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ENVIS NEWSLETTER

FOREST GENETIC RESOURCES & TREE IMPROVEMENT

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INSTITUTE OF FOREST GENETICS AND TREE BREEDING
(Indian Council of Forestry Research and Education)

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From the Director's Desk

Institute of Forest Genetics & Tree Breeding (IFGTB), a national Institute under ICFRE, is committed to work in areas of forestry research and for its mandated states of Tamil Nadu, Kerala, Puducherry, Andaman and Nicobar Islands and Lakshadweep. Since 1988, this Institute has undertaken research in various areas like genetics, biotechnology, seed technology, pest and disease management, restoration ecology and species recovery. IFGTB deems it an honour to take up the responsibility of ENVIS Centre on FGRs and Tree Improvement at this juncture when we have celebrated our Silver Jubilee.

In this inaugural issue of the quarterly newsletter under ENVIS, we would like to introduce the readers to Forest Genetic Resources. Every issue will carry details on different tree species of the country under 'Know your tree'. We plan to bring out information related to FGRs and Tree improvement in the form of articles, reports and documents. The ENVIS team sincerely looks forward to your suggestions and feedback and seeks your support and co-operation.

R.S. Prashanth
Director, IFGTB

In this Issue

Forest Genetic Resources and Tree Improvement - Thematic Centre of ENVIS

The subject of Forest Genetic Resources conservation and management is gaining tremendous significance world over and particularly in India as the country has a rich repository of FGR particularly tree resources of ecological and economical significance. In view of their socio-economic importance and contribution to the forest based industries, a large number of initiatives have been taken in the country for improving the productivity of forest plantations through tree improvement, involving breeding, biotechnology and silviculture. However, the information on these valuable resources as well as the improvement efforts lies scattered in various statistics and research reports of forest departments, agricultural universities and wood-based industries. The Ministry of Environment and Forests, has recognised the Institute of Forest Genetics Tree Breeding, Coimbatore for establishment of a Thematic ENVIS on Forest Genetic Resources and Tree Improvement (FGR-TIP). The Centre was formally inaugurated by Dr V. Rajagopalan, then Secretary, MoEF, Government of India on 3rd February, 2014 during the Fifth International Casuarina Workshop held at Mamallapuram in the presence of Dr N. Krishnakumar, the then Director, IFGTB and the ex-Chairperson of National Biodiversity Authority, Dr Balakrishna Pisupathi.

IFGTB is now entrusted with the responsibility of documenting the existing genetic resources available with various stakeholders across the country for the dissemination of information and create National and International Networking among the users.

IFGTB would strive its best to keep all stakeholders updated on the status of forest genetic resources, provide detailed information on various tree improvement activities already carried out and being pursued on different tree species in various parts of the country for the benefit of all stakeholders which includes research organisations, state forest departments, universities, wood based industries etc.

The potential of FGRs being large in a country like India, where a large sector of the rural population are dependent on forest genetic resources for livelihood security and poverty alleviation, there is a need to churn out large volumes of information on FGRs through research being carried out by various organisations in the country. IFGTB will be the single window information provider on FGR through this ENVIS centre for ecological and economic gain through trees.

Forest Genetic Resources (FGR): What are they and why they need to be conserved?

Photo Credit : Dr Kannan C.S. Warrier

Forests are complex ecosystems occupying most of the Earth's terrestrial biodiversity (Millennium Ecosystem Assessment, 2005) and it is doubtless that trees are the keystone species in maintaining their structure and function. The role of forests in supporting the socioeconomic development of livelihoods by providing food, raw materials for shelter, energy and manufacturing is inevitable and dates back to several centuries. Particularly in the era of climate change their crucial role both as a carbon source and sink receives greater attention from global ecologists. Besides their significance in ecosystem functioning, forests represent a key genetic resource for farmers and plantation growers throughout the world by providing globally important tree species. Nevertheless, forests exhibiting these immense potential are overexploited by anthropogenic intervention especially in last few decades, leading to unsustainable harvest of forestry resources. It has been gestated that during 2050-60 the world may witness a population explosion of 30% or more from its present level of 7.3 billion. Hence, it is obvious that this will exert more and more pressure on forests resulting in forest land loss or degradation, which remains a major global concern. Even a precise estimation of genetic loss due to forest destruction is absolutely impossible as they are degraded at such an alarming rate. As a consequence, the survival ability of genetic resources of numerous tree species is highly threatened. Hence from a conservation perspective, a combined knowledge of selective and evolutionary forces acting on the genetic structure of forest trees should be acquired. Based on these informations, strategies can be formulated for effective management and sustainable utilization of prioritized forest tree species.

