Completed ICFRE Funded Project 2012-13

Project Sl. No.	Name of Project	PI	Thrust Area	Research Findings
1	Study on reproductive biology and breeding systems in *Ailanthus excelsa* and *Ailanthus triphysa*. (IFGTB-RP-96/2010-2013)	D. Rajasugunasekar	Genetic Improvement (Tree improvement)	Ailanthus seeds have been collected from Seeds from Kerala Forest research institute and Palakkad Division, KFD. 2000 Seedlings have been raised in the nursery for further studies. Plantation Details of Ailanthus triphysa by KFD has been collected. Ailanthus triphysa Karyotyping work has been initiated with root tips and FAA fixed pollens. Ailanthus excelsa seeds collected from Maharshtra has been raised in IFGTB Nursery.1 acre *Ailanthus triphysa* Germplasm has been established at Panampalli research station. Pollen viability and male & female structural variation Ailanthus triphysa have been studied. Key pollinator (*Apis cerena indic)* Indian Honey bee*) and* Dammar bee *(Trigona iridipennis) haven identified.* Pollen storage is being standardized. Intra specific control crossing of *Ailanthus triphysa* has been attempted. 1 ha of *Ailanthus triphysa* germplasm assemblage has been done in Nilambur Division, Kerala state.
2	Quantitative trait loci (QTL) mapping in eucalypts for salinity tolerance. (IFGTB/RP 62/ 2008-2011)	R. Yasodha	Forest genetic resource management and tree improvement (Tree Improvement)	Salt tolerant *E. camaldulensis* clones and hybrid individuals identified through hydroponic experiments. Individuals with hybrid vigour were identified from field trials, require replicated trails for hybrid clone release. Immortal mapping population was established in the filed as vegetative multiplication garden.

				Controlled hybridization produced 70% fruit set and 9.4 seeds per capsule. Hybrid purity values for 25 SSR loci were > 85.0% which is acceptable in controlled hybridization through conventional methods. Genetic linkage map developed for the cross *E.camaldulensis* x *E.tereticornis* was developed and the total length of paternal and maternal map was 1422.28 cM and 1845.8 cM respectively. One significant QTL was detected in the chromosome 6 explaining 64% variation. Field trials were conducted to evaluate the performance of hybrids in comparison with open pollinated trees, self pollinated trees and commercial clones and found few individuals perform better than commercial clones.
3	Allelic diversity of CCR gene in Casuarina equisetifolia. (IFGTB/RP 60/ 2008-2011)	Dr. A. Shanthi	Forest genetics resource management and tree improvement (Theme: Biotechnology)	For the identification of DNA marker for lignin gene (CCR) in *Casuarina equisetifolia* we have studied the basic wood proximate characters of the clones. The results obtained from this proximate study showed variation especially in the wood traits (Hollocellulose and Lignin content) which are economically useful in the paper pulp industry. The study showed that the local clones have higher lignin content than the international sources. The present study identified four clones having higher holo cellulose content [TNIPT-12 (80.7%), TNIPT-15 (80.4%), PY131 (80.0%), TNRM-8 (80.0%)] which are most preferable for the paper pulp industry. The CCR enzyme activity was estimated. using spectrophotometer . The study

				showed in four clones (TNIPT-21 TNIPT-,18, TNIPT-15, TNBS-8) have higher content of trans cinnamic acid (< 220umoles). Twenty set of CCR primers pairs were developed. Two primer pairs were well amplified with specific product sizes. Cloning work was optimized with modification in ligation procedure using pTZ57R/T vector. Positive colonies were sequenced. Sequence data were analysed in BLASTn & CLUSTALW programmes. CCR gene confirmation in Casuarina equisetifolia was obtained and partial gene sequence was deposited in NCBI.
4	Species recovery using diversity estimate and control pollination in *Bruguiera sexangula* (IFGTB-RP-88/2010-2013)	Dr. B. Nagarajan		
5	Identification of secondary xylem specific cellulose synthase genes from *Eucalyptus tereticornis* (IFGTB/RP 63/ 2008-2011)	Dr. Modhumita Dasgupta	Genetic Improvement (Biotechnology)	a. Six families of truncated cellulose synthase transcripts (*EtCesA1* – *EtCesA6*) were isolated from different tissues of *E. tereticornis* and three developing xylem specific full length genes (*EtCesA1, EtCesA2* and *EtCesA3*) were isolated and characterized. b. A complete genomic clone of 6.523 kb was assembled for *EtCesA1* harboring the complete CDS of 2940 bp encoding a predicted protein with 979 aminoacids. The sequence showed 94% similarity to *Eucalyptus globulus EglCesA1* and assigned GenBank accession number JX276651. c. Similarly, a full length genomic clone of 6.611 kb

