

CHAPTER-III

INSTITUTE OF FOREST GENETICS AND TREE BREEDING COIMBATORE

The Institute of Forest Genetics and Tree Breeding, Coimbatore, is a premier Institution under the Indian Council of Forestry Research and Education, mandated to develop the techniques to improve the yield in plantation forests and increase the productivity in the natural forests. The emphasis is on developing tree improvement strategies for selected tree species and production of quality planting stock through vegetative and reproductive means. The details of the work done by different Divisions is as follows:

GENETICS AND TREE BREEDING

Genetic improvement of teak

An International provenance trial of teak has been started at Panampulli, Kerala state with seeds from Thailand, Nicaragua and Tanzania. Early observations were recorded on survival and growth. DNA extraction work was carried out for Random Amplified polymorphic DNA analysis.

Characterisation of the phenotypes and genotypes of *Emblica officinalis*

Intensive survey and collection of *Emblica officinalis* seeds were carried out in the forest areas of Shervaroy hills, Kolli hills, Karavalli Reserve forests, Chitheri hills, Arur Southern and Northern range of Salem District, Madurai, Kodaikanal Districts etc.

Genetic improvement of *Eucalyptus camaldulensis*

Fifty candidate plus trees of *E. camaldulensis* were selected. Seedlings of 182 superior families of *E. camaldulensis* (imported and local) were raised in nurseries at Pudukkottai and Coimbatore. Two progeny trials were started, one each at Panampulli, Kerala and Pudukkottai, Tamil Nadu.

Genetic improvement of *Casuarina equisetifolia*

Fifty candidate plus trees (CPTs) among superior provenances of *C. equisetifolia* were selected. The seedlings of CPTs were raised separately in nursery and a progeny trial was started at Panampulli.

Reproductive biology and breeding systems of tropical tree species

Crossing work was carried out in teak in the clonal seed orchard at Walayar, Kerala. Pollen was stored in ultra deep freezer and deep freezer for viability studies. Studies on pollen fertility and viability were carried out in respect of *Casuarina equisetifolia* and a hybrid between *C. equisetifolia* and *C. junghuhniana*. Crossing work was carried out in tamarind at Hosaekote germplasm bank in Karnataka state.

Tree breeding

An area of 5 ha land was acquired in Pondicherry for field planting. International provenances of *Casuarina equisetifolia* were assessed based on the different phenotypic characters from the trial laid out in Neyveli. Ten trees and some provenances of *C. equisetifolia*

suitable for agroforestry were identified in the trial plot. Trees of *Tectona grandis* were selected for agroforestry.

PLANT BIO-TECHNOLOGY

Genetic analysis in *Casuarina equisetifolia*

Clones selected from Chidambaram, Chengalpet and Tiruchendur (Tamil Nādu) were used for the divergence studies. Thirty seven clones collected from Tiruchendur area were raised in six clusters with 2-8 clones per cluster. Twenty eight clones of Chidambaram, Chengalpet area were raised in four clusters with 2-12 clones per cluster. Characters considered for analysis are height, dbh, frustum volume, total volume, needle length, etc.

Quality seeds from genetically divergent clones of *Casuarina equisetifolia* were used for half sib progeny trial. Seedlings were planted in a completely randomized block design with four replications. The data on height, cdm, dbh, flowering and fruiting behaviour were collected at three months interval. Based on the analysis of growth parameters and genetic divergence studies, 12 clones of *Casuarina equisetifolia* (4 male and 8 female) were identified for establishment of clonal seed orchards. Forty ramets for each clones were planted in a completely randomized block design and the data on height, cdm, dbh, flowering and fruiting behaviour were collected at three months interval.

Multilocation trials in collaboration with various organizations are being conducted to evaluate the performance of different clones in the given environment.

Half-sib trials in *Eucalyptus*

Plantations of *Eucalyptus tereticornis* and *Eucalyptus camaldulensis* were extensively surveyed to study the variability for selection of superior phenotypes. The identified phenotypes were established as clone bank in the vegetative propagation complex at IFGTB. Among the selected clones, 10 clones of *Eucalyptus tereticornis* and 19 clones of *Eucalyptus camaldulensis* flowered during 1995-96. The seeds collected from these clones were distributed to Kerala Forest Development Corporation, Andhra Pradesh Forest Development Corporation and Maharashtra Forest Development Corporation for half sib progeny trials and further selection for advanced generation improvement.

