.263	21.084	4.152	1.227	0.906
5	Hiriya Shige	35	17.650	1.622	5.022	4.303	20.903	2.696	1.172	0.949
6	South Bargur	7	13.554	7.788	3.865	3.111	21.872	5.031	1.249	0.897
7	Kalmalai	11	15.781	1.337	4.758	3.941	22.633	3.524	1.215	0.914
	Mean		15.77	4.66	3.65	3.04	16.63	2.98	1.21	0.93

Population studies

For studies on population structure including regeneration status in the shortlisted study areas, 1 km transects were laid out. At 0, 250, 500, 750 and 1000m along transect, a quadrat of 100 X 40 m (4000 sq. m) was laid out and all the individuals present within quadrat were measured for girth at breast height (gbh) and height along with its phenological status. On completion of population studies within 100 x 40 m quadrates, two sub quadrates of 10 X10 m was laid to study regeneration at either end of the quadrat (i.e.) 4000 sq. m of quadrat for population studies and 200 sq. m for regeneration study. For each study site, 2ha area was assessed for population structure while 0.1 ha was assessed for regeneration. The classification adopted for regeneration studies is detailed below:

- Recruits: Current year's seedling
- Seedling: More than I year (> 1) old and less than 1 meter (<1) height
- Sapling : More than 1 m (> 1) & absence of dead bark
- Pole: 1 to 2.5 m height and more than 10 cm (> 10) diameter at breast height (dbh)
- Tree : 1 to 2.5 m height and more than 10 cm (> 10) diameter, crown expanded and lower branches fall off

Table 4. Distribution of height classes (m) in study sites on Eastern aspect of Western Ghats (Tamil Nadu)

S.No.	Location	1.0-2.5	2.6-7.5	7.6-12.5	12.6-17.5	17.6-22.5	22.6-27.5	Total
1	Tekkumalai west	-	2	18	18	3	-	41
2	Singampatti	-	9	37	11	1	-	58
3	Kuttralam	-	9	29	10	9	2	59
4	Chokkampatti	-	40	9	-	-	-	49
5	Sivagiri	1	24	14	13	4	-	56
6	Erasakkanayakannur	-	103	17	-	-	-	120
7	Gandamanur	-	67	-	-	-	-	67
8	Agamalai	-	2	31	19	-	-	52
9	Amaravathi	-	-	3	9	17	5	34
10	Siruvattukadu	-	-	3	13	23	-	39
11	Bolampatti	-	2	31	51	24	-	108
12	Anaikatty	-	3	7	7	5	-	22
13	Hiriya Shinge	2	38	22	2	-	-	64
14	South Bargur	-	-	-	18	2	-	20
15	Thalamalai	-	2	25	8	18	-	53
16	Nilgiri Eastern slopes	-		26	7	-	-	33
17	Kalmalai	-	1	24	12	-	-	37
	Total	3	302	296	198	106	7	912

Fig. 3. Distribution of height classes (m) in study sites on Eastern aspect of Western Ghats (Tamil Nadu)

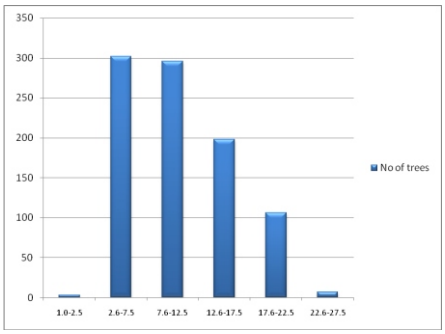
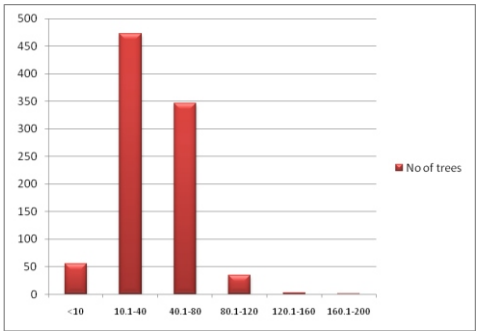