				was assembled for *EtCesA2* and the sequence showed 95% similarity with *Eucalyptus grandis CesA2*. The gene encompassed a CDS of 3.114 Kb with predicted 1037 aminoacid and was assigned the GenBank accession number JX276652. d. The *EtCesA3* gene characterized in the present study was of approximately 5.532 kb with complete CDS of 3,042 bp with predicted protein of 1037 aminoacids and was assigned the GenBank Accession number of JX276653. This is the first report on isolation of full length cellulose synthase genes from E. tereticornis. e. Seven reference genes were evaluated for normalization of RT-qPCR data and Actin (*EtAct2*) was found to be the most stable gene for gene expression across tissues. *EtAct2* and *EtSAND* were identified as the most stable genes in pair for expression profiling. This is the first report on selection of reference genes for normalization of RT-qPCR data in *E. tereticornis.* f. The expression patter of all the six families of *EtCesAs* were studied using reverse northern and RT-qPCR and both analysis revealed the presence of two groups of *CesAs* in *E. tereticornis,* including the three genes involved in cellulose biosynthesis during primary cell wall formation (*EtCesA4, EtCesA5* and *EtCesA6*) while the expression of *EtCesA1, EtCesA2* and *EtCesA3* were predominantly found in the

				developing and mature xylem tissues.
6	Characterization of Eucalyptus clones for physiological and nutritional parameters. (IFGTB/NFRP-59/2008-2013)	Shri. S. Saravanan	Tree Physiology and Silviculture	IFGTB short listed clones were tested for physiological and nutritional parameters for better water and nutrient use efficiency clones and 6 clones were shortlisted for better water and nutrient use efficiency aspects.
7	Evaluation of selected phenotypes of Casuarina for establishment of windbreaks in farmlands. (IFGTB-RP-95/2010-2013)	Dr. C. Buvaneswaran	Forest Productivity (Social forestry, Agroforestry/ Farm forestry)	The project primarily aims to demonstrate how selected phenotypes of casuarinas tested at IFGTB can be used to design windbreaks in farmlands in wind prone areas of Coimbatore district in the most appropriate planting configuration and orientation. It also aims at demonstrating how appropriate designing and management practices in this agroforestry practice (Wind breaks) can enhance the productivity of trees and agricultural crops through positive bio-physical interactions in soil and microclimate. International Provenance trials conducted by IFGTB have shown that certain phenotypes of *Casuarina equisetifolia* and *C. junghuhniana* have certain branching characteristics which are ideally sought for in windbreaks. The selected phenotypes of Casuarina was used in designing windbreak system in this project to address the recurrent problem of crop damages particularly in plantain growing belt of the Coimbatore district, which is caused by strong gusty winds during monsoon period. As envisaged, 25 phenotypes were selected and the selected phenotypes have been assembled in germplasm bank at IFGTB. On the basis of rooting ability of clones and within clone variation in initial growth traits, ten clones were selected and multiplied for field trials. These