Studies on salinity resistance in *Casuarina equisetifolia*

To identify the salinity resistant clones of *Casuarina equisetifolia*, 99 clones of *Casuarina equisetifolia* have been subjected to salinity. The salinity resistance of the each clone was assessed by measuring growth characters like height, etc., biochemical characters like Chlorophyll, proline, carbohydrates; and physiological characters like photosynthesis and Chlorophyll florescence. The result of the various assays showed significant variation among the clones in their susceptibility to saline conditions.

To study the *Casuarina-Frankia* interaction under saline condition, eight clones of *Casuarina equisetifolia* were inoculated with three *Frankia* strains, namely, UGL 020605, UGL 020604 and CCI₃. The results showed significant variation between the *Frankia* strains in terms of growth performance among the 8 clones.

Production of quality planting stock in bamboos

Bench scale method was developed using seed quality and seedling vigour to mass produce quality propagules for commercial propagation of *Bambusa nutans* and *Dendrocalamus*

membranaceous. Multiple shoots were produced from nodal segments of aseptically grown seedlings, cultured on Murashige and Skoog medium containing BA- (Benzyl Amino-Purine) Rooting was done in 0.5 mg/l IBA-(Indole butyric Acid). This method produced 967 plants of *Bambusa nutans* and 1069 plants of *Dendrocalamus membranaceous* within a span of 5-6 months, which can be scaled upto four times through macroproliferation.

Mass propagation has been carried out in respect of *Bambusa arundinacea*, *Bambusa nutans*, *Dendrocalamus strictus* and *Dendrocalamus membranaceous*. The multiplication is being carried out in a commercial tissue culture laboratory (SPIC Agro Biotech Ltd., Coimbatore) at the rate of Rs.5/- per plant. By transferring the multiple shoot cultures and standardizing protocol to SPIC ABC Ltd., large volume of quality planting stock of bamboo could be produced. Four thousand bamboo plants were sent to Karnataka Forest Development Corporation for planting.

Commercial production of Eucalyptus clones

Recalcitrant clones of *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* were multiplied using micropropagation techniques. Among different root induction media composition tested, Knop's medium was found to be the most suitable one. After 15-20 days of rooting medium, plants were directly transferred to the shade house for acclimatization. Survival rate of the plants after three months was found to be 80%.

Biochemical analysis

Electrophoretic protein pattern for the seeds of *Bambusa arundinacea* has been established to study the response of seeds under micropropagation conditions. Three different provenance seed proteins were analyzed in polyacrylamide gradient gel electrophoresis system and the banding pattern studied. The seeds from Wyanad region of Kerala showed 11 major protein profiles ranging from 23,9480 to 15000 Daltons molecular weight. The seeds from Kanchanapuri (Thailand) provenance showed only 8 major protein bands ranging from 26,4310 to 45,942 Daltons. Total protein content and the rate of multiple shoot production was high in Wyanad provenance when compared to the seeds of Kanchanapuri (Thailand) provenance.

Biotechnology of trees

Various laboratory facilities are available for genetic analysis and production of improved genotypes of Eucalyptus, Casuarina and Bamboos. Attempts were made to establish genetic markers to help breeding programmes. The clones of *Casuarina equisetifolia*, were used for Random Amplified Polymorphic DNA (RAPD) analysis.

Use of rooting medium in clonal propagation

The success of vegetative propagation of clones of Eucalyptus mainly depends on the rooting medium apart from the environment conditions. The rooting medium should provide required air-water ratio, pH level and C:N ratio to the cuttings. Considering the above factors and cost involved, various media were tested for their suitability for rooting of *Eucalyptus camaldulensis* clone (EC 89 2-1).

Though the rooting percentage was similar under mist chamber conditions for all the rooting medium, the use of polytunnels reduces production cost.

