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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 Resource Partner 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 Resource Partner. 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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ISSN: 2394-7543

ENVIS Newsletter
Forest Genetic Resources & Tree Improvement
VAN VIGYAN

INSTITUTE OF FOREST GENETICS AND TREE BREEDING

(Indian Council of Forestry Research and Education)

- Volume 5 Number 2
- A Quarterly Issue
- July - September 2018

From the Director's Desk

Greetings from IFGTB!

This quarter has been a very eventful one for the ENVIS RP on Forest Genetic Resources and Tree Improvement. The ENVIS holds the credit of being the first and only Centre to conduct the Green Skill Development Programme of the MoEF&CC on "Quality Planting Material Producer" in the country. This tailor-made GSDP programme aimed at capacity building of entrepreneurs for development of tree nurseries. The outreach of the programme has been so wide, that we are envisaging another course during the current year. The GSDP has proved to be an excellent platform to amplify the gains of tree improvement and conservation of forest genetic resources. A brief report on the training finds a place in this newsletter.

This issue carries information on Indian agarwood, a globally threatened species, listed in the IUCN red list and CITES. This information will provide baseline data for policy makers to plan Non-Detrimental Findings (NDF) for the species. An article on the status of traded FGRs of the Eastern Ghats is also included.

I am sure, this newsletter will raise many thought provoking questions and provide food for thought for the forestry researchers.

Mohit Gera
Director, IFGTB

In this issue

1. Know Your Trees - *Aquilaria malaccensis*
2. Vegetation analysis for Assisted Natural Regeneration (ANR) of traded Forest Genetic Resources of Eastern Ghats
3. ENVIS Activites

Know Your Trees - *Aquilaria malaccensis*

Know your trees - *Aquilaria malaccensis*

Taxonomic classification

Kingdom : Plantae
Phylum : Tracheophyta
Class : Angiosperms
Order : Malvales
Family : Thymelaeaceae
Genus : *Aquilaria*
Species : *malaccensis*

Common names

English: Agarwood, Aloeswood, Eaglewood, Lign-aloes (Biblical)

India : Agar (Hindi); Sasi (Assamese); Aghil (Tamil); Aguru (Sanskrit, Kannada, Telugu); Agor (Bengali)

Introduction

Aquilaria malaccensis syn. *A. agallocha* is one of 13 recognized fragrant resin producing *Aquilaria* species in the Indo-malayan genus *Aquilaria*, family Thymelaeaceae (Lee and Mohamed, 2016). Commonly known as agarwood, the species produces a dark coloured resinous aromatic compound in the heartwood of the tree upon infection by microbes. The resinous compound is believed to be produced by the plant as a self-defense mechanism against fungal infection, but there are also views that it is produced by the fungus drawing raw material from the plant. The infected plant heartwood is highly prized and used in perfumery, incense sticks and as a raw material in traditional and modern medicines. Owing to high demand for agarwood, infected trees were harvested in an unsustainable manner during the past leading to local extinction in many areas. Consequently, it is listed as Critically Endangered in the IUCN Red List (Harvey-Brown, 2018) and in Appendix II (potentially threatened species) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2010).

In India, *A. malaccensis* is mainly found in the evergreen forests of northeast India. Though there are 21 *Aquilaria* species recorded worldwide, only 13 are reported to produce fragrant resin (Lee and Mohamed, 2016). India is home to only two species of *Aquilaria* namely *A. malaccensis* and *A. khasiana*. *A. macrophylla* earlier reported from India is now considered as *Gonostylus macrophyllus*.

Due to high medicinal and perfumery value, the species has a great demand in the national and international market hence the attempts are now being made to cultivate the species in plantations in India and other places around the world. Currently, the species is mainly surviving in plantations, home gardens and along with tea plantations in Assam and its adjoining areas of northeast India and Bangladesh and significantly contributing to the local economy of the region. Two distinct variants “Bhola sanchi” and “Jati sanchi” of *A. malaccensis* are cultivated in Assam, of which former is reported to grow faster and yield less agarwood than the latter variant which is slow growing and high yielder (Saikia and Khan, 2013).