				field trials were established in four locations and evaluated the selected phenotypes for their efficacy in minimizing wind speed. On 14th February 2013, the Implementation Team of Regional Variety Testing Committee (RVTC) of IFGTB visited all the field trials established under this project. On observing the performance of different clones in the fields under windbreak agroforestry system, the Implementation Team recommended five superior clones for release as varieties for windbreaks. The performance of these five recommended clones was also presented before the members of RVTC of IFGTB on 14.08.2013 and RVTC also approved for release of these five superior clones for windbreaks. Approval from Variety Release Committee (VRC) of ICFRE is awaited for final release of these clones.
8	Exploration of potential native natural enemies with a special emphasis on microbial biocontrol agents for management of **casuarina**hairy caterpillar, *Lymantriaampla* and **Ailanthus** defoliators, *Eligma narcissus* and *Atteva fabriciella*. (IFGTB/RP97/2010-2013)	Dr. A. Balu	Managing forests and forest products for livelihood support and Economic growth	The needle feeder, *Lymantriaampla* and the defoliators, *Eligma narcissus* and *Atteva fabriciella* are considered as the key pests of casuarina and Ailanthus, respectively. Except for some chemical method of management of these pests at nursery level and some casual record of few natural enemies in the field no detailed information available on their potential natural enemies which can be exploited for ecofriendly management of the pests. An attempt was made in the present study to document the natural enemies operating in the field against these pest and to prioritize the potential ones for management of the pests. The finds of the study include 22 rounds (17for Ailanthus pests and 5 for Casuarina pest) of

				surveys at the plantations located in different parts of Tamilnadu were carried out. Two species of entomopathogenic fungus and 12 isolates of bacteria, on casuarinas hairy caterpillar, *L. ampla* and 6 isolates of bacteria, a species of dipteran parasite and a species of predatory bug on Ailanthus defoliators, *E. narcissus* and *A. fabriciella* were recorded from the field. Morphological characterization of the fungi isolated from casuarina hairy caterpillar, *L. ampla* was done out and identified as *Beauveria* sp. and *Metarhizium* sp. Morphological and Biochemical characterization for 12 isolates of bacteria isolated from the targeted pests of Casuarina and Ailanthus was completed and characterized to the genus level. All the isolates were found belonging to *Bacillus thuringiensis*. Pathogenicity tests were carried out in the lab with all the isolates of bacteria and the fungi obtained from the field. The pathogenicity tests exhibited only two isolates of bacteria were potential against the targeted pests. Molecular characterization using RAPD techniques exhibited genetic diversity among the bacterial isolates. The potential isolates were sequenced through 16SrRNA and submitted to EMBL (European Molecular Biology Laboratory) and obtained accession numbers **AC HF545005, AC HF545006** . The fungi species referred above were tested at two different concentrations against the targeted pests in the laboratory

				condition. The species *B. bassiana* at $2x10^8$ spores/mlexhibited 80-90% larval mortality only in the case of Ailanthus defoliator, *A. fabriciella*. Whereas in the case of the casuarina caterpillar, *L. ampla* the product did not show effective mortality. It resulted in only 20% larval mortality. Bioassay of the two potential isolates of bacteria against the pests, *A. fabriciella,E. narcissus* and *L. ampla* at the laboratory exhibited that the concentration $1x10^8$ cells/ml was effective to result in 100% larval mortality over a period of 72-96 hrs. Liquid and Powder formulations of 2 Potential isolates of bacteria were developed and field tested on the targeted insect species. The liquid formulation was found more effective than the powder formulation. While the liquid formulation at $1x10^8$ cells/ml resulted in 70 – 90 % mortality of both the defoliators of Ailanthus over a period of 120 to 144hrs and it was observed to be 60-70% mortality over a period of 168hrs in the case of casuarina caterpillar.
9	Management of pre and post harvest pests on seeds of fast growing native tree species. (IFGTB-RP-99/2010-2013)	Dr. J.P. Jacob		Regular surveys conducted during flowering, seed setting and monitoring during seed storage of eight fast growing species like *Ailanthus excelsa*, *Anthocephalus cadamba*, *Thespesia populnea*, *Melia dubia, Pongamia pinnata Sapindus emaginatus* and *Gmelina arboria* resulted in identification of various species of insects infesting buds, flowers, maturing seeds and seeds during storage. Lepidopterous and coleopterous species dominate in many cases followed by Homopterous pests.