SEED TECHNOLOGY

Seeds of *Azadirachta indica* with and without endocarp were stored under three different sets of environmental conditions viz. ambient, +5°C and -5°C for assessing the viability. Initial observation shows the seeds stored at ambient condition gave better results.

Pre-treatment requirement studies were carried out in respect of seeds of *Aegle marmelos*, *Strychnos nux-vomica* and *Terminalia chebula*. Seeds of *Aegle marmelos* require no pretreatment, whereas the seeds of *Strychnos nux-vomica* soaked in cold water for 48 hours after nicking gave a germination of 70-80%.

Seeds of various important species viz. *Acacia*, *Albizia lebbek*, *Bambusa arundinacea*, *Casuarina equisetifolia*, teak, and various medicinal species were collected and supplied to the end users. Neem seeds collected from Annur provenance during July, 1996 were supplied to various participating countries under Neem Network. Seeds of *Acacia* sp. and *Eucalyptus* sp. received from, CSIRO Australia were also supplied to the indentors.

Seeds of *Jatropha curcas* and *Pongamia pinnata* collected from various localities and stored at ambient condition are being assessed for germination capacity and viability. 70-80% germination was recorded in case of *Pongamia pinnata* after 8th month and 60-70% in case of *Jatropha curcas* even after one year. The seeds of *Pongamia pinnata* collected from various locality are being stored under different environmental conditions to be assessed for germination capacity to standardize the optimum storage environment. Seeds stored at 5°C have been found to be more viable. Seeds of the aforesaid species collected from different areas were also assessed for their bio-chemical composition and oil content.

SILVICULTURE

Species and soil amendment trials for reclamation of minespoils

Magnesite mine spoil from Burn & co, Salem was collected for species and soil amendment trials at World Bank Nursery of Silviculture Division. Four different tree species, i.e. *Acacia nilotica*, *Delonix regia*, *Samanea saman* and *Casuarina equisetifolia* were selected for the trials with eight different soil amendment prescriptions for increasing nutrient status, microbial population and water holding capacity of the mine spoil.

Limestone minespoil from ACC, Madukarai was collected for species and soil amendment trials at World Bank Nursery of Silviculture Division. Ten different tree species, namely, *Acacia mellifera*, *Albizia lebbek*, *Acacia auriculiformis*, *Bauhinia variegata*, *Adenanthera pavonia*, *Acacia nilotica*, *Delonix regia*, *Leucaena leucocephala* and *Samanea saman* were selected for the trials with eight different soil amendment recipes.

Species and soil amendment trials for reclamation of quartz dumps

Quartz sand from ACC, Madukarai was collected for species and soil amendment trials at World Bank Nursery of Silviculture Division. Five different tree species, viz, *Acacia nilotica*, *A. auriculiformis*, *A. mellifera*, *A. suma* and *Casuarina equisetifolia* were selected for the trials with eight different soil amendment treatments for increasing the nutrient status, microbial population and water holding capacity of the mine spoil.

Trials were carried out at Madukarai with two species viz., *Casuarina equisetifolia* and *Acacia auriculiformis* with soil amendment measures like addition of Gypsum, biofertilizers, macronutrients and water holding material in combination and isolation. *Acacia auriculiformis* in soil containing Jalshakthi, *Rhizobium*, VAM, and Gypsum; and *Casuarina*



Provenance trial of *Jatropha curcas* established in forest campus, Coimbatore



Teak and Casuarina with cotton in agri-silviculture system under ICFRE - NABARD Project



Silvi-pasture system established under
ICFRE - NABARD Project



Ceiba pentandra seedling stock in village nursery

equisetifolia in soil containing Coirpith, *Frankia*, Phosphobacteria and Gypsum performed better than other treatments.

FOREST PRODUCTIVITY AND AGROFORESTRY

Nutrient cycling

Productivity studies were initiated in 7 Teak plantations in different age groups at Tirunelveli Forest division. 10 to 20 sample plots were laid out in each age group and growth parameters such as girth (GBH) and height were measured and recorded. Soil samples were collected from sample plots of each plantation for analysis of physiochemical properties. Chemical analysis of plant samples collected from Mudumalai Forest division was continued. Layout plan was prepared for conducting Nutrient Cycling Studies such as litter production, litter decomposition and rainfall interception in one age groups of teak plantations in Bolampatti range of Coimbatore Forest Division.