Gene diversity - The crucial factor

Genetic diversity in simple terms is the number and relative abundant of alleles within a species or population of a species. It is the foundation for all diversity and can be assessed at three levels such as (1) diversity within- (2) diversity between-breeding populations within a specific geographical area and (3) diversity within species (Dunster, 1996). It has been well established that gene diversity facilitates any living organism to mitigate and survive under fluctuating climatic conditions (Loveless and Hamrick, 1984; Hamrick *et al.*, 1992; Lacerda *et al.*, 2001). Selection, mutation, migration via gene flow and genetic drift are the major factors determining the genetic diversity and in turn population structure of any species.

Photo Credit : Dr Kannan C.S. Warrier

A thorough knowledge on distribution of genetic diversity in plants will enable a better insight into their modes of speciation, adaptation and population dynamics (Bussell, 1999). Populations with low genetic variability may have a reduced potential to adapt to environmental change (Ellstrand and Elam, 1993). In the forestry scenario, as trees are long lived and mostly exhibit outcrossing behaviour, they generally maintain high levels of genetic variation. In fact their genetic makeup is as complex as their ecosystems because trees are often subjected to spatial and environmental heterogeneity. Earlier assessment of genetic variation in forest trees relied on isozymes and they dominated for almost 30 years. The advent of molecular tools coupled with refinements of the PCR (Polymerase chain reaction) technique has revolutionized the field of forest genetic diversity by providing greater insights. Thus, genetic diversity is of prime importance in forest conservation since sustainable management and utilization of forestry resources requires a refined knowledge on the genetic diversity and population structure of tree species.

Delineation of FGR concept

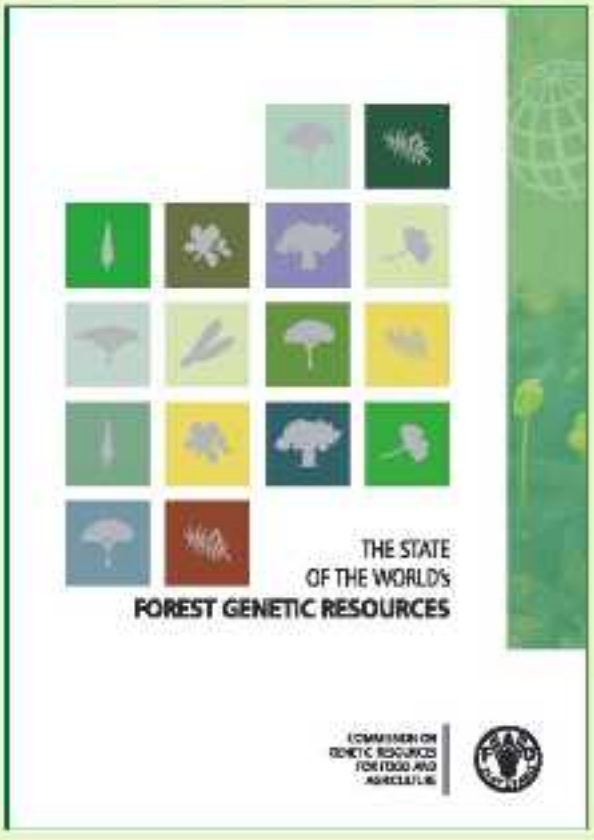
The field of Forest Genetic Resources (FGR) as known now has a concept evolutionary history coupled with functional significance and was deduced after several consultative meetings of FAO. Usage of the term 'gene resource' received attention during late 60s. Ziehe *et al.* (1989) had clearly stated that gene resources can appear as whole communities, populations, or single individuals as well as seed-, pollen- or soma-banks and even cloned DNA fragments. Also it has been insisted that before making a collection eligible for declaration as a gene resource, its suitability as a source of particular genetic variant or a defined range of variants must be ensured. Later, after the International Treaty on Plant Genetic Resources for Food and Agriculture (2006), Convention on Biological Diversity (CBD) (2002, 2005) and many other fora, FAO had formulated the guidelines for usage of various terminologies. By definition, Forest Genetic Resources (FGR) refers to the heritable materials that are of actual or potential economic, scientific or societal value (FAO, 2007). It should be noted that forest genetic diversity represents the sum total of genetic variability occurring within or among tree species whereas FGR is the forest genetic material of actual or potential benefit to human. This is because, usage of the terminology 'diversity' is often considered as synonymous with 'resources' and FAO (2007) had posited that "resources are managed, harvested and products are obtained from 'resources', while 'diversity' denotes the variability among organisms".