Distribution

Aquilaria malaccensis is found in Bangladesh, Bhutan, India, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, and Thailand. The World List of Threatened Trees (Oldfield *et al.,* 1998) listed Iran as one of the countries with a population of *A. malaccensis*, but an exploratory review in 2002 by CITES confirmed that Iran has no record of the species (CITES, 2003). In India, it occurs mostly in the foothills of North-Eastern states as well as West Bengal up to an altitude of 1000 m above mean sea level. The plant grows well in mean annual maximum temperature of 22-28^{0}C and a mean annual minimum temperature of 14-21^{0}C and prefers a mean annual rainfall of 1500 to 6500 mm. In Assam, it is cultivated extensively in Upper Brahmaputra Valley (Beniwal, 1989).

Botanical Description

Aquilaria malaccensis Lamk. is medium to large sized tree, 20 to 40 m tall, usually with a straight bole, sometimes fluted with thick buttresses up to 2 m high, bole up to 60 cm in diameter, with thin, smooth, ash coloured tough bark. Branchlets slender, pale brown, pubescent, glabrescent. Wood light soft and porous. Leaves simple, alternate; petiole 4-6 mm long; blade elliptical-oblong to oblong-lanceolate, 7.5-12 cm × 2.5-5.5 cm, chartaceous to subcoriaceous, glabrous, sometimes pubescent and glabrescent beneath, shiny on both surfaces, base acute, attenuate or obtuse, apex acuminate, acumen up to 2 cm long; veins in 12-16 pairs, rather irregular, often branched, elevated and distinct beneath, curving upward to the margin, plane or obscure above. Inflorescence a terminal, axillary or supra-axillary, sometimes internodal umbel, usually branched into 2-3 umbels, each with about 10 flowers; peduncle 5-15 mm long; pedicel slender, 3-6 mm long; flowers 5-merous, campanulate, 5-6 mm long, green or dirty-yellow, scattered puberulous outside; floral tube nearly glabrous inside, distinctly 10-ribbed, persistent in fruit; calyx lobes 5, ovate-oblong, 2-3 mm long, almost as long as the tube, reflexed, densely puberulous within; petaloid appendages 10, inserted at the throat of the tube, oblong or slightly ovate-oblong, about 1 mm long, slightly incurved, densely pilose; stamens 10, free, emerging from the throat of the tube, filamentous, 1.2-2 mm long, episepalous ones longer than the others; anthers linear, obtuse; pistil included; ovary ovoid, 1-1.5 mm long, 2-celled, densely pubescent; style obscure, stigma capitate. Fruit a loculicidal capsule, obovoid or obovoid-cylindrical, 3-4 × 2.5 cm, usually compressed, pubescent, glabrescent, base cuneate, apex rounded; pericarp woody. Seed ovoid, 10 × 6 mm including a beak 4 mm long, densely red-haired, bearing from the base a twisted, tail-like, pubescent appendage as long as the seed. (Hooker, 1886; Beniwal, 1989).

Phenology and Reproductive Biology

Flowering occurs from April to June, and flowering phenophase lasts for about 2 months. The time required for fruit setting is about one month and seed maturation is about two months from flowering. In upper Assam, flowering starts in the later parts of March if there is early monsoon. Otherwise, flowering occurs from April onwards. In Tripura flowering takes place in April-May and fruiting takes place in June-July. Flowering is

Fruits of agarwood

Know Your Trees - *Aquilaria malaccensis*

influenced by temperature and rainfall. *A malaccensis* is a highly cross pollinated species and mode of pollination is entomophilous. Generally flowering is pre-monsoon and fruiting is during monsoon, as an adaptation for survival. About 10-15% of capsule split open naturally and seeds remain attached to the plant hanging by the funicle cord (thread) for 2-4 days till they drop down or are blown away by winds. Seeds are carried away by wasps, which disperse the seeds (vespichory) (Saha and Datta, 2018; Borogayary *et al.,* 2018).