Biofertilizer inoculated seedlings of different tree species, namely, teak, casuarina, Acacias, neem, tamarind, moringa, Annona etc., were planted for establishing different agroforestry models, viz, Agri-silviculture, Silvi-horticulture, Agri-silvi-horticulture and bund, boundary, block planting with different combinations, pattern and spacements. About 22,583 number of seedlings of different Silviculture and Horticulture species were planted in three micro watersheds in 110 farmers fields. The patterns under different species models include row planting of teak, casuarina and moringa; interplanting of teak and moringa; and bund and boundary planting of teak, casuarina, neem, tamarind and silk cotton. The spacing adopted between rows is 4 to 12 m and between trees 1 to 4 m depending upon the species, combination of species and agroforestry models. Block plantation of teak and casuarina were also established with a spacing of 2 x 2 m. Biofertilizers, namely, Azospirillum, Phosphobacterium and VAM were procured and applied to the seedlings in the field after planting.

FOREST PROTECTION

Pest problems in nurseries and plantations

Teak

In addition to heavy defoliation by the teak defoliator *Hybleae puera* and damage by the skeletonizer *Eutectona machaeralis*, high intensity defoliation by grass hopper and sporadic attack of a weevil *Myloccerus viridanus* on the leaves were recorded in young plantations located in Tamil Nadu and Kerala. Other serious problem of leaf curling and crinkling caused by sapsuckers, spittle bug and tingid bug was encountered in a number of young plantations in Tamil Nadu and Kerala. Scanty infestation by the new lepidopteran defoliator *Miresa albipuncta* and another defoliator *Hyposidra successaria* was noticed in certain plantations raised in the rural area of Coimbatore. Spraying of Chlorpyrifos 20 EC at 0.05% was found effective in controlling the problem of mealy bug attack on seedlings in nurseries and on saplings in plantations.

Bamboo

In Kerala, seedlings of *Bambusa arundinacea* in nurseries were found attacked by the grasshopper *Orthacris* sp. Leaf feeding by a lepidopteran pest in coastal area in central Kerala and scarring of upper epidermis of the leaves by the grubs of a species of coleopteran beetle resulting in drying of leaves were other important pest problems recorded.

Tamarindus indica

Severe outbreak of the lepidopteran defoliator *Achaea janata* was noticed in few plantations in Tamil Nadu. The affected plants were completely denuded by large number of larvae.

Studies on seed pests

Tamarindus indica

Seeds stored in the laboratory were found destroyed by the storage pests, particularly, *Caryedon serratus*. The level of damage by the pest was estimated at 95%. High damage was also caused by *Sitophilus linearis* while other insect species *Lyctus* sp. caused only mild destruction. The infested seeds were treated with pepper powder in the ratio of 1:5 (by weight) and the efficacy of the treatment was assessed.

Studies on host resistance against pests

Casuarina equisetifolia

A preliminary assessment of the resistance/susceptibility of various provenances of an International trial at Neyveli indicated that the provenance KILIFI (Kenya) is resistant to the serious bark feeder *Indarbela quadrinotata*.

Studies on botanical pesticides

Efficacy of Neem Seed Kernel Extract (NSKE) was tested against the defoliator *Miresa albipuncta* and the sap sucking pest *Aphis gossypii* of teak. Application of aqueous extract of NSKE at 5% concentration was found effective in control of *A. gossypii* in the field.

Data were collected to evaluate efficacy of a Neem based insecticidal commercial formulation and a residual product of neem was evaluated against the teak defoliator *Hyblea puera* and the babul defoliator *Tephрина pulinda*.

Experiments were also carried out to assess the impact of a commercial Neem product on parasitization of the eggs of *H. puera* by *Trichogramma* sp. and it was found that higher the concentration lesser the per cent of parasitization.