				Insect pest attack was observed during flowering *of S. emarginatus, N. cadamba* and *P. pinnata*. Species like *P. pinnata, S. emarginatus* amd *M. dubia* showed pest infestation during seed storage. *A. excelsa, T. populnea* and *G. arborea* showed no insect pest incidence while flowering, fruiting or seed storage. While species of Lepidopterous and Coleopterous insects tend to cause 25-30% injury to buds and young fruits of *S. emarginatus* and *P. pinnata,* 100% injury was observed during seed storage of these tree species. A Dipteran insect cause 90-100% injury to the flowers of *P. pinnata.* Lab trials with plant based extracts and synthetic pesticides showed significant variation in seed protection from seed pests. Among plant based extracts, Tobacco extract and Neem oil based extracts showed significant protection for a period of 40 days. All synthetic pesticides showed seed protection for 3-4 months period. Treatment of receptacles like gunny bags, paper bags etc. were also efficient in seed protection for a maximum of 3 months. Integrated pest management methods standerdised for seed pests during seed storage include periodic monitoring, trapping and need based receptacle / seed treatment. No efficient biocontrol agents were identified during the study.
10	Influence of beneficial microbes in conferring salt tolerance to	Dr. V. Mohan	Managing Forests and Forest Products for Livelihood	* All soil samples were analyzed for physico-chemical parameters and determine the level of salinity and nutrient status. * 51 isolates of Plant Growth

	Casuarina clones. (IFGTB/RP-103/ 2010-2013)		Support and Economic Growth (Theme: Mycorrhizae, Rhizobia and other useful microbes)	Promoting Rhizobacteria (PGPRs) [18 isolates of Phosphate Solubilizing Bacteria (PSB), 16 isolates of *Azotobacter* sp. and 17 isolates of *Azospirillum* sp.] were isolated from the samples collected from different salt affected areas in Tamil Nadu and Puducherry and maintained the pure cultures in laboratory for further studies. * Estimated population density of PGPRs from various samples. Biochemical characteristics of different isolates of PGPRs (*Azotobacter, Azospirillum* and Phosphobacteria) have been determined. Species level identification of different PGPR isolates was undertaken. * Efficacy of all the PGPRs for production of IAA and Phosphate solubilization was determined under *in vitro*. It was found that some of the isolates showed high IAA production and phosphate solubilization. * Percent root colonization and soil spore population of Arbuscular Mycorrhizal (AM) fungi were assessed from different study locations. Percent root colonization and soil spore population was found maximum in the samples collected from the rhizosphere of plants grown in salt affected areas as compared to barren salt affected areas in different study locations. Genus and species level identification of AM fungi was done. * Experiments were conducted in order to test the salt tolerance ability of all the beneficial microbes by using 3 different salts *viz.,* sodium chloride, sodium citrate and sodium sulphate under *in vitro* condition and selected the best salt tolerant beneficial microbes. It was observed that the absorbance of the culture broth

				grown in salt stress to Sodium chloride decreased with increasing concentration of the salt. Similarly, decrease in growth pattern in terms of the absorbance was also observed in salt stress to Sodium citrate and Sodium sulphate. * Another experiment was conducted to determine salt tolerance ability of selected ECM fungi *viz., Alnicola* sp. and *Laccaria fraterna*. It was observed that both the ECM fungi could grow well even up to 300mM of sodium salts. But the growth rate and biomass yield decreased with increasing salt concentration. * Strains of *Frankia* were isolated from the root nodules of *Casuarina equisetifolia* collected from salt affected areas. Typical *Frankia* cultures grow in Bensen's medium producing white globose colonies at the edge of nodule pieces. * Sixteen different clones of *Casuarina equisetifolia* were raised and inoculated with selected beneficial microbes (AM and ECM fungi, PGPRs and *Frankia*) in nursery. Growth data such as seedling height, root length, collar diameter, shoot and root biomass was collected. It was observed that there is a variation in growth and biomass of different clones treated with different beneficial microbes in saline soil condition. * Persistence of inoculated beneficial microbes and nutrition status was also determined from the rhizosphere soil samples collected from different clones of *C. equisetifolia* in various treatments of the nursery experiment.