Silviculture of the species:

Collection of seeds

Seeds are collected from mature fruits. Fruits have normally two seeds. Seed collection can be started from mid-June and continued till mid August. Peak time of collection is July-August. Maturity of capsule can be judged by observing the easy splitting of capsule on pressure between two fingers. Fruits should be dried under shade for two days before extraction of seeds. For transportation of seed to long distances well ventilated cotton cloth bag should be used. One kg of fruit will give about 1300 seeds. Individual seed weight ranges from 29 to 135 mg and seed weight has strong effect on germination. Germination percentage increases with increase in seed weight; heavier seeds also need less time for germination. The seedling growth parameters are also better with heavy seeds.

Agar cultivated with tea

Therefore sowing of heavy seeds of over 80 mg fresh weight is recommended (Uma Shankar, 2012).

Processing and handling

Aquilaria seeds are recalcitrant, and rapidly lose viability at moisture content below 20%. The seed cannot be stored for long and should be sown within 2-5 days after collection. Storing in refrigerator may prolong the viability up to 30 days. The seeds do not require any pre-treatment.

Sowing medium and germination

Raised seed beds are required as seeds are sensitive to high moisture and water logging. For approximately 1000 seedlings, two beds of 2.5 x 1.2 m are sufficient. Initial shading is required. Sand medium is best for raising the seedlings, and it can be mixed with farmyard manure or cow dung. Appropriate mycorrhiza can be inoculated. The seeds can be sown at 5 x 5 cm spacing on top of the bed and slightly pressed into the medium. One kg of seeds will give about 1000 seedlings. Germination of seed is epigeal and cotyledons are raised above the ground where they continue to provide nutritive support to the growing plants. Germination starts in 10-12 days of sowing and completes within one month. After germination, seedlings attaining 4-5 cm height with 2-3 leaves should be transferred to the poly bags (20 x 25 cm) containing sand, soil and FYM in the ratio of 1:2:1. The seeds can also be directly germinated in root trainers (Saikia and Shrivastava, 2013).

Planting in the field

Seedlings of 30-60 cm height, generally achieved in 1-1.5 years, are ready for planting. Plantation in the month of May to September during monsoon, gives better survival of the seedlings in the field. The spacing of 2.5 to 3.5 m is generally adopted for block plantations, and it may be wider in agroforestry or in tea estates. The growth is good in sandy to sandy-clay soils.

Care after plantation

After transplanting to the field, the site should be kept free from weeds for better and faster growth. To provide proper aeration hoeing should be done at 50 cm radius around the seedlings at 3-4 months interval. Plantation should be protected from grazing.

Fertilization

In plantations that are intensively managed, Urea: SSP: MOP @182:518:55 (gm) can be applied for each plant after 2 years of plantation. Again after 3 years of planting these should be applied @ 275:781:80 (gm) and in fourth year the rate of fertilizer should be 458:1300:138 (gm) against each plant. After 6-7 years of planting 400-500 gm of nitrogen rich fertilizer should be supplied to each plant.

Pest and Disease Management

Aquilaria are susceptible to various pests and diseases. Care should be taken to ensure good hygiene during nursery, early growth and at the planting site. Germinating seeds and young seedlings are prone to damping off caused by fungi. Careful preparation of seedbed avoiding too much moisture is the best precaution. The initial establishment of seedlings is a problem and most of the seedlings die due to root infestation by soil borne pathogens. Treatment with fungicide may be necessary.

Agarwood defoliator

Agarwood infested by borer showing the healed borehole

Heortia vitessoides a defoliating caterpillar is the main pest of this plant. The intensity of attack during the months of March-April (drier season) is more as compared to the months of July-August (rainy season). Agar trees in open condition are more susceptible to this pest as compared to the trees under shade. Hand picking of the caterpillar and destruction of clusters of caterpillars is recommended in nurseries and small plantations. Application of neem seed kernel extract or green chilly extract at 7-14 days interval is also effective. In case of severe infestation insecticides like Endosulfan 35 EC, Nuvacron 40 EC, Ekalux EC 25 can be applied at 10-15 days interval. Generally chemical control is not advisable as it kills the beneficial insect borer associated with agarwood formation.