Photo Credit : Dr Kannan C.S. Warrier

Photo Credit : Dr B. Nagarajan

Need for FGR conservation

Estimates reveal that the total number of tree species throughout the world ranges between 80,000 - 1,00,000. However, less than 500 trees have been exploited in any depth for their present and future potential (FAO, 2014). Thus a huge quantity of genetic resources available in forest trees remains vast and unexplored which may contain potential traits useful for mankind. Also at this instance, there arises a need for priority setting among the available tree species based on their utilization potential. But this process is hindered by the lack of data on their variation patterns and potentials. Thus this knowledge gap, together with changes in forest land use, deforestation, warming temperature and inappropriate forest management practices jeopardise the integrity of forest genetic resources. Earlier, a decade ago FAO (2004) too stressed that benefits from forests and trees will only be sustained if forest genetic resources remain available. Usually it is suggested to conserve FGR in a dynamic state both *in situ* (in field conditions) and *ex-situ* (outside the field, in nursery/lab storage) while adopting conservation measures.



Highlights of State of World FGR - FAO Report 2014

On recognizing the importance of FGR for food security, poverty alleviation and environmental sustainability, The Commission on Genetic Resources for Food and Agriculture at its eleventh session during 2007 had requested the FAO to prepare a global report on the state of FGR based on the reports from several countries. The main objective of this initiative is to fill the knowledge gap that limits the capacity of decision-makers to identify and formulate strategies for management of FGR at the international, national, regional and local levels (FAO, 2014). A final report was released by FAO in 2014 after compiling the individual information supplied by 86 participating countries which account for 76% of world's land area and 85% of global forest area.

The most striking observation is that in most countries, knowledge on FGR is apparently inadequate for framing policies and management strategies. Genetic studies (both molecular and quantitative) are described for less than 1% of total available tree species and these too are oriented towards temperate Conifers, Eucalypts, some Acacias, Teak and other fewer species. On the other hand, a large number of tropical species needs to be investigated for their potential. The report further states that though genomic knowledge of trees lags behind that of important agricultural crops, molecular information on trees are accumulating faster. However, utilization of this data in direct application towards the management and conservation of FGR is yet to happen.

Forest Genetic Resource Management Network (FGRMN)

MoEF/ICFRE started Forest Genetic Resource Management Network (FGRMN) in the country with IFGTB as the Southern nodal centre for conservation and management and effective utilization of FGR through a network programme in the country. The FGRMN has been entrusted with the responsibility to plan, conduct, promote, co-ordinate and take lead in activities concerning exploration, collection, characterization, evaluation, conservation, exchange, documentation and sustainable utilization of diverse germplasm of important forestry species with a view to ensure their availability for use over time to breeders and other researchers. A National level workshop was organized at IFGTB in 2011 to develop strategies for FGRMN and also prioritize important tree species for FGRMN programme. A new building for FGRMN has been established in the Institute. The FGRMN activities have to be taken up for the prioritized species through involvement of stake holders like State Forest Departments, ICFRE Institutes, State Forest Research Institutes and Universities across the country.