				* A field trial was established in salt affected land at TNPL, Pugalur by planting all the 16 different clones inoculated with different beneficial microbes. It was observed that there is a variation in growth and survival of different clones treated with different beneficial microbes.
11	Development of Tree DNA Fingerprint database. (IFGTB-RP-83/2010-2013)	R. Vivekanandan	Conservation of forest genetic resources - Biotechnology,	In this project, DNA fingerprint data collected from different researchers of IFGTB based on different techniques used such as AFLP, RAPD, ISSR, SSR etc from the Institute. The database contains information related to experiments conducted in Eucalyptus and Casuarinas species containing provenance related details, primer details, genetic variability details etc .
12	A New paradigm: A study to evaluate different innovative and successful marketing strategies and its suitability for forestry products. (IFGTB-RP-125/2011-2013)	R. Vivekanandan	Managing forest and forest products for livelihood support (Value Addition and Utilization) - Innovative marketing strategies	In this project, Analyzed successful strategies in Agriculture and allied sectors implemented by different agencies/ stakeholders. Analyzed successful marketing strategies in forestry sector by State Forest departments, forest corporations, Paper mills, NGO's, wood craft industry, musical industry, bamboo products, NTFP products etc. Analyzed successful Information Technology enabled (web 2.0) marketing strategies to be implemented in Forestry products. case studies prepared.
13	Evaluation of certain flora based on ethno botanical records for their pesticidal properties against important forestry insect pests. (IFGTB/RP-104/ 2010-2013)	Dr. N. Senthilkumar	Forest Entomology/ Phytochemistry	Ten plants have been short listed based on ethnobotanical records to identify their pesticidal properties against insect pests of forestry importance. Surveys have been made in different districts of Tamil Nadu and samples have been collected, processed, powdered and stored under deep freezer for further analysis. Different organic solvents such as acetone, methanol and ethyl acetate extracts of the collected leaves were sequentially

				performed and solvents were evaporated using vacuum evaporator, dried, lyophilised and stored at -20° C till bioassays and other analysis completed. Larvae of the test insects (*Hyblaeapuera)* collected from teak fields were mass cultured and established nucleus culture under laboratory for bioassay studies. Bioassay studies of the extracts made from the selected plants were evaluated against teak defoliator at Nilambur, Kerala Forest Research Institute, Research station at and Ailanthus defoliator *Atteva fabriciella* and *Eligma narcissus* in *Ailanthus excelsa* plantations at Kurumbapatti, Salem. All the extracts were found to possess antifeedant and insecticidal property (40-80 %) at higher concentrations (5000 and 10,000 ppm). The extracts were subjected to column chromatographic separation followed by UV Spectrum and the fractions were analysed using HPLC for phenol and phenolics. Further GC/MS/MS analysis of extracts made out of plant species was carried out to characterize bioactive principles. The bioefficacy of individual compounds identified showed significant results when tested against teak defoliator and ailanthus defoliators in laboratory as well at field. Based on the promising results the two preformulations developed showed 60% insecticidal activity when tested against casuarina bark eating caterpillar, *Indarbelaquadr inotata* under field conditions.
14	Studies on oil: chemical composition, antifeedant, insecticidal and antifungal activities of tree	Dr.S.Murugesan	Phytochemistry	The selected Tree Born Oil seeds (TBOs) were collected from the natural stands in Tamilnadu and Kerala. Seeds were processed and extracted oil fractions for bioassays and chemical analysis. Nucleus cultures of teak defoliator

	borne oil seeds. (IFGTB/RP-105/2010-2013)			and fungal cultures were maintained under laboratory condition till the bioassay study was completed. Antifungal activity of TBOs oils was tested against five fungal pathogens in comparison with fungicide and observed no antagonistic activity but found to have synergetic activity. The bioefficacy of the oils was tested against teak defoliator at laboratory in different concentrations and observed larval mortality after 24 hours of treatment. Oils fractions were tested against *Atteva fabricella* and *Eligma narcissus* larvae in *Ailanthus excelsa* field plantation at Kurumbapatti, Salem and restrain the larval activity. The bioactivity of the extracts and fractions of the oils were further confirmed through bioassay methods. Extracts were sprayed against some of the microbials infected seedlings viz. *Tectona grandis*, *Swietenia mahagoni*, *Terminalia bellirica, Syzygium cumini, Pterocarpus Marsupium* and *Gmelina arborea* raised by Tamil Nadu Forest Department at Thirumurthi Hills, Udumalpet. Tree born seed oils were analysed, and identified the major bioactive compounds like fatty acid methyl esters (FAME). Study of bioefficacy of the identified individual compounds against the defoliators of Teak, Ailanthus in terms of antifeedant, insecticidal activity showed significant larval mortality for Cyclopentanedeconone compared to other molecules. Based on the significant insecticidal property of the TBO oil & identified individual compounds like fatty acid methyl esters (FAME) preformulations were developed. Bioefficacy of the preformulation of oil fractions extracted from the *H.pentandra, L.camara*, neem and Pongam tested against the