Formation and Development of Agarwood:

Natural infection

The diseased wood of the Agar tree which is formed as a result of fungus-host interaction is commercially termed as Agarwood. Plants above the age of seven years are vulnerable for infection by the fungus. Natural infection by the fungi occur in the wood when trunks of standing trees are bored by the larvae of *Zeuzera conferta*, a stem borer (Gogoi and Mitra, 1994). The stem borer larvae make vertical tunnels which are the initial sites of infection and from there, infection gradually spreads up and oleoresins are accumulated in the infected areas. The

invasion by fungi through these tunnels has led to the hypothesis that the oleoresinous deposits in agar trees are the results of defence mechanism inherent to the tree itself (Gibson, 1977). However, there are reports that the oleoresin is produced by the fungus and not the plant, which only provides the substrate (Adams *et al.,* 2016). Although, various workers have been investigating the different aspects regarding agar wood formation, what triggers agar wood to form is still an unsolved mystery. Naturally the fungal infection takes long time to establish and trees of about 50 years old may produce highest concentration of agarwood. Only 7-10% of the trees are reported to get infected (Ng *et al.,* 1997) though the rate of infection is much higher in Upper Assam due to presence of *Zeuzera conferta* in large numbers. If the infection starts at a young age (5-6 years), then the tree may yield agarwood at 10 years. In India, Rain Forest Research Institute, Jorhat has identified three fungi responsible for agarwood formation and is maintaining the pure cultures of the same in the laboratory for future studies as well as artificial inoculation (Borah 2015). TERI also has identified specific microbes (Vide patent No: 664/DEL/2015) that have capacity to induce production of agarwood through artificial infection methods.

Artificial infection

Several techniques are practiced for artificial induction of agarwood in *Aquilaria*. Broadly they can be classified as physical, chemical and biological methods. In physical method, mechanical injury is caused to the plant to allow infection to take place, by deep cuts or driving of nails, partial trunk pruning, burning-chisel drilling, etc., but this can be successful only if sufficient pathogen load is available in the locality. In chemical method, certain hormones and chemicals are injected into the tree, which causes formation of agarwood. There is a kit called the CA Kit (CA- Cultivated Agarwood) developed in the University of Minnesota and patented in USA which

Physical damage to tree for agarwood formation

is in use. There are reports of failure as well as death of the tree, when chemical methods are employed. In biological method, the disease causing organism is cultured and injected into the plant, allowing its natural growth and spread within the plant. This method has been reported to be reliable and effective. Since the recent studies indicate that the production of oleoresins may be by the pathogen rather than the host, the comparatively higher success rate of biological methods is justified.

Key for identification of infected agar trees

The external symptoms for identifications of initiation or formation of agarwood in agar tree are described below-

I) Appearance of borer hole

ii) Oozing out of watery substances from fresh borer hole

iii) Accumulation of frass at the base of the tree.

iv) Closing of borer hole by the growth of host tissue leaving a small spindle shaped mark.

v) Longitudinal cracks on the trunk/bole.

vi) A poor unhealthy crown with small and yellow leaves

vii) Swelling or depression and sometime canker formation on the bole/tree.

viii) Appearance of hordes of ants in the tissue and formation of ant's nests.

Yield, trade and economics:

Crop Maturity and Harvesting

Time of harvesting depends on the extent of disease infestation and oleoresin accumulation in the hardwood. The infected tree whose further growth is arrested can be selected for harvesting hardwood for commercial use by observing the black patches in the bark which is a indicator of infection. Dry season between February to May is preferred for harvesting to get maximum concentration of oil and less waxy substances in the wood.

Post-harvest processing

Wood chips or chips powdered mechanically without generating heat are soaked in water for 2-3 days and transferred to stainless steel vessel which is part of a distillation unit. The steam distillation is done for 30-36 hours. Oil and water gets collected in a separator and is stored. The oil and water ratio in the condenser is kept low on account of the high boiling point. Oil is stored in closed container preferable in Aluminum bottles.

Yield

Under proper management practices, an agarwood tree of 6-7 years having 30-45 cm girth can be artificially inoculated and harvested after 2-3 years. A 10 year old tree may yield 15-20 kg of agarwood which upon processing may yield 3-4 kg of chips. These chips, if distilled can yield 10-15 gm of oil. Generally 1700 trees are planted per hectare at 3.5 x 4.5 m spacing. Thus, one hectare can fetch about Rs 1.5 to 2 crores from oil (provided oil is of good quality), besides generating extra income from the intercrops during early stages of growth. Three grades of oil are being extracted from the agarwood namely Boya, Boha and Khara and the price is highly variable, and the income mentioned is only indicative.