Fig. 4.Distribution of diameter at breast height (dbh) classes (cm) in study sites on Eastern aspect of Western Ghats (Tamil Nadu)



Population structure studies on Eastern aspect of Western Ghats

In all, 912 trees were studied in the 85 quadrates of 100 x 40 mt located with 17 study sites and these trees were grouped into different classes of height, diameter at breast height and clean bole height in Tables 4, 5 and 6 respectively. Trees were classified into different height classes with a mean interval of 2.5 meters (Fig. 3) while trees were classified into different diameter at breast

Table 5. Distribution of diameter at breast height (dbh) classes (cm) in study sites on Eastern aspect of Western Ghats (Tamil Nadu)

S. No.	Location	<10	10.1-40	40.1-80	80.1-120	120.1-160	160.1-200	Total
1	Tekkumalai west	-	22	18	-	1	-	41
2	Singampatti	-	38	20	-	-	-	58
3	Kuttralam	-	21	35	3	-	-	59
4	Chokkampatti	-	32	16	1	-	-	49
5	Sivagiri	-	22	30	4	-	-	56
6	Erasakkanayakannur	10	110	-	-	-	-	120
7	Gandamanur	24	43	-	-	-	-	67
8	Agamalai	-	31	15	4	1	1	52
9	Amaravathi	-	10	19	5	-	-	34
10	Siruvattukadu	1	16	22	-	-	-	39
11	Bolampatti	-	25	77	6	-	-	108
12	Anaikatty	-	12	10		-	-	22
13	Hiriya Shinge	20	33	10	1	-	-	64
14	South Bargur	-	3	12	5	-	-	20
15	Thalamalai	-	24	25	3	1	-	53
16	Nilgiri Eastern slopes	-	24	7	2	-	-	33
17	Kalmalai	-	7	30	-	-	-	37
	Total	55	473	346	34	3	1	912

Table 6. Distribution of clean bole height classes (m) in study sites on Eastern aspect of Western Ghats (Tamil Nadu)

S. No.	Location	<1	1-2.5	2.6-7.5	7.6-12.5	12.6-17.5	Total
1	Tekkumalai west		11	28	2		41
2	Singampatti		40	18			58
3	Kuttralam		14	42	2	1	59
4	Chokkampatti		26	23			49
5	Sivagiri		28	28			56
6	Erasakkanayakannur	1	50	69			120
7	Gandamanur		49	18			67
8	Agamalai			44	8		52
9	Amaravathi		1	22	10	1	34
10	Siruvattukadu			11	24	4	39
11	Bolampatti		3	77	27	1	108
12	Anaikatty		2	13	5	2	22
13	Hiriya Shinge	5	26	33			64
14	South Bargur			16	3	1	20
15	Thalamalai		5	46	2		53
16	Nilgiri Eastern slopes		1	30	2		33
17	Kalmalai		1	36			37
	Total	6	257	510	121	18	912

height classes with interval of 40 cm (Fig. 4) and grouped into different clean bole height classes with interval of 2.5 meters (Fig. 5).

The distribution curve of different height classes showed a shift towards higher height classes. Out of 912 trees assessed, most trees (302), were in the 2.6-7.5 m & 7.6 -12.5 m (296 trees) which were closely followed by 198 trees in 12.6 - 17.5 meter height class and 106 trees in 17.6 - 22.5 meter height class. Very few trees (7 trees) had height > 22.6 meters and were restricted to just 2 locations.

The distribution of diameter at breast height (dbh) for all 17 sites showed a slight shift towards higher girth classes (Fig. 4). Of 912 trees studied, 473 trees were in 10 40 cm group while 346 trees were in 40 - 80 cm group and 38 trees were having dbh > 80 cm. Very few saplings / pole trees (55 trees) were available in the <10 cm category.

Out of the 912 trees assessed, most trees (510) had a clean bole heigh of 2.6 - 7.5 meters closely followed by 257 trees with 1 - 2.5 meter clean bole height. Very few trees (139) had clean bole height of > 7.5 meters.