				defoliators of teak/ ailanthus, casuarinas both in the laboratory and field condition showed significant result and a new product Tree Pal (H) has been developed and released during the Tree Growers Mela 2013.
15	Studies on Essential Oils: Chemical constituents and toxicity assessment of the Leaf oil *of Lantana camara* from Tamil Nadu Regions. (IFGTB/RP-107/2010-2013)	Dr. S. Murugesan	Phytochemistry	Essential oil was steam distilled from the leaves of *Lantana camara* differing in flower colour (orange, pink, white pink, pink yellow, orange yellow) collected from different agro climatic zones. Essential oil percentage varied from region to region and the leaves with rose colour flower found to yield more oil. Nucleus cultures of the teak defoliator larvae *Hyblaea puera* and fungal cultures such as *Alternaria solani, Fusarium oxysporum, Cylindrocladium, Rhizoctonia solani* and *Trichosporium vesiculosum* were initiated and maintained to conduct bioassay studies. Bioactivity of the essential oil was evaluated against the teak defoliator and observed 60 % mortality at higher concentration and found antagonistic activity against fungal pathogens. The bioactive compounds of the essential oil have been eluted by sequential chromatographic techniques and the elutants were further fractionated and analyzed by MPLC, HPLC and GC-MS-MS for characterization of β Caryophyllene and Aromadendrene II oxide as major compounds. The bioefficacy of the bioactive compounds Aromadendrene and caryophyllene identified from the essential oil of *L.camara* tested against *H.puera, Eligma narcissus* and *Atteva fabriciella* showed significant larval mortality. Based on the significant insecticidal activity of the *L.camara* essential oil against teak defoliators

				developed preformulation. Developed preformulation containing bioactive fractions extracted from *Lantana camara*, *Hydnocarpus pentandra,* Neem, Pongam tested for its bioefficacy against the defoliators of teak/ ailanthus, casuarinas both in the laboratory and field condition showed significant result based on which a new product Tree Pal (H) has been developed and released during the Tree Growers Mela 2013.
16	Biotransformation of some secondary metabolites by sporulate surface cultures of Frankia strains for nodulation capacity *in C. equisetifolia* and *C. junghuhniana.* (IFGTB/RP-108/2010-2013)	Dr. S. Murugesan	Phyto chemistry	Lyophilized Frankia of 15, 25 and 30^{th} day cultures were sequentially extracted with ethyl acetate and methanol/chloroform for lipid. The extracts of the lyophilized cultures were resolved in TLC using different solvents. The eluates were further fractionated in HPLC for mass spectral characterization in GC. The GC-MS-MS analysis and the spectral comparison revealed a total of 13, 23 and 14 components in 15, 25 & 30^{th} day cultures respectively. Presence of some of the hopanoids and fatty acid derivatives and their variations were estimated in different day Frankia cultures. It was observed that some of them are very specific to nodulation/nitrogen fixation and to different day cultures. Better growth performance was observed at the mixtures of Frankia in combination with bioactive compounds inoculated to casuarina seedlings under nursery condition. Frankia with identified bioactive compounds were inoculated to casuarina seedlings under nursery condition and observations were made in terms of performance, nodulation and biomass. Casuarina seedlings inoculated with the identified bioactive compounds like catechin, epicatechin, phthalic acid and phenyl acetic acid under

