COMPLETED: EXTERNALLY AIDED PROJECTS

Project 1: Germplasm collection and production of improved planting stocks of *Terminalia chebula* Retz and *Terminalia bellirica* (IFGTB/EF-RP-25/ 2005-2008)

Findings: Selection criteria for identifying superior trees in terms of fruit yield and quality have been standardized for *T. chebula* and *T. bellirica*. Superior trees of *T. chebula* (85) and *T. bellirica* (19) were selected based on fruit yield, fruit size and fruit color in various places viz., Talawadi, Kallar, Bargur, Kalrayan hills, Courtallum, Chitteri hills, Javadhu hills and Nagarcoil in Tamil Nadu. Nursery techniques including seed processing, seed treatment, biofertilizer dosage etc., have been standardized for both the species. Vegetative propagation in *T. chebula* and *T. bellerica* have been standardized. Among the rooting of branch cuttings, airlayering, budding and grafting the wedge grafting method found to be relatively successful. Grafting of selected trees was attempted and wide variation was observed for response to cleft grafting. A germplasm bank of 9 *T. chebula* and 3 *T. bellirica* clones has been established at Panampally. Methods for estimation of medicinally active major biochemical compounds have been standardized. Four distinct populations of *T. chebula* and five populations of *T. bellirica* were screened for medicinally important biochemical compounds like total phenols, tannins, gallotannin, free gallic acid and ellagitannins to investigate the relationship between geographic location and the biochemical content. Though different populations showed variation for all these compounds, the tree to tree variation was also high within a population. Significant levels of variation for various active compounds content in fruits of selected superior trees were also observed.

Project 2: Germplasm conservation and establishment of seed stands for production of quality seeds and seedlings (IFGTB/EF-RP-09/2003-2006; Extended up to 2008)

Findings: Tree selection strategies were developed for *Aegle marmelos, Saraca asoca, Asparagus racemosus, Gymnema xylvestre, Tinospora cordifolia, Emblica officinalis* and *Oroxylum indicum* based on their distribution patterns, medicinal importance and threatened status. Appropriate seed handlings methods were also worked out. Vegetation propagation techniques and seed germination methods were standardized. Population survey was conducted in the States of Tamil Nadu and Kerala to identify and select trees/plants ased on the selection strategies. *Aegle marmelos* from 14 locations, *Asparagus racemosus* from 9 locations, *Gymnema sylvestre* from 9 locations and *Tinospora cardifolia* from 8 locations were collected, vegetatively propagated and assembled in the Medicinal Plants Seed Production System established in an area of about 1 Ha at Anaikatti, Tamil Nadu. Accessions of the above medicinal species from different locations in the states of Tamil Nadu and Kerala were assembled in the Institute. These accessions have been utilized to establish a germplasm bank cum seed production system for medicinal plants at Anaikatti in Tamil Nadu. The system has been established in an area of 1 ha including wild accessions of *Tinaspora cordifolia* (33), *Gymnema sylvestre* (15), *Saraca asoca* (6), *Asparagus racemosus*(20), *Aegle marmelos*(24), *Emblica officinalis* (6), *Strychnos potatorum* (1), *Oraxylum indicum* (2) and *Rauvolfia serpentine*(3).

Project 3: Field Performance of Micro and Macro-Propagated planting stock of selected five commercially important Bamboo Species [IFGTB EF-RP 17]

Findings: Twenty five hectares field plantations were established to study the performance of micropropagated plants of three species of bamboos, *B.bambos*, *D.strictus* and *P.stocksii* at four locations in Coimbatore and Salem districts. Among the three species tested, *B.bambos* showed better growth than *P.stocksii* and *D.strictus*, however the utility value of the culms vary among the species. Micropropagated, seed raised and cuttings propagated plants show similar growth in the field conditions. Initially, cuttings raised plants showed lesser mean number of shoots, however, no significant variation was noticed after 3 years of planting. It may be due to the number of rhizomes developed during the initial phase of establishment. Bamboo propagules over 8 months old at the time of field planting were escaped from rabbit damage, hence to avoid the damage of the shoots by rabbits, it is essential to plant 8 to12 months old plants. If the newly produced culm is thick, vulnerability to rabbit damage is less. Bamboos prefer well drained loamy soil and growth and production of new culms was highly affected in poor soils like gravel and rocky types. In irrigated conditions, the mean height of the tallest culm of micropropagated *B.bambos* at the age of 1.5 years was 4.2 m, whereas under unirrigated conditions, 4.5 year old plants showed 3.1m height. In unirrigated but good soil type micropropagated *D. strictus* was growing well than *B.bambos* and *P.stocksii*. Enough care need be taken for the plants during the initial years of establishment especially watering and weeding. Farmer's field is preferable for bamboo cultivation than unmanaged areas (Plate). Fire hazards are not uncommon in bamboo fields and to avoid the same regular weeding is essential during the establishment stages. Watering to the bamboo plants once in 15 days is essential in low rainfall areas at least for initial three years. Number of shoots produced was similar among the propagule types and culm growth is determined by the water availability. Supply NPK along with farmyard manure promoted the growth of bamboo plants than providing farmyard manure alone. A bamboo germplasm garden with 37 genotypes belonging to 19 species was established under this project.