Population structure studies in the Western aspect of Western Ghats (Kerala)

On the eastern aspect of Western Ghats, 9 shortlisted sites were surveyed and trees, numbering 195 were marked in field for data collection on morphological parameters. The 195 trees marked for morphological studies were studied for their height, diameter at breast height and clean bole height. Height recorded from these trees was distributed into height classes at 2.5 meter intervals (Table 7 & Fig. 6), Diameter at breast height recorded was distributed into dbh intervals of 40 cm (Table 8 & Fig. 7) & Clean bole height was distributed into height classes of 2.5 m interval (Table 9 & Fig. 8).

Fig 5. Distribution of clean bole height classes (m) in study sites on Eastern aspect of Western Ghats (Tamil Nadu)

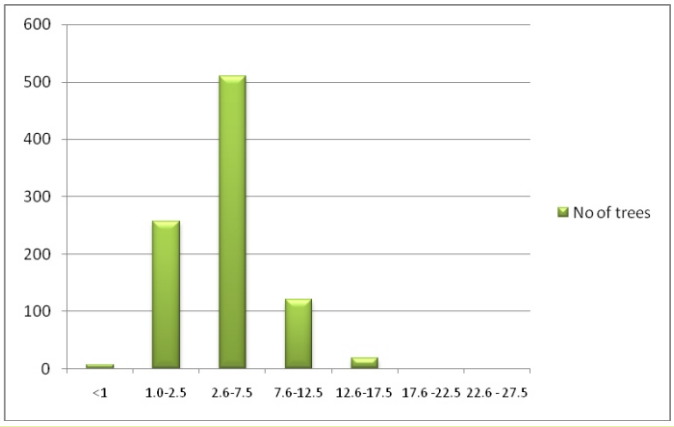


Fig 6. Distribution of height classes (m) in study sites on Western aspect of Western Ghats (Kerala)

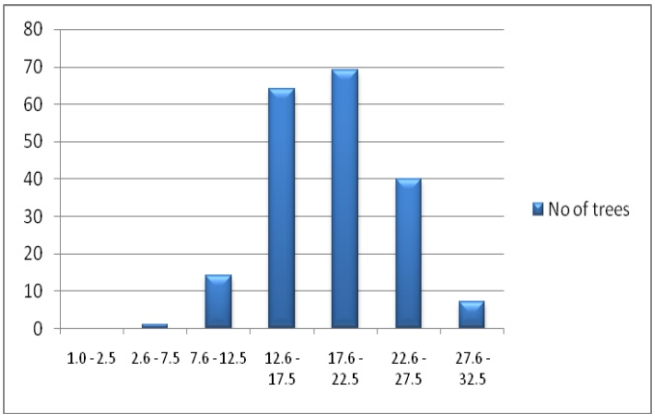


Table 7. Distribution of height classes (m) in study sites on Western aspect of Western Ghats (Kerala)

S. No.	Location	1-2.5	2.6-7.5	7.6-12.5	12.6-17.5	17.6-22.5	22.6.27.5	27.6-32.5	Total
1	Kalmalai	-	-	2	6	16	14	3	41
2	Kottur	-	-	1	4	12	16	4	37
3	Achankovil	-	1	1	5	6	3	-	16
4	Kumaran Perur	-	-	-	-	4	5	-	9
5	Thodupuzha	-	-	2	11	14	-	-	27
6	Malayattur	-	-	1	6	11	2	-	20
7	Ladysmith	-	-	4	2	1	-	-	7
8	Allatur	-	-	-	23	2	-	-	25
9	Kinnanur	-	-	3	7	3	-	-	13
		-	1	14	64	69	40	7	195

Table 8. Distribution of diameter at breast height (dbh) classes (cm) in study sites on Western aspect of Western Ghats (Kerala)