				nursery condition after initial observations and revealed better performance, nodulation and biomass. The root nodules collected from 7 months old casuarina seedlings inoculated with bioactive biosignalling molecules were analysed for GC MS MS characterization. The chromatographic data was analysed and concluded the results for the identification of bioactive principles with biosignalling molecules for the enhancement of nodulation in casuarinas. Bioactive compounds of primary and secondary metabolites and enzymes responsible for elucidation of signaling molecules were identified. Effect of those molecules was assessed in terms of biomass on Casurina seedlings as well as nodulation activity.
17	Orthopteran diversity of the Nilgiri Biosphere Reserve (Tamil Nadu part) (IFGTB/RP-110/2010-2013)	Dr. N. Senthilkumar	Forest Entomology	A total of 44 species of Orthoptera belonging to three different families was recorded from seven different habitat types viz., Scrub jungle, Deciduous forest, evergreen forest, grassland, plantations, sholas and swamp forests in NBR. Seven habitats namely Scrub jungle at Masinagudi; Deciduous forest at Mudumalai; Shola forest at Kothagiri; Grassland at Kodanadu; Teak Plantation at Kargudi and Evergreen forest at Gudalur have been surveyed at regular interval to observe the incidence and seasonality of Orthopteran insects. The species *Xenocatantop shumilis, Conocephalus maculatus* and *Phlaeoba infumata* are common in all habitat types surveyed. Studied the host range of *Xenocatantop shumilis, Phlaeoba infumata, Oxya sp. Acrida sp. Gastrimargus sp.* And *Orthacris maindroni*. Conducted extensive study on

				orthopteran diversity of high altitude shunted wet evergreen forests called shola to understand the impact of landscape changes. The upland forests act as refuges for highly mobile polyphagous insects like grasshoppers. *Oxyapusco vitata, Phaleobain fumata, Oxyanitidula* and *Xenocatantop shumilis s*pecies were recorded during the orthopteran population survey conducted in shola forest, grasslands and swamps at Kotagiri and Kodanaad. Diversity of grasshoppers in Nilgiris shola forests at three different locations each in Nilgiris north and Nilgiris south divisions respectively based on anthropogenic pressure and climate change have been studied. A total of 15 species including an unknown gryllid and two unidentified Acridid have been recorded from Nilgiris Shola forests and grasslands. Prioritization of Orthopteran species for conservation of sites and vice- versa has been made using root weighting method and studied the impact of Anthropogenic disturbances on Orthopteran diversity in different sites.
18	Impact of continuous moisture on growth, flowering, seed production and wood characteristics of canal teak plantations in Tamilnadu. (IFGTB-RP - 78/2009-2012)	Dr. K. Palanisamy	Tree Improvement	Studied the growth characteristics, flowering pattern, seed production and wood properties of canal bund raised teak. In addition, selection of superior trees for clonal multiplication and hollowness in canal teak was also studied. The flowering status in the canal teak plantations was studied and was found to vary from 40 to 84%. The percentage of fruit setting in canal teak plantations was 4 to 5% which was higher, compared to other teak plantations. The plantation at Nadupadugaiin Thanjavur district and Kondathur Vaikalin Nagapattinam district showed outstanding growth

				characteristics with good flowering and hence have been marked for converting into seed production areas (SPA's) to meet the seed demand for raising canal bund plantations. 21 superior teak trees in Tiruvarur and Thanjavur districts were felled by Tamil Nadu Forest Department and coppice shoots of the sameare being collected and multiplied clonally. The canal teak exhibited fast growth and showed 18 -30 m height and GBH of 110 to 170 cm at the age of 30 to 33 years and it is generally harvested at the age of 30 years. Comparative studies on the wood properties of fast growing canal teak were compared with 50 to 60 year old teak trees of Nilambur. Seeds of canal teak were collected and seedling characteristics like biomass and photosynthetic efficiency have been studied. As hollowness is a major problem in canal teak plantations, field and laboratory studies have been conducted to understand the hollowness problem and also develop a suitable control measures to improve the quality of wood. The damage and decay indicator in canal teak was also studied and it was found that canker punk knot, hollowness and top broken were very common in most of the canal teak plantations. Among these plantations, few good trees with straight and clear bole were observed in 5-10 year old young plantations in Thanjavur and Nagapattinam districts which in later stages - after 20 to 30 years – were found to be damaged due to improper pruning which had lead to pathogen infection and hollowness. Another possibility for infection is through root system due to continuous moisture in the root zone. The canal teak plantation of 30 years