Regulation of Harvesting and Trade:

Trade in India

In India harvesting of agarwood species from wild is banned. Harvesting from plantations is permissible, for which plantation has to be registered with the Forest Department. However there is no regulation on community lands where the species exists, and much of forests in northeast India are under the possession and control of local communities.

Export of all wood products (including log, timber, chip, powder, flake, dust, etc.) of all species is prohibited through the Export-Import Policy and therefore, the agarwood export is also banned. Agarwood imports are also under 'restricted' category items and are subjected to CITES regulations. Therefore, import of unprocessed Agarwood into India requires a CITES permit from the exporting country. Re-export of Agarwood in the form of processed incense chips, oil and dust are permissible with CITES re-export permit.

International trade

Agarwood and its products from *Aquilaria* spp. are traded mainly in the form of logs, chips, carvings, powder and oil. The volume of trade from Asia-pacific is estimated at 10 million cu.m. The major importers of logs are China and Hong Kong, while the major exporter is Indonesia. Agarwood chips are exported mainly from Malaysia, Singapore and Indonesia and imported mainly by UAE, China,

Singapore and Japan. Singapore is a major importer as well as exporter, as it does value addition and re-export. Agarwood carvings are exported mainly from Bangladesh. Thailand is the major exporter of agar oil, while South Africa, France and Singapore are the main importers, of whom Singapore re-exports after value addition (Source: CITES Trade Database). The global market of agar oil and other agarwood products was in the range of 6-8 billion USD in 2013, and is steadily increasing. The value of agar oil was $30,000- 40,000 in 2014. The agarwood chips were fetching $30- 10,000 per kg depending on the resin content in 2015 (Chowdhury *et al.,* 2017).

India does not figure anywhere as a significant player in international trade, in spite of having

Agarwood beads

Agarwood chips

Agar oil of different grades

Men at work extracting wood chips

substantial population in plantations as it is yet to fix its quota for export under CITES. This has to be done after carrying out the Non-Detriment Findings study (both for wild populations and plantations) through a CITES Scientific Authority. Only then the country would be able to make use of the agarwood resources for export and thus ensure income generation for the agarwood cultivators.

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VAN VIGYAN

Vegetation analysis for Assisted Natural Regeneration (ANR) of traded Forest Genetic Resources of Eastern Ghats

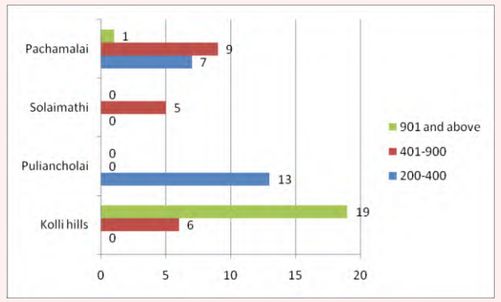
Conservation of forest genetic resources (FGR) for sustainable utilization is undoubtedly the need of the hour to improve the health and wealth of forests and well being of mankind. Degradation of forests continue to cause severe problems in the tropical forests especially in forests of Kolli hills and Pachamalai located in the Eastern Ghats of Tamil Nadu where anthropogenic activities are very high. Restoration efforts to improve the quality of such degrading forests has been felt essential and one such tool applied is Assisted Natural Regeneration (ANR), a variation of enrichment planting which was first developed for tropical forests with poor natural regeneration. It is based on the ecological principle of secondary forest succession, utilizes natural processes, and promotes the regeneration of indigenous species. As ANR relies on natural processes, it is especially effective in restoring and enhancing biological diversity and ecological processes.

A study was undertaken in Kolli hills and Pachamalai in Tamil Nadu, to collect seeds / propagules, develop nursery for the selected species and carry out aided natural regeneration through gap planting. The following species that are traded from Kolli hills were selected for the study.