S. No.	Location	<10	10.1-40	40.1-80	80.1-120	120.1-160	160.1-200	Total
1	Kalmalai	-	28	13	-	-	-	41
2	Kottur	1	21	15	-	-	-	37
3	Achankovil	2	9	4	1	-	-	16
4	Kumaran Perur	-	1	8	-	-	-	9
5	Thodupuzha	-	12	14	1	-	-	27
6	Malayattur	-	6	14	-	-	-	20
7	Ladysmith	-	5	2	-	-	-	7
8	Allatur	-	12	13	-	-	-	25
9	Kinnanur	-	6	7	-	-	-	13
		3	100	90	2	-	-	195

Fig 7. Distribution of diameter at breast height (dbh) classes (cm) in study sites on Western aspect of Western Ghats (Kerala)

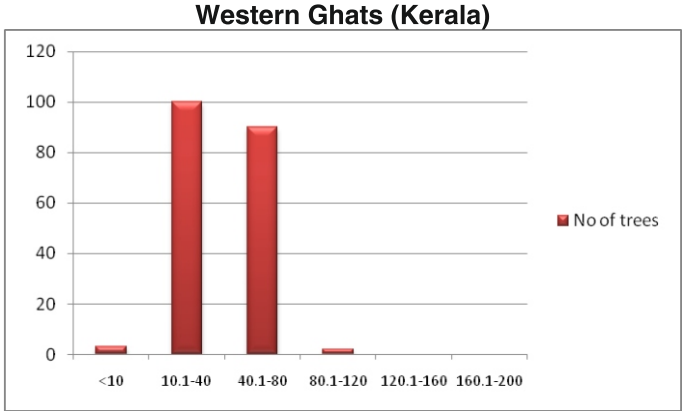
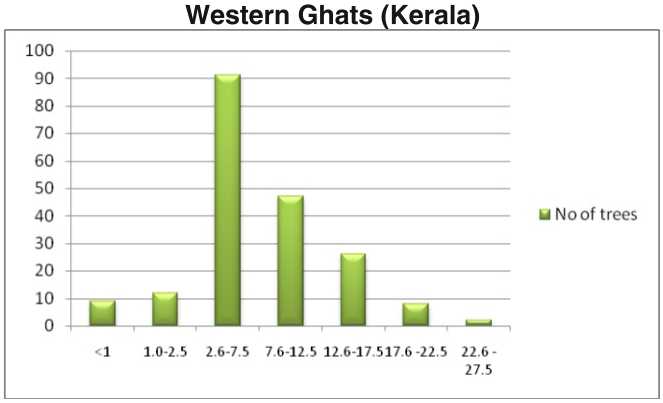


Fig 8. Distribution of clean bole height classes (m) in study sites on Western aspect of Western Ghats (Kerala)



The distribution curve of different height classes, for all 9 sites, show a marked shift towards lower height classes. Of the 195 trees assessed, most (69 trees), were in the 17.6 - 22.5 m which were closely followed by 64 trees in 12.6 - 17.5 meter height class and 40 trees in 22.6 - 27.5 meter height class. Very few trees (7 trees) were having height > 27.6 meters.

The distribution of diameter at breast height (dbh), for all 9 sites, showed a slight shift towards higher diameter classes (Table 8 & Fig. 7). Of 195 trees studied, 100 trees were in 10- 40 cm group while 90 trees were in 40 - 80 cm group and 2 trees were having dbh > 80 cm. Very few saplings / pole trees (3 trees) were available in the <10 cm category.

The distribution of clean bole height, for all 9 sites, showed a slight shift towards higher height classes (Table 9 & Fig. 8). Of 195 trees studied, most trees (91 trees) were in 2.6 - 7.5 m & 7.6 - 12.5 m (47 trees) which were closely

Table 9. Distribution of clean bole height classes (m) in study sites on Western aspect of Western Ghats (Kerala)

S. No.	Location	<1	1-2.5	2.6-7.5	7.6-12.5	12.6-17.5	17.6-22.5	22.6-27.5	Total
1	Kalmalai	1	1	11	13	12	1	2	41
2	Kottur	1	-	9	16	8	3	-	37
3	Achankovil	-	1	5	8	1	1	-	16
4	Kumaran Perur	-	-	1	1	4	3	-	9
5	Thodupuzha	5	4	16	1	1	-	-	27
6	Malayattur	2	2	13	3	-	-	-	20
7	Ladysmith	-	2	5	-	-	-	-	7
8	Allatur	-	1	21	3	-	-	-	25
9	Kinnanur	-	1	10	2	-	-	-	13
		9	12	91	47	26	8	2	195

followed by 26 trees in 12.6 - 17.5 meter clean bole height class. Few trees (10 trees) were having clean bole height > 17.6 meters.