Mandate: To act as nodal agency at national level for acquisition and management of indigenous and exotic forest genetic resources for their exploration, documentation, conservation and their sustainable utilization.

Major Activities of FGRMN: Exploration, collection, conservation, characterization, evaluation, documentation, sustainable utilization, exchange of germplasm and quarantine are the major activities of FGRMN.

Stakeholders of FGRMN: All the State Forest Departments, State Forest Research Institutes, Agricultural Universities (Forestry colleges), ICFRE institutes covering the region and other Research Organization involved in forestry Research in the country with special reference to the Southern and Central tracks of India which includes Tamil Nadu, Kerala, Pondicherry, Andaman and Nicobar Islands, Lakshadweep, Karnataka, Seemandhra, Telangana, Maharashtra, Goa, Gujarat, Madhya Pradesh, Chattisgarh and Orissa are the stakeholders of FGRMN operating in IFGTB. The rest of areas are to be handled by FGRMN-FRI.

Species prioritization: IFGTB over series of workshop have prioritized the following 30 species to be taken up under the FGRMN.

Phase I	Phase II
Acacia auriculiformis	*Aegle marmelos*
Acacia mangium	*Ailanthus triphysa*
Ailanthus excelsa	*Albizia lebbeck*
Azadirachta indica	*Artocarpus heterophyllus*
Calophyllum inophyllum	Bamboos*
Casuarina equisetifolia	*Bombax ceiba*
Casuarina junghuhniana	*Dalbergia latifolia*
Eucalyptus camaldulensis	*Dalbergia sissoo*
Eucalyptus tereticornis	*Leucaena leucocephala*
Gmelina arborea	*Terminalia chebula*
Melia dubia	*Pongamia pinnata*
Neolamarckia cadamba	*Pterocarpus marsupium*
Pterocarpus santalinus	*Santalum album*
Sapindus emarginatus	*Tamarindus indica*
Tectona grandis	*Thespesia populnea*

*13 economically important bamboo species identified by NMBA

Outcome of FGRMN: Database on Forest Genetic Resources of prioritized species will be available to the user agencies / stakeholders. The germplasms exhibiting high genetic diversity will be conserved under *in-situ* and *ex-situ* conservation which will be used for genetic improvement. Validated and characterized forest genetic resources in the form of genetic stocks, seed orchards, improved germplasm, clones and hybrids will be available. The FGRMN will identify trees for livelihood support, poverty

alleviation and ecological restoration. The Govt. of India's policy of increasing tree cover from the existing 23% to 33% can come only through Trees Outside Forests (TOF) for which good planting material in the form of improved resources and seeds are required. This effort will ensure support to the on-going programs of Govt. of India and the State Govts. in increasing tree cover in the country. Agroforestry and plantation forestry to support wood based industries will gain momentum through this effort. Food along with wood security will be guaranteed at the same time ensuring sustainable development and utilization of the natural resources.

Conclusion

The environmental services offered by forests and trees outside forests (TOF) are plenty. Our current forestry practices cannot withstand the huge pressure exerted by demographic and climatic factors. Hence genetically, ecologically and economically based forestry practices are highly essential at this moment. Knowledge of FGR of important tree species is thus indispensible. Conservation and sustainable management of Forest Genetic Resources is regarded as a fundamental commitment in forest policies of both developed and developing countries. Identification and characterization of potential phenotypes from genetically rich and diverse population of trees will serve as a base for FGR database. This should be executed at national levels and coordination at international level for exchange and better utilization of FGR materials worldwide. Finally this could pave way for sustainable forest management.

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KNOW YOUR TREES - TEAK

Tectona grandis

Family: Verbenaceae

Vernacular names : Sagwan (Hindi)
Thekku (Malayalam)
Sagwan (Marathi)
Saguan (Kannada)
Singuru (Oriya)
Tekkumaram (Tamil)
Adaviteeku (Telugu)

Distribution and habitat

Teak occurs in natural forests in India, Myanmar, Laos People's Democratic Republic and Thailand. North – South Limits - 9°N to 25°N in Myanmar. Longitudinal limits - 70°-100°E. Observed naturally in the States of Kerala, Andhra Pradesh, Karnataka, Orissa, Madhya Pradesh, Maharashtra, Gujrat, Rajasthan, Uttar Pradesh and Manipur.