				at Neivasal of Thanjavur district showed 38% of canker compared to other plantations in the same age groups of Vadavaru of Tiruvarur (35%) and Kondathur vaikkal of Nagapattinam (24%). Most of the trees in the plantations of Nagapattinam district - in all six age groups - were top broken (39% in Arupathyvaikkal) due to strong wind and cyclone compared to Thanjavur and Tiruvarur districts. In canal teak plantation areas of Tamil Nadu, 22 outstanding trees were selected, felled and coppice shoots are maintained for clonal multiplication. These clones will be supplied to Tamil Nadu Forest department for planting programme.
19	Documentation of Agroforestry Systems and wood flow to Wood based industries in Tamil Nadu. (IFGTB-RP-82/2010-2013)	K. Ravichandran Co-PIs : 1.Shri. S. Saravanan 2. Dr.C. Buvaneswran 3. Dr. Rekha Warrier	Managing Forest and Forest Products for Livelihood Support and Economics Growth	Agroforestry systems have been shown to produce private and social benefits which justify their promotion and which are recognized by farmers. They allow farm families the opportunity to integrate trees into their farms enhancing diversity and increasing overall productivity without taking agricultural land out of production. Because tree planting for the production of wood products is a relatively new activity for farmers and many of the successful species are new, diffusion has not yet become widespread. Thus, extension activities to promote tree planting are needed. Public resources should be focused on applied research linked to development efforts, training support for community-based extension, minimal in-kind subsidies, and removal of regulatory constraints. Public agencies, farmer organizations and NGOs can work directly with the private sector to expand

				markets and marketing services for new products or new sources of supply. Extension should continue to make available high-quality germplasm of tree species preferred by farmers for household use and by commercial markets, Improved inter-agency coordination, particularly at a local level, can support regular exchange of information and innovative practices. Public support for agroforestry and farm forestry can be integrated into a wide range of on-going development and environmental efforts. The study is conducted with the overall objective of the analysis and forecast of demand and the supply of pulpwood, so forest based industries can raise their raw materials to meet their needs through agro-forestry programs
20	Studies on the impact of *Indarbela quadrinotata* on growth of *Casuarina equisetifolia,* factors influencing the pest infestation and developing eco-friendly management practices. (IFGTB/RP 67/ 2008-2012)	Dr. K.R. Sasidharan	Managing Forest and Forest Products for Livelihood Support and Economics Growth	The bark eating caterpillar infestation was able to cause a loss of 6.66 percent in terms of diameter growth and 7.31 percent in terms of height growth of trees per annum. A positive correlation was found between the infestation level and the growth of the trees, with significantly higher impact on diameter increment. Wide variation was noticed in the infestation levels of bark eating caterpillar across the four agro-climatic zones. Among the climatological factors, the minimum temperature was found to have profound influence on the pest infestation. Various entomopathogens and botanicals were evaluated against the pest both in the laboratory and field condition and effective ones short-listed based on their efficacy.
21	Quantitative trait loci (QTL) mapping in eucalypts for	Dr. R. Yasodha	Genetic Improvement (Biotechnology)	Inter-specific cross between salt tolerance *E.camaldulensis* clone and salt susceptible *E.tereticornis* clone, both having good volume

	salinity tolerance. (IFGTB/RP 62/ 2008-2011)			production, was made. The F1 hybrid seeds thus produced were tested for their hybrid purity as the species is highly cross pollinated, the hybrid purity was 85%. The hybrid seedlings were field planted and vegetatively propagated for the production of multiple ramets for phenotyping experiments. The F1 individuals were subjected to 250mM NaCl hydroponically and scored for their susceptibility/tolerance. Similarly, genotyping experiments were carried out with 53 microsatellite markers and 100 F1 individuals. Statistical analysis was carried out using gMendel and ICIM mapping tools to generate species-specific linkage map and QTL map. Eleven linkage groups were identified and the total length of the paternal and maternal map was 1422.28 cM and 1845.8 cM respectively. One significant QTL (P=0.01) explaining 64% variation was detected. The hybrid individuals showing >80% tolerance are being multiplied for further field tests.