Studies on bio-control

The egg parasitoid *Trichogramma* sp. was tested in the laboratory against the teak defoliator *H. puera* and was found to be very effective. The percentage of parasitization was promising. The entomopathogenic fungi *Verticillium lecanii* and *Beauveria bassiana* were also tested against the defoliators of teak in the laboratory and relevant data were recorded. The fungus *B. bassiana* was also tested against the bark feeding borer, *Indarbela quadrinotata* in the field. Preliminary results so obtained have been impressive.

PATHOLOGY

Disease problems in nurseries and plantations

The wilt disease of *Casuarina* caused by *Trichosporium vesiculosum* was observed in many plantations. Mortality of the plants was assessed in two plantations raised at Coimbatore and it was observed to be 75% in one plantation and 55% in another one.

Studies on biofertilizers

Studies conducted on the VAM colonization in the rhizosphere of teak revealed that the mycorrhizal colonisation on the roots was comparatively poor (less than 25%). The VAM flora analyzed was found rich in *Glomus* sp., *Gigaspora* spp. and *Sclerocystis* sp.

Issuance of phytosanitary certificate

Exportable plant materials and seeds were investigated for pest and disease incidence and about 32 Phytosanitary Certificates were issued to different agencies and universities.

ECONOMICS AND SOCIOLOGY

The division of Economics and Sociology in the Institute of Forest Genetics and Tree Breeding functions as an interactive and multi-disciplinary focus for all other disciplines. The areas of concern under the division are cost-benefit analysis of forestry activities and programmes, studies on social and institutional acceptance of forestry research, technology studies on forest people interaction, market intelligence, surveys on the utilization of forestry products, impact analysis of forestry projects etc.

Data on pricing and utilization pattern of timber products in the markets of Madras and Calicut is being collected, compiled, and analyzed periodically by undertaking extensive surveys.

PLANTING STOCK IMPROVEMENT PROGRAMME (UNDER WORLD BANK)

Research cum demonstration nursery

Under the FREE Project, the land identified for locating the Research cum Demonstration Nursery was filled with red soil and sand, levelled, and fenced. Action has been initiated for raising structures like green house, mist chambers, and shade house for the nursery. 21 germination beds have been formed and seedlings are being produced under Planting Stock Improvement programme and other projects of the Institute.

Action has been initiated for studying the optimum physical and chemical properties of mother beds and potting mixtures, container size, watering regime, primary culling in the mother beds, nutritional requirement of seedlings, nutrient deficiencies, and integrated pest and disease management in the nurseries.

Establishment of clone banks and multiplication gardens of casuarina, eucalyptus and teak

Selection of CPTs of *Casuarina equisetifolia*: 58 CPTs have been identified from Tamil Nadu and Andaman and Nicobar islands. Ramets of 29 clones identified in Andhra Pradesh have been obtained from the State Silviculturist, Rajahmundry, Andhra Pradesh. Ramets of 15 clones have been obtained from JK Corp., Ltd., Rayagad, Orissa. Contacts have been made with Silviculturists of Orissa, West Bengal, Maharashtra and Gujrat for exchange of clones.

Selection of CPTs of *Eucalyptus*: Ramets of 15 clones from ITC Bhadrachalam and 10 clones from JK Corp., Ltd., Rayagada Orissa have been obtained. Contacts have been made with Mysore Paper Mills, Shimoga for exchange of clones. Superior clones identified by IFGTB have been given to JK Corp., Ltd., Rayagada under exchange programme.

Selection of CPTs of Teak: 19 Clones were collected from the Germplasm Bank at Chandrapur, Maharashtra. 51 clones were collected from the State Silviculturist, Rajamundhry, Andhra Pradesh

Seedling seed orchards

Two Seedling Seed Orchards of *Eucalyptus camaldulensis* were established at Panampulli (Kerala) and at Pudukkottai (Tamil Nadu). At Panampulli, seedling seed orchards of *Casuarina equisetifolia* and *Acacia auriculiformis* were established.

Clonal seed orchard

A teak clonal seed orchard consisting of 9 plus trees from Kerala and 10 plus trees from Tamil Nadu was laid out at Panampulli, Kerala.