Project 4: Population Structure and Reproduction in Bruguiera and Ceriops: Implication on Conservation [IFGTB EF-RP 26/2005 - 2008]

Findings: Studies were concluded on the pollination, floral biology and reproductive success in seven rare true mangrove species namely *Bruguiera cylindrica, B.gymnorhiza, B.sexangula, B.parviflora, Ceriops tagal and Ceriops decandra*. Detailed studies were conducted in 6 locations across the East and West Coasts. In the West Coast, Kannur and Ernakulam districts in Kerala were surveyed. The *B. cylindrica* populations in Pitchavaram, East Coast flower during April – May, whereas, in West Coast, they flower during October – November. Both sunbirds and insects pollinate *B. gymnorrhiza*. *B. cylindrica* pollinated by thrips shows the highest reproductive success. *B.sexangula* is exclusively pollinated by sunbirds exhibited the lowest reproductive success. In all the three species, the flowers produce enormous amount of pollen and show very high pollen to ovule ratio. *B. gymnorrhiza* and *B. sexangula* exhibit very high pollen fertility. Regeneration and development of families beneath mother trees was common in all the three *Brugueira* species.

Project 5: Development of post harvest techniques for seed production in *Jatropha curcas* [IFGTB EF-RP 24/2005 - 2008]

Findings: Phenology studies conducted in a plantation at Anaikatti, Tamil Nadu, over two peak flowering-fruiting seasons indicated that *Jatropha curcas* has high reproductive efficiency. The studies on maturity revealed attainment of physiological maturity when fruits turn yellow as shown by no significant variation in germination percentage among later stages of fruit ripening. With respect to harvesting maturity, though oil content among different maturity stages did not vary significantly, fruit maturity stage had considerable effect on oil physico-chemical characteristics like Acid value, Iodine No., Peroxide Value & Viscosity. The results indicate that fruits need to be harvested at late yellow stage or black pulpy stage and is safer to avoid collecting fruits at dry stage. Effect of drying method on Jatropha oil was studied in seeds extracted from fruits at black pulpy stage. Considering the oil yield, shade drying for 10 days and oven drying at 40°C for 1 day were found suitable methods. However, desirable values for most of the oil characteristics in the oven drying treatment at 40°C for 1 day renders it superior to 10 days of shade drying treatment. Comparing the two fruiting seasons, it is found that during the second season (October-December) the oil yield and quality was more than the first (July-September). Studies on seed processing showed that it is essential to separate the shell or seed coat from seed in order to maximize oil recovery. Hence developed a prototype, 'Seed Decoater' for processing jatropha seeds which separates kernel from seed coat. The seed is broken by milling technique while the separation of seed coat from kernel is through air suction. The prototype is driven by a 1hp motor and a minimum of 10 kg seed per hour can be processed by this Seed Decoater. The separation (80% kernel and 20% seed coat) of kernel enables to check loss of oil through adsorption by seed coat and thereby maximize oil recovery. In addition, the oil from the processed seeds is found to have better physico-chemical characteristics compared to whole seed oil. Seed grading experiment revealed that soaking jatropha seeds (insect attacked seedlot) for 24 hours in water followed by 2 hours drying helps recovery of good seeds as floaters while insect attacked seeds sink. The infection in the seeds was confirmed through the X -ray images. By this grading method the germination, percentage of a poor seedlot could be substantially improved. Effect of desiccation on jatropha seeds showed that 6% moisture content is the Lowest Safe Moisture Content to which the seeds need to be dried both with regard to oil quantity and quality. Effect of storage container on seed oil parameters and viability was tested on seeds stored in different containers such as polybag, jute bag, cloth bag, paper bag and black polybag. The most apt material to store jatropha seeds was found to be cotton cloth bag or jute bag. Effect of different temperatures on storability of Jatropha suggest that seeds need be stored at 10°C (normal refrigerated conditions) for a period of one year to obtain maximum oil content with desirable characteristics. From the midstorage correction trials, it was evident that both roll towel and wet sand treatments were good midstorage correction treatments for about 12 months storage.