S. No.	Species	Local/ Common name	Family	RET category
1.	*Aegle marmelos*	Vilvam / Bael	Rutaceae	Vulnerable
2.	*Albizia amara*	Arappu	Leguminosae	-
3.	*Canarium strictum*	Karunkungiliyam	Burseraceae	Threatened
4.	*Celastrus paniculatus*	Valuluvai / Jyotishmati	Celastraceae	Near threatened
5.	*Givotia rottleriformis*	Thaala Maram / White Catamaran tree	Euphorbiaceae	-
6.	*Limonia acidissima*	Vila maram/ Wood apple	Rutaceae	Vulnerable
7.	*Santalum album*	Sandhanam/ Sandal	Santalaceae	Endangered
8.	*Sapindus emarginatus*	Poochakai/ Soapnut	Sapindaceae	-
9.	*Schleichera oleosa*	Kumbadiri/ Lac tree, Kusum	Sapindaceae	-
10.	*Strychnos nux-vomica*	Etti maram/ Strychnine Tree	Loganiaceae	Vulnerable
11.	*Syzygium cumini*	Naaval / Jamun	Myrtaceae	-
12.	*Terminalia bellirica*	Thandri / Belliric Myrobalan	Combretaceae	Near threatened

Field surveys was conducted from July to November 2017 to assess and document the species diversity at 4 locations in Kolli hills and Pachamalai, stratified at three different altitude ranges 200-400 msl, 401-900 msl, >901 msl (approx. upto 1350 msl). Sixty survey plots each spreading over 1 ha were laid in Kolli hills, Puliancholai, Solaimathi and Pachamalai, 20 quadrats each at three different altitudes were marked and enumerated for the vegetation comprising trees, saplings and seedlings/ recruits. A total of 291 species from 81 families were recorded in the four locations.

Distribution of quadrats across four locations



Occurrence of the families in the study area

Family	No. of species	Relative Proportion of each family (%)
Leguminosae	26	8.93
Rubiaceae	22	7.56
Apocynaceae	14	4.81
Malvaceae	14	4.81
Acanthaceae	12	4.12
Moraceae	11	3.78
Rutaceae	10	3.44
Phyllanthaceae	9	3.09
Sapindaceae	9	3.09
Celastraceae	8	2.75
Euphorbiaceae	8	2.75
Oleaceae	7	2.41
Rhamnaceae	7	2.41
Lamiaceae	6	2.06
Lauraceae	6	2.06
Ebenaceae	5	1.72
Meliaceae	5	1.72
Boraginaceae	4	1.37
Compositae	4	1.37
Ranunculaceae	4	1.37
Rosaceae	4	1.37
Solanaceae	4	1.37
Anacardiaceae	3	1.03
Burseraceae	3	1.03
Combretaceae	3	1.03
Convolvulaceae	3	1.03
Dioscoreaceae	3	1.03
Fabaceae	3	1.03
Menispermaceae	3	1.03
Piperaceae	3	1.03
Araceae	2	0.69
Asparagaceae	2	0.69
Asteraceae	2	0.69
Bignoniaceae	2	0.69
Calophyllaceae	2	0.69
Cannabaceae	2	0.69
Capparaceae	2	0.69
Elaeagnaceae	2	0.69
Loganiaceae	2	0.69
Melastomataceae	2	0.69
Olacaceae	2	0.69
Pteridaceae	2	0.69
Putranjivaceae	2	0.69
Salicaceae	2	0.69
Sapotaceae	2	0.69
Verbenaceae	2	0.69
Vitaceae	2	0.69
Achariaceae	1	0.34
Amaranthaceae	1	0.34
Annonaceae	1	0.34
Arecaceae	1	0.34
Aristolochiaceae	1	0.34
Begoniaceae	1	0.34
Colchicaceae	1	0.34
Commelinaceae	1	0.34
Connaraceae	1	0.34
Cornaceae	1	0.34
Cucurbitaceae	1	0.34
Cyperaceae	1	0.34
Elaeocarpaceae	1	0.34
Erythroxylaceae	1	0.34
Hernandiaceae	1	0.34
Hypoxidaceae	1	0.34
Icacinaceae	1	0.34
Linaceae	1	0.34
Magnoliaceae	1	0.34
Malpighiaceae	1	0.34
Moringaceae	1	0.34
Myristicaceae	1	0.34
Myrtaceae	1	0.34
Opiliaceae	1	0.34
Osmundaceae	1	0.34
Poaceae	1	0.34
Polygonaceae	1	0.34
Primulaceae	1	0.34
Sabiaceae	1	0.34
Santalaceae	1	0.34
Smilacaceae	1	0.34
Symplocaceae	1	0.34
Ulmaceae	1	0.34
Zingiberaceae	1	0.34
	291	**100.00**