Seed production area

The Tamil Nadu Government has accepted the proposal for entering into MOU. 5 plantations in Kerala have been identified for converting into SPA.

UNDP/FAO REGIONAL PROJECT ON "IMPROVING PRODUCTIVITY OF THE MAN-MADE FORESTS

The project was designed to assist member countries to strengthen their national capability to produce genetically improved seed and planting materials of proven species. This was to be achieved through training, technology transfer, and research and development aimed at substantially increasing the productivity.

The Institute of Forest Genetics and Tree Breeding (IFGTB) of the Indian Council of Forestry Research and Education (ICFRE) was nominated as the focal agency to provide scientific and technical series to the select member countries in the project.

Establishment of seed production areas

1. A provenance area of *Casuarina equisetifolia* at Pondicherry with 35 seedlots supplied by CSIRO, Australia has been established.
2. A provenance area of *Acacia nilotica* at Panampulli, Kerala State with 20 seedlots supplied by DANIDA, Denmark has been established.
3. Provenance area of *Casuarina junghuhniana* with 21 seedlots supplied by ATSC, CSIRO at two locations - Pondicherry and Panampulli (Kerala) have been established.
4. Seedling Seed Production Areas of *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* have been set up at two locations - Pudukkottai (Tamil Nadu) and Panampulli (Kerala) (seeds supplied by ATSC, CSIRO).

Establishment of progeny trial cum seedling seed orchard

- a. A progeny trial cum seedling Seed Orchard with 50 candidate plus trees of *E. tereticornis* has been established at Pondicherry.
- b. A progeny trial cum Seedling Seed Orchard with 50 candidate Plus trees of *Casuarina equisetifolia* has been established at Panampulli (Kerala).

Evaluation of genotypes for difficult sites

99 clones of *C.equisetifolia* established in IFGTB clone bank have been laid out in a trial plot at a highly saline site at Muthukulam (Trichy) in Tamil Nadu for evaluating tolerance to salinity.

Clonal propagation

The IFGTB clone bank has a collection of 19 clones of *Eucalyptus camaldulensis*, 65 clones of *E. tereticornis*, and 106 clones of *Casuarina equisetifolia*. The clones have been given to other ICFRE institutes, Forest Development Corporations and other companies.

Improvement of tamarind for fruit production

14 superior trees of Tamarind in Kanyakumari and Tirunelveli districts of Tamil Nadu were identified and a progeny trial site of these candidate plus trees has been established.

EXTENSION (WORLD BANK PROJECT)

Contact printing

Ten ICFRE brochures, viz. Eucalypts, *Casuarina equisetifolia*, Sandal, Tamarind, Moringa, Neem, *Acacia nilotica*, *Pongamia pinnata*, *Prosopis juliflora*, and *Sesbania* were translated in Tamil and given for printing. Four brochures viz., Tamarind, *Pongamia pinnata*, *Casuarina equisetifolia*, and Sandal were translated in Malayalam and given for printing.

Demonstration classes

A programme was conducted on Nursery Practice, Macro propagation and Biofertiliser application for 30 members of Nehru Yuva Kendra, Ministry of Human Resources and Development, Coimbatore on 08-08-1996. The classes were taken by the resource persons from the Institute. A lectures were arranged on Agroforestry for 30 Trainee Officers of State Forest Service College, Coimbatore on 16-11-96. Dr. John mead, Reader in Forestry, Lincon University, Canterbury, New Zealand was the resource person.

General

The Deputy Director (extension) contacted various user agencies like State Forest Departments, Universities, Research Institutes, NGOs, Farmers, Industries, and Private entrepreneurs for arranging demonstration classes on submitting Extension Projects under the Extension Support Fund for technologies developed by the Institutes of ICFRE.

EDUCATION/TRAINING

Pests and disease problems encountered in the agroforestry models created at UNDP adopted villages were investigated and suitable pest and disease management methods were demonstrated. Two one day training on "Pest and disease problems of Teak and *Albizia lebeck* and their management" were conducted for University Research scholars and Post Graduate students under the UNDP Project.