Population studies

Growing stock of individuals of trees can be classified into different categories like seedlings, saplings, young trees and mature trees. Relative distribution of individuals in different girth classes is used to prepare population structure for species in a forest and it can partly indicate its regeneration behaviour and future composition of the forest community. Though size of the individuals may not be correlated with age, an overall population trend can be obtained. Population structure data have been used to interpret succession pattern and to develop succession models (Shugart, 1984). A shift in the trend towards higher girth classes of individuals and absence in lower girth classes may be a sign that a population is on its way to local extinction, while the occurrence of greater proportion of individuals in lower girth categories is indicative of frequent reproduction (Knight, 1975; Buell, 1945).

In order to understand the morphological characters and population structure of *P. marsupium*, 17 populations on eastern aspect and 9 populations on western aspect was shortlisted for study based on the distribution of the species. 556 trees or individuals on the eastern aspect representing 16 populations and 195 trees representing 9 populations on western aspect of Western Ghats were studied for their morphological characters.

Of 556 trees studied - included in the Eastern aspect of Western Ghats, 277 trees (49.82%) were in 10 - 40 cm group while 203 trees (36.53%) were in 40 - 80 cm group and 46 trees (8.26%) were having dbh > 80 cm. Very few saplings, 30 trees, (5.40%) were in <10 cm category. Low number of individuals in < 10 cm category is of concern when the overall picture of 16 sites is taken into consideration. Though diameter at breat height (dbh) class distribution of 556 trees, studied over 16 sites, showed a marked shift towards higher diameter category, variation in diameter at breast height class distribution amongst individual study sites were noted. Study sites viz., Tekkumalai west, Sivagiri, Amaravathi, South Bargur, Thalamalai and Kalmalai exhibited a near normal distibution of diameter at breast height class while Singampatti, cuttralam, Erasakkanyakannur, Gandamanur, Agamalai, Siruvattukadu, Bolampatti, Anaikatti, Hiriya Shige, Nilgiri Eastern Slopes showed a marked shift towards higher diameter at breast height classes indicating less regeneration. Hence these 10 sites - Singampatti, Cuttralam, Erasakkanyakannur, Gandamanur, Agamalai, Siruvattukadu, Bolampatti, Anaikatti, Hiriya Shige & Nilgiri Eastern Slopes - out of 16 sites studied on eastern aspect of Western Ghats that need augmentation of regeneration as data of these locations show very low regeneration.

Data on population structure was collected from 17 sites spread over western aspect of Western Ghats. In all, an area covering 34 ha was studied for trees while an area of 1.70 ha was studied for regeneration in these 17 locations. In all, 912 trees were studied in 85 quadrates of 100 x 40 m indicating an average density of 27 trees per ha. For regeneration 170 sub-quadrates of 10X10 were studied indicating an average density of 37 saplings per ha. These 63 saplings were studied from 16 sub-quadrates - spread over 5 locations - while in remaining 154 sub-quadrates spread over 12 locations - regeneration was absent. Regeneration study results indicate urgent need to augment regeneration of *P. marsupium*. Erasakkanyakannur and Boluvampatti sites containing high density of *P. marsupium* (> 50 trees / ha.) can be converted into Seed Production Areas for *P. marsupium* by adopting appropriate techniques for conversion by removal of poor performers.