Uses

One of the most versatile timber species, used for heavy and light construction work, house building, carpentry, wood carvings etc. Considered one of the primary timbers of India.

Botanical description

Teak is a deciduous tree with an average height and DBH (diameter at breast height) of 20 to 35 m and 29 to 54 cm in 50 years, respectively, often fluted near the base and pale brown and grey in colour. The bark is thick, grey or light greyish-brown.

Leaves are opposite, broadly elliptic, obovate, about 30-70 cm long and 25-40 cm broad, glabrescent above and stellate-pubescent below, at the base rounded to acute; in apex obtuse to acute, and for petiole stout and 5-6 cm long. Teak sheds its leaves from November to January (India) and remains leafless for long time (3-4 months). The new leaves appear from April to June according to locality.

Photo Credit : Dr K. Palanisamy

The flowers are small (6-8 mm in diameter), whitish and bisexual. They appear in large panicles containing up to a few thousand flower buds, which open only a few at a time during the flowering period of 2-4 weeks.

Photo Credit : Dr Kannan C.S. Warrier

Fruit is a drupe, globose, 5 to 20 mm in size, enclosed by an accrescent calyx with thick shaggy exocarp of matted hairs, epicarp inflated, spongy, and stellate pubescent, endocarp stony, 4-celled, seeds 1-4, oblong and exalbuminous. The fruits ripen from November to January and fall gradually, some remaining on the tree throughout the hot season. The fruits are yellowish and brownish in colour and the number varies from 1150 to 2800 per kg. Fruits in moist areas are heavy compared to drier areas.

Photo Credit : Dr K. Palanisamy

The seeds are oval and about 6 x 4 mm. Most fruits produce only one fully developed seed and 3 locules are empty.

Reproductive Biology

Pollination is by insects. Sometimes flower and fruit setting is greatly disturbed by defoliating insects which also eat the flower buds. The fruit attains its full size in approximately 50 days, but it is not mature until 120-150 days after fertilization. A sign of maturity is that fruits can be shaken from the tree, or fall to the ground naturally.

Seed collection, processing and Nursery techniques

Generally teak starts flowering 6 years after planting, but profuse flowering occurs after 15 years. Flowering occurs from June to September and fruits can be collected from November to January. Though teak produces profuse flowering the fruit set was very poor (1 to 2%),

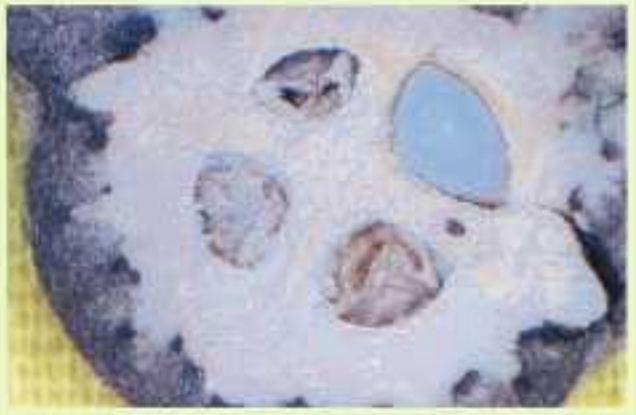

Photo Credit : Dr B. Nagarajan

probably the coincidence south west monsoon with flowering which affects pollination. The fruits are yellowish and brownish in colour and the number of fruits varies from 1150 to 2800 per kg. A 40 year old tree produces an average of about 3 kg fruits. Teak fruit contains 4 seeds, but mostly filled with 1 or 2 seeds only. After collection, the fruits are cleaned and then sun dried for 2-3 days and stored in bags. Teak seeds can be stored for up to two years with 12% moisture content in airtight containers.