Leguminosae followed by Rubiaceae dominated in the study area while the spread of other families in descending order were Apocynaceae > Malvaceae > Acanthaceae > Moraceae > Rutaceae > Phyllanthaceae > Sapindaceae > Celastraceae and so on. Under the family Leguminosae, *Abrus precatorius, Acacia caesia, Acacia instia, Acacia leucophloea, Acacia planifrons, Acacia tarta, Alysicarpus vaginalis, Caesalpinia caudata, Canavalia virosa, Cassia absus, Cassia fistula, Cassia sp., Chionanthus mala-elangi, Clianthus sp., Clitoria ternata, Dalbergia paniculata, Derris scandens, Entada pursaetha, Entada scandens, Pongamia pinnata, Pterolobium hexapetalum, Tamarindus indica, Tephrosia purpurea, Tephrosia villosa* and *Zornia gibbosa* were recorded. However the occurrences of the traded species taken up for the study were found to be low in number.

Distribution of study species across locations in Kolli Hills and Pachamalai

	Kolli Hills			Puliancholai			Pachamalai			Solaimathi		
	Trees	Saplings	Recruits	Trees	Saplings	Recruits	Trees	Saplings	Recruits	Trees	Saplings	Recruits
Aegle marmelos	0	0	0	0	0	0	0	0	0	0	0	0
Albizia amara	2	0	0	19	16	4	3	1	1	0	0	0
Canarium strictum	8	8	10	0	0	0	0	0	0	0	0	0
Celastrus paniculatus	1	1	3	0	0	0	0	0	0	0	0	0
Givotia rottleriformis	2	0	0	0	0	0	0	0	0	0	0	0
Limonia acidissima	0	0	0	0	0	0	0	0	0	0	0	0
Santalum album	1	3	0	0	0	0	0	0	0	0	0	0
Sapindus emarginatus	0	0	3	0	3	0	1	0	1	0	0	0
Schleichera oleosa	1	3	3	0	0	0	0	9	3	4	2	2
Strychnos nux- vomica	0	0	0	1	0	0	2	0	1	1	3	0
Syzygium cumini	5	6	16	0	0	0	1	1	0	0	1	0
Terminalia bellirica	0	0	0	0	0	0	0	0	0	2	0	117

The study indicated poor distribution of *Aegle marmelos* and *Limonia acidissima* in the sample plots. Recruits were not recorded for *Aegle marmelos, Limonia acidissima, Givotia rotelleriformis* and *Santalum album* which implies poor regeneration and high probability of endangering of these species in the study area. No saplings were recorded for *Terminalia bellirica* in all the four locations from which it can concluded that establishment of *T. bellirica* is at risk despite very good regeneration. Hence the study in general shows that there is an urgent need to carry out Assisted Natural regeneration for the selected species in The Koli Hills and Pachamalai. The authors are grateful to the CAMPA (TNFD) for the financial and logistic support.

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ENVIS ACTIVITIES

Green Skill Development Programme (GSDP) "Quality Planting Material Producer (QPMP)" - Course I Organized by ENVIS RP, Institute of Forest Genetics and Tree Breeding, Coimbatore

A certificate course on **"Quality Planting Material Producer (QPMP)"** under Green Skill Development Programme (GSDP) for level- 3 (Nursery worker) was conducted by ENVIS Resource Partner on Forest Genetic Resources and Tree Improvement (FGR-TIP) at the Institute of Forest Genetics and Tree Breeding, Coimbatore. The training programme was for a period of 30 working days (01st August to 06th September 2018, 240 hours).

The training programme was inaugurated by Dr Mohit Gera, IFS., Director, IFGTB. Following the inaugural session, a presentation about IFGTB was given by Dr Kannan C.S. Warrier, Scientist – F, ENVIS Coordinator & Nodal Officer - GSDP. The participants were then taken to various laboratories, Fischer Herbarium and Gass Forest Museum by Dr A. Vijayaraghavan, Scientist – E & Training in charge.