Of 195 trees included in the western aspect of Western Ghats - 100 trees (51.28%) were in 10 - 40 cm group while 90 trees (46.15%) were in 40 - 80 cm group and 2 trees (1.03%) were having dbh > 80 cm. Very few saplings (3 trees) were available in the <10 cm category (1.54%). Low number of individuals in <10 cm dbh in all 9 sites studied along western aspect of Western Ghats is of concern and steps to augment regeneration needs to be carried out. Out of 9 sites studied in Western aspect of Western Ghats, excluding Achankovil, remaining 8 sites viz., Kalmalai, Kottur, Lady Smith, Kumaran Perur, Thodupuzha, Malayathur, Alathur and Kinnaur need steps to augment regenration of *P. marsupium*.

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Recent literature on FGRs & TIP

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ENVIS ACTIVITIES

Release of mobile application (android) on important tree pests of south India

The ENVIS Centre on Forest Genetic Resources and Tree Improvement at the Institute of Forest Genetics and Tree Breeding (IFGTB) has developed a mobile application named **"Tree Pests of India".** It was released by the Secretary of MoEF&CC Shri. Ajay Narayan Jha, IAS, in the presence of Senior Economic Advisor Dr Anandi Subramanian, IES, Economic Advisor Shri. Yashvir Singh and officials from Govt. of Gujarat during the 'Summary Evaluation and Roll-out of the Revamped ENVIS Scheme' held at Gandhinagar on 17th March 2017. The mobile application (android) provides basic information on the major insect pests of important tree species of south India. It also includes the various symptoms of diseases and control measures to be followed in each case. The mobile application can be downloaded from the link given below:

https://play.google.com/store/apps/details?id=treepest.treepest

Brochure Precious trees

An **information brochure** with tree passport data named **"Precious trees of India - Series I"** was released by the Secretary of MoEF&CC Shri. Ajay Narayan Jha, IAS, in the presence of Shri. R.S.Prashanth, Director, IFGTB. The brochure highlights some important tree species endemic to India that have tremendous resource potential. The genetic resources of these trees can be utilized for meeting out the various demands of mankind in a sustainable manner and hence they deserve a greater attention and better conservation status.

ABOUT IFGTB

Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore is a National Research Institute under the Indian Council of Forestry Research and Education. IFGTB envisions a wood secure society. The Institute primarily aims to carry out research to improve productivity of forest tree species through conventional breeding programmes and biotechnological interventions. The major areas of research include tree improvement , breeding, planting stock improvement, marker assisted selection, genomics, clonal propagation, agroforestry systems, climate change research, integrated disease and pest management, seed handling and testing, eco restoration and conservation.

ABOUT ENVIS

ENVIS established by the Government of India, in 1982 has been on providing environmental information to decision makers, policy planners, scientists and engineers, research workers, etc. all over the country. It is a comprehensive decentralized information system on environment involving effective participation of institutions / organisations in the country actively engaged in work relating to different subject areas of environment. A large number of nodes, known as ENVIS Centres, have been established in the network to cover the broad subject areas of environment with a Focal Point in the Ministry of Environment, Forest and Climate Change.

INSTRUCTIONS TO CONTRIBUTORS

Dear Author/ Subscriber/ Contributor,

We invite contributions to the ENVIS Newsletter issues! The ENVIS Centre at IFGTB focuses on Forest Genetic Resources and Tree Improvement. It aims to act as a window for quality scientific publications and a forum for presenting your thinking on the challenges in the fields of FGRs and tree improvement. The ENVIS Newsletter, Van Vigyan, a quarterly publication, publishes original research articles, reviews, reports, research highlights, news-scan etc., related to the thematic area of the ENVIS Centre. Original research and review articles, notes, research and meeting reports are invited for the newsletter. Details of forthcoming conferences / seminars / symposia /trainings / workshops also will be considered for publication in the newsletter. Articles may be sent in Times New Roman (with font size 12) in double spacing with a maximum of 5-6 typed pages. Photographs/line drawings and graphs need to be of good quality with clarity for reproduction in the newsletter. Only electronic submission will be accepted.

Details may be sent to: ifgtb@envis.nic.in.

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