



**All India Coordinated Research
Project (AICRP)**

Multi institutional Project (MIP)



AICRP/MIP Projects

National Programme for Conservation and Development of Forest Genetic Resources: Pilot on 'Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)' at FRI Dehradun

Funding Agency:

Adhoc CAMPA Fund, Ministry of Environment, Forest & Climate Change, Govt. of India

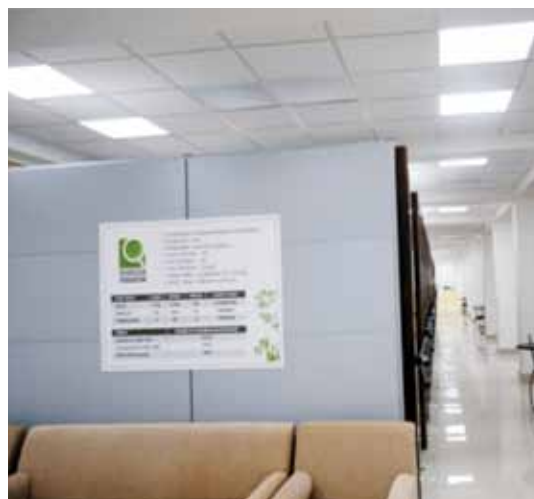
Forest Genetic Resources (FGRs) constitute a very important sub-set of biodiversity. Conserving FGR is vital, as they are unique and irreplaceable resources for the future. In India alone, more than 340 million people are estimated to be dependent upon the FGRs for their livelihoods. To generate understanding and knowledge on FGR, and to develop and strengthen in situ and ex situ FGR conservation programmes, the National CAMPA Advisory Council (NCAC) of Ministry of Environment and Forests & Climate Change, Govt. of India has sanctioned a pilot project on "Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)" at FRI.

The activities of the projects are being executed through four Working Groups created within the strength of FRI viz. FGR Documentation, FGR Seed and Germplasm Storage, FGR Characterization and FGR Conservation. The progress made under these working groups in last one year is summarized hereunder:

A. FGR Documentation

1. Upgradation of DD Herbarium

The DD herbarium building has been renovated through expert's consultation. The renovation works comprise civil works and super structural activities including flooring, false roofing, plastering and tile work, window panel fixation, and electrical work etc. Mobile herbarium compactors have been procured and installed in the renovated herbarium building. This has given a total facelift to the existing herbarium. Voluminous task of transferring and arranging Dicotyledonous floral specimens following the Bentham & Hooker classification has been initiated.



A view of new herbarium hall with state of art compactors after furnish



2. Documentation of FGR species

A list of 250 priority species (141- tree species, 29 shrubs, 15 lianas/woody climbers and 65 RET species) has been prepared. Out of which 50 species have been selected for the preparation of eco-distribution maps. Distribution of 200 species has been traced from DD herbarium, BSI herbarium and working plans. List of remaining 50 species is under progress. DD Herbarium, BSI Herbarium (Northern Circle), working plans and records from literature has been consulted for this purpose.

Field survey of five districts (6 Forest Divisions) viz. Dehradun (Narendra Nagar, Chakrata) Haridwar, Champawat, Almora, Pithoragarh, Chamoli (Kedarnath W.L.S., Valley of flowers W.L.S.), East Terai (Kishenpur, Dolly range, Surai range) and

TehriForest Division were carried out for ground verification on distribution and record of regeneration of the species.

3. Development of Eco-distribution maps of important FGRs

For development of eco-distribution maps of important FGR species, mapping methodology has been developed. Sampling methodology was developed for collection of GPS points. The methodology was tested by carrying out field visits in the Mohand and Sukhblock of Chhillawalii Range, Rajaji National Park, Dehradun (Uttarakhand). The estimation was quite similar to the FSI Forest Type Report (Satellite Image LISS III used) and working plan for Rajaji National Park indicating the reliability and accurateness of the developed methodology.

B. FGR Seed and Germplasm Storage

1. Collaboration with NBPGR, New Delhi

Explored the possibility of utilizing long term storage facility of NBPGR for storage of forestry specie.

As per the request of FRI, National Bureau of Plant Genetic Resources (NBPGR) New Delhi organised a training course on "Techniques for of Conservation of Plant Genetic Resources" from 27th June to 2nd July, 2016. Ten Scientists and research personnel working in various components of CoFGR-CAMPA project, participated in the training

An MoU has been developed and signed between FRI Dehradun and NBPGR New Delhi for utilizing the genebank space of NBPGR for the long term storage of the FGR species.

2. Survey of populations for seed collection

It is intended to collect seeds of 90 important FGR species in this project for their storage and conservation. Surveys were conducted for demarcation of populations of important FGR species and availability of their seeds. Seed of more than 18 FGR species collected from different parts of Uttarakhand and their seed handing and viability testing procedure were performed. Seeds have been kept for medium term storage.



In vitro multiplication of *H. salicifolia* shoots

3. In-vitro storage of FGR species

In order to develop protocols for in vitro storage of germplasm of FGR species of very high conservation concern and

ones having recalcitrant seeds, explants of *Taxus contorta*, *Hippophae salicifolia* and *Rhododendron arboretum* were collected from the wild populations and micro-propagation trial initiated.

A. FGR Characterization

Extensive survey and sampling work has been initiated in Uttarakhand hills for the selected species. Samples of seven species (*Rhododendron arboretum* var. red, *Rhododendron arboretum* var. pink, *Taxus wallichiana*, *Quercus semecarpifolia*, *Myrica esculenta*, *Diploknemma butyracea* and *Betula utilis*) have been collected from their natural zone of occurrence and stored at -80 °C. A total of 30-35 samples/trees were collected from each population in all the species. So far 45 populations have been sampled from Uttarakhand along with their geographical coordinates. The samples of these populations were segregated for chemical examination and DNA fingerprinting. DNA extraction protocol has been standardized for *Diploknemma butyracea* as well as *Betula utilis*. Chemical characterization/chemical marker(s) assisted screening of *Rhododendron arboretum* and *Myrica esculanta* is under process.

B. FGR conservation

Five priority species have been short listed for FGR Conservation as per the target of the project. The species are *Cinnamom umtamala*, *Diploknema butyracea*, *Rhododendron arboretum*, *Myrica esculanta* and *Taxus wallichiana*. The survey and review and literature through records were conducted to know distribution and status of prioritized species. Scientists have visited forest areas at Chakrata area and Dhanaulti area for exploring the possibility of field gene banks. Preliminary survey of all the species selected for conservation was completed in both lower and middle Himalaya.



AICRP/MIP Projects

Bamboo Genetic Evaluation, Improvement and Propagation Follow up Project (Phase II)

Funding Agency:

National Bamboo Mission - Bamboo Technical Support Group

Bamboo genetic diversity provides scope for selection of superior genotypes for improved productivity, quality of product, development of bio resource and sustainable utilization.

Keeping in view the importance of the improved planting material, an inter-institutional project on bamboo improvement was executed by FRI, Dehradun (nodal agency) along