Project 6: Evaluation of superior planting stock of *Acacia mangium* in agroforestry systems at different eco-climatic zones of Kerala and Tamil Nadu [IFGTB/EF-RP 11/2003-2006]

Findings: Experimental plots were established with seedlings raised using the seeds collected from seed orchards of *Acacia mangium* (Mangium) in Panampalli, Kerala along with ramets of superior trees of Mangium procured from Mysore Paper Mills both in Tamil Nadu and Kerala. Intercropping was done up to third year. Biological productivity was assessed at three years - half rotation age of tree component. Observation on growth parameters at the age of three years

revealed that maximum growth was recorded in southern zone of Kerala by registering girth at breast height (gbh) of 36.0 cm and total height of 15 m. The mean commercial bole height recorded was 12.7m in this zone. Minimum growth recorded was in central zone of Kerala with gbh of 24.5 cm and total height of 6.6 m. The gbh and total height recorded in southern zone of Tamil Nadu was 30 cm and 6.1 m respectively. In turn, volume production was highest at southern region of Kerala registering 79.12 m^3 ha^{-1} compared to central zone of Kerala (13.56 m^3 ha^{-1}) and southern zone (10.64 m^3 ha^{-1}) of Tamil Nadu. Results on biomass studies revealed that estimated wood yield (on fresh weight basis) at 3 years was 54.0 MT ha^{-1} in southern zone of Kerala which was 4-6 times greater than that registered in central zone of Kerala (12.0 MT ha^{-1}) and in southern zone of Tamil Nadu (9.0 MT ha^{-1}). While comparing the performance of seedlings of Mangium with that of hybrids of Mangium, more dry matter allocation in branch biomass was observed (17 to 28%) in hybrids of Mangium than in seedling raised plantations (5 to 16%). With heavy branching habit, the hybrids of Mangium are not suitable for agroforestry system.

Among different agricultural crops intercropped with *A. mangium*, blackgram, horsegram, fodder sorghum and beans were found to be compatible and onion was observed to be less compatible. The recommended agroforestry systems are i) *Acacia mangium* + Green Beans based system for Tamil Nadu and ii) *Acacia mangium* + Pepper based system for Kerala.

Project 7: Infrastructure development of the Botanical Garden of the Institute of Forest Genetics and Tree Breeding and *ex*-situ conservation of selected Rare and Threatened species (Funding Agency: MoEF)

Achievements: Infrastructure development work like repair of green house, laying out path and irrigation pipeline and labelling of plants in the garden has been completed. 140 plant species have been introduced and maintained in the Botanical Garden.

Project 8: Establishment of seed production systems for NTFPs of Attapady Hills [IFGTB/EF RP /2006 -2008]

Findings: Agriculture and sale of minor forest products are the two traditional income sources to the Attapady tribals. The species selected for the study are the major NTFP yielding species for the tribal communities which face destruction due to their destructible harvest. Population status of the NTFPs was studied. Seed handling procedures were developed in *Acacia concina, Caesalpinia sappan, Terminalia chebula.* Different NTFP species harvested were collected from Attapady Reserve Forest; studies conducted and produced seedlings for the establishment of Seed Production System (SPS). A seed production system has been established in an area of 1.615 ha. The species *Aegle marmelos, Saraca asoca, Oroxylum indicum, Acacia concina, Terminalia chebula, Asparagus racemosus* and *Caesalpinia sappan* have been planted. The espacement followed is 5 x 5 m with pits of size 50 x 50 x 50 cm. The tribal farming society was involved in the establishment of the SPS right from the time of site preparation and has been giving protective watering and maintenance till date. The survival of the plants at the end of 3 months was 84 % on an average (ranging from 78-91 depending on the species) and at the end of 6 months it is 70 % on an average (ranging from 70-90 depending on the species). The Vattaluki Tribal Farming Society (VTFS) is the beneficiary of the project output.