During the first week various aspects on basics of forest seed technology were taught to the trainees by Dr R. Anandalakshmi, Scientist - F and her team. A visit to directorate of seed certification centre, Tamil Nadu Agricultural University was arranged, where the participants learnt about seed testing (paddy, sorghum, maize etc.) and seed certification.

During the second week Introduction to nursery technology concepts and layout of nursery was taught by Shri. Maria Dominic Savio, Scientist E. Group assignments were also given to all the trainees to develop their own nursery blue print. Shri. S. Senthil Kumar IFS., Head, Silviculture and Forest Management discussed on the types of nurseries that can be developed.

The third week was handled by Dr V.K.W. Bachpai, Scientist – D, where he exposed the trainees to different methods of vegetative propagation. Dr Kannan C.S. Warrier, Scientist – F, Coordinator ENVIS & Nodal Officer - GSDP delivered a lecture on introduction to clonal forestry. Participants also had hands on training on processing of cuttings, rooting media preparation and grafting.

Parthenium eradication week observation

In order to create awareness about parthenium and its health hazards, the participants were taught about harmful effects of parthenium on human health and livestock and immense economical losses caused due to the invasion of parthenium weed. The participants observed Parthenium eradication week from 16.08.18 to 22.08.18 by means of removing the parthenium in forest campus. Method of preparing the compost from parthenium was also discussed.

During the fourth week the production of plant growth promoting substances, production and its application, production of bio control agents, seed and seedling diseases were taught and hands on training was given by Dr A. Karthikeyan, Scientist - F and his team. Dr S. Murugesan, Scientist – G and Group Coordinator Research delivered a lecture on bio pesticides.

The participants visited the Green Life Biotech Lab unit at Somanur, Coimbatore to see the production of bio fertilizers on large scale. Dr S. Easwaramoorthy, Founder, Green Life Biotech Lab explained the significance of bio fertilizers. Lecture on seed health, nursery pests and its control measures was handled by Dr A. Balu, Scientist G, Dr. John Prasanth Jacob and team.

A field trip was arranged to Shanthi Nursery- Kurinjipaadi (Near Cuddalore). Shri Sakthivel (an engineer) and a young entrepreneur who supplies around 10-15 lakhs of clonal material of tree species (*Casuarina* and *Eucalyptus*) every year, demonstrated how he got benefitted through clones released by IFGTB.

The participants were also taken to TNPL- Karur. The nursery production and management activities were explained by Dr P. Chezhian, Manager Plantations and Dr G.V. Prasath, Asst. Manager Plantations.

The participants visited Forest College and Research Institute (FC & RI), Mettupalayam, where they got to see plantations of different tree species.

Run for Green Skill Development Programme

In order to create awareness about the Green Skill Development among the general public, Run for Green Skill Development Programme (Marathon 5 kms & 10 kms) was organized by the ENVIS RP on 02.09.2018 (Sunday) at Forest Campus, R.S. Puram, Coimbatore. Around 50 participants (GSDP participants & staff of IFGTB) took part in the event. Certificates and medals were distributed to the Marathon winners and participants.

During the last week Shri. Rajesh Gopalan, IFS., Conservator of Forests & Head of Extension shared his experience on skill development programme organized by Odisha Forest Department. A lecture on entrepreneurship development was delivered by Dr C. Muralidharan, Asst. Professor, Agricultural & Research Institute (TNAU). Shri. S. Venkataramanan, Deputy Manager, Canara Bank explained about banking linkages and how to avail loan for nursery establishment. Shri. B.R. Narayanaswamy, Chief Executive Officer, Coimbatore Agro Forestry Farmer Producer Co., Ltd explained about agroforestry and motivated the participants to become entrepreneurs. He also offered job opportunities to the participants. A wrap up summary presentation with a quiz competition was conducted on 03.09.2018.

Assessment & Evaluation was done by an external examiner from Forest College & Research Institute (FC&RI), Mettupalayam and an in-house officer. The participants were assessed based on the performance in theory (35%) and practicals (65%). Sixteen participants successfully completed the training programme.