Germination of teak is often poor due to dormancy. Pre-treatment of the seeds by alternate wetting and drying of seed for a week is required to break the dormancy before sowing. The seeds must be kept in a gunny bag and dock the bag in water, preferably in a running stream, for 12 hours, then spread the seed in the sunlight to dry for 12 hours. This has to be repeated for one week. Grading of fruits according to size helps in improving germination. Germination increases with increase in size of fruits. The germination percentage varies from 30 to 50% in moist teak and 5 to 10% in dry teak. The seeds were sown in the raised nursery beds (10 x 1 x 0.3 m) prepared with soil and sand mixture. The nursery beds have to be watered regularly and covered with coconut leaf or paddy straw.

Germination starts 10 to 15 days after sowing and continues up to 35 to 45 days. The paddy straw may be removed once the seed started germinating. The seedlings can be transplanted to polythene bags or it can be maintained in the nursery beds for 10 to 12 months for preparation of stumps.

Seed storage

Teak seed stores well and may keep its germination capacity for several years provided the seed has low moisture content before storage and is protected against fluctuations in temperature and humidity during storage. If seeds are to be used in the same planting season, no special storage is needed. Seed can be piled in a convenient place near the nursery, preferably in a shed or in a storeroom, but not necessarily dried. Seed can be stored this way for maximum 3-4 months. Seed can be stored for up to two years at around 12 % moisture content and stored in airtight containers (glass jars or sealed plastic bags) and kept in a dry, shaded and relatively cool place. If stored at low moisture content and in a cold store (0-4°C), the germination capacity of the seed can be maintained for 5-10 years.

Planting stock

Generally stumps or seedlings are used as planting material. For stump preparation, the seedlings have to be maintained in the nursery for about one year. Then the seedlings are uprooted, all the leaves and secondary roots are removed and stumps (4 to 6 cm shoot with 15 to 20 cm tap root portion) were prepared.

Photo Credit : Dr B. Gurudev Singh

Stump planting is generally preferred and it is easy for transport. For seedling plantation, young seedlings are shifted to polythene bags containing soil mixture and maintained in the nursery for 3 to 6 months.

Plantation Management

A suitable land with good soil and rainfall of >1200 mm may be selected for raising teak plantation. The land should be ploughed thoroughly and prepare pits (45 x 45 x 45 cm) in 2 x 2 m or 3 x 3 m or 3 x 4 m spacing before rainy season. Farm yard manure with soil mixture has to be prepared and filled in the pits. Seedlings are planted in the pits during rainy season. For stump planting crowbar may be used and pitting is not required. In the initial stage the plants have to be watered weekly, and regular weeding and pruning have to be done. The branches have to be removed periodically without affecting the main stem. Drip irrigation is beneficial in farm lands. Irrigation reduces the rotation period and also enhance the productivity. Application of 50 g of urea and 30 g of super phosphate after six months and 75 g of urea and 60 g of super phosphate after 24 months of planting increases the growth rate. The fertilizers are effective for enhancement of growth in young teak trees than mature trees.

Thinning (removing alternate rows) is done 5 years and 10 years after planting in plantation raised with closer spacing (2 x 2 m). Mechanical thinning is also needed. The interval of thinning cycle is at age of 5, 10, 15, 20 and 30 for 60 year rotation, in Kerala. Teak can also be planted in bunds in south and north direction in such way the agricultural crops get sufficient light. It was found that there was no significant variation in wood properties of young (25 to 30 years old) and mature teak (50 to 60 years old). Therefore teak plantation raised with good quality planting material or clones in good soil with limited irrigation and dry period with silivicultural practices can be harvested within 20 to 25 years. In Brazil and Malaysia teak is harvested at the age of 15 to 20 years. The teak growing in the canal areas in Thanjavur and Tiruvarur (Tamil Nadu) showed fast growth with good girth (> 150 cm) within 20 years and canal teak is harvested at the age of 30 years.

Photo Credit : Dr Kannan C.S. Warrier

Genetics and Tree Improvement

Kedharnath and Mathews (1962) first formulated a programme for the genetic improvement of teak in India and following this, teak improvement activities gained importance in all the teak growing states. For the past four decades considerable progress has been made on provenance variations, selection of plus trees, establishment of clonal seed orchards and seed production areas to augment productivity in teak.

The diversity of teak populations studied using molecular markers (isozymes and RAPDs) showed that teak is an outcrossing species with major portion of diversity present within the populations. A study on genetic variation within and among ten populations of teak from Western Ghats and Central Indian regions showed that 78% of variation existing within the population and the rest between populations. In general, populations from the Western Ghats region possessed more diversity compared to those from Central India. The current selection strategy of selecting a few outstanding trees from different populations needs to be revised and many superior trees should be selected to capture the within-population diversity. Western Ghats and Central Indian regions may be designated as separate breeding zones since these populations are genetically distant.

Provenance variations in wood quality, growth rate, stem form; seed morphology and germination have been observed in teak. The All-India Provenance trials initiated in 1930 with 11 provenances indicated that the local provenances performed well. However, provenances from moist Southern India (Nilambur, Kerala) seem to be stable and vigorous. International provenance trials with 75 provenances and 48 field trials were established in early 1970s by IUFRO-DANIDA Forest Seed Centre (DFSC). The Indian moist provenances were found to be the best for moist and semi-moist regions of West Africa and Brazil, and also recommended for Central American region. About 5000 ha of SPAs of teak are established in different teak growing states in India.

In India, the International Provenance trial was established at Maredumilli in Andhra Pradesh with 11 provenances in the year 1973. The evaluation of the trial after 26 years indicated no significant difference on survival rate, growth, gbh, straightness and roundness of stem and health characteristics. Genetic analysis showed low heritability in height and GBH and moderate to high heritability for straightness and roundness of stem. Among the indigenous seed sources Konni (Kerala) and exotic source Ban Mae pan (Thailand) were the best for all the parameters studied.

About 1000 ha CSO has been established in India in different teak growing states, whereas Thailand has about 1,830 ha of CSOs. The major constraint in CSO in India and Thailand is poor flowering, asynchrony in flowering, low fruit and seed set. The reason for low fruit yield is not clearly understood. The seed production in clonal seed orchards of teak is very low and not meeting the annual planting target in India. Palanisamy and Subramanian (2001) have developed a technique for mass multiplying CSO seedlings through vegetative propagation to produce quality planting stock in large scale for operational planting programme.

Seed production areas (SPA) are established by converting the best natural stand or plantation by removing the inferior trees, and allowing to remain only good trees to produce quality seeds for raising plantations. It functions as an interim measure till the seed orchards produce seed. About 5000 ha of SPAs of teak are established in different teak growing states in India. Selection of outstanding trees called plus trees from natural populations and plantations is the first step in tree breeding programme. About 700 plus trees of teak have been selected in different teak growing states in India. A series of studies on controlled pollination of teak in Thailand indicated that the percentage of fruit setting in the self-controlled pollination is only 4%, when compared to that of the cross controlled pollination which is up to 60%.

Agroforestry

Teak is one of the favoured silvicultural species by the farmers. It is planted in different models, combinations as well as in different spacements. Agroforestry models like, Agri-silvicultural models (Teak + casuarinas with agricultural crops maize, cotton, turmeric, tomato and chilly), Agri-silvi-horticulture model (Teak + coconut with agricultural crops plantain, turmeric, vegetables, maize and cotton) and Silvihorticulture model (Teak-Guava, Annona) have been developed. Under irrigated lands, silvipasture model was developed with Teak and Casuarina as tree components and Napier and Guinea as pasture components.

Yield

The average productivity of teak in Nilambur teak plantations was 2.85 $m^3ha^{-1}yr^{-1}$ in 53 years rotation period. In Indonesia the MAI at the harvest age (40 to 90 years) was 2.91 $m^3ha^{-1}yr^{-1}$. The productivity in moist semi deciduous forest in Ghana was 8-10 $m^3ha^{-1}yr^{-1}$ (Oteng-Amoako and Sarfo, 2005) while in Central America it was 8-12 $m^3ha^{-1}yr^{-1}$. Recent studies conducted on teak growing in farmlands with irrigation, fertilizer application and management revealed the possibility of reducing the rotation period to 25 years with increase in productivity. The trees that grow in farm lands grow

faster and produce more biomass when compared to plantations in the forest areas. The quality of teak timber in farm land at 12 years was found to be similar to that of 20 years in forest land.

Important insect pests and diseases

Teak defoliator, *Hyblaea puera* and leaf skeletonizer, *Eutectona machaeralis* are considered to be the major pests in teak. These insects are known to occur on seedlings in nurseries and also in grown up trees in plantations. *H. puera* feeds on tender foliages during the early part of the growth season and *E. machaeralis* feeds on older foliage towards the end of the season. Making regular pest surveillance in nurseries and young plantations, particularly during rainy season when there is a new flush formation to detect the occurrence of the pest and removal and destruction of larvae if the population is less. If the pest attack is severe it can be controlled by spraying of the foliage with the chemicals like monocrotophos 0.05-0.075% or neem based formulations (Neem azal 1%) at 10-12 days intervals. A virus (NPV) based formulation (biocide) is also available for management of the defoliator *H. puera*.

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Forthcoming Events

February 2015

The Economics of Climate Change mitigation Options in the Forestry Sector – International Online Conference 06-27 February 2015

May 2015

United Nations Forum on Forests – UNFF 11 New York, 04-15 May 2015

Ligna 2015, Hannover, Germany 11-15 May 2015

Third World Teak Conference 2015 Guayaquil, Ecuador 11-16 May 2015

Forest Biotech for Smallholders Foz do Iguassu, Brazil 19-22 May 2015

September 2015

A Global Perspective on the Ecology and Management of Bark and Wood Boring Insects Bariloche, Argentina 01-04 September 2015

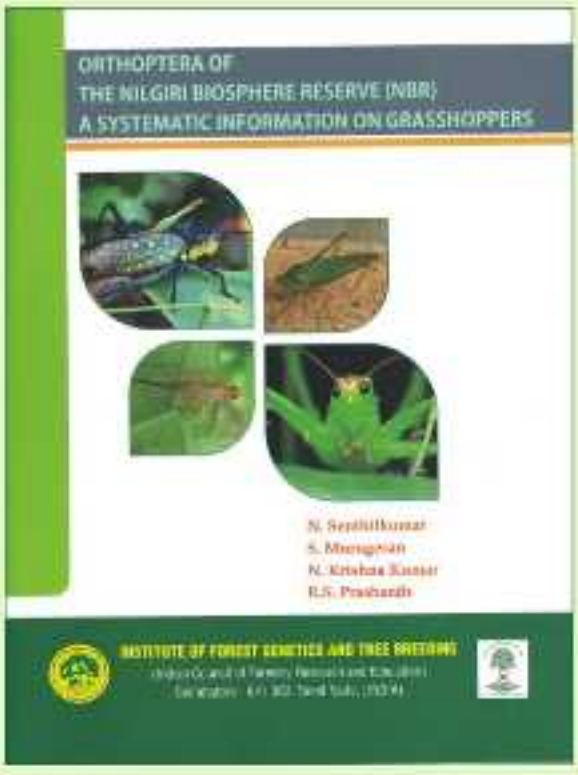
14th World Forestry Congress - Durban, South Africa 07-11 September 2015

World Bamboo Congress - Damyang, Republic of Korea 17-22 September 2015

Books Published

Orthoptera of Nilgiri Biosphere Reserve (NBR): A systematic information on grasshoppers.

Orthoptera, one of the largest orders of the class Insecta includes the well-known grasshoppers, locusts, crickets, and katydids. The lesser known group of insects globally, they are a dominant group of herbivorous insects throughout the world. They are good indicators of landscape and climate change since they are sensitive to disturbances. They are important components in terrestrial ecosystem since they are the primary consumers in food web and are involved in health maintenance of ecosystem. The details of these insects in Nilgiri Biosphere Reserve (NBR-1986), the first biosphere reserve in India has not been documented. Hence an exploratory survey was made on grasshoppers and a pictorial guide has been prepared. This book would be useful to ZSI, conservation biologists and field forest officers.



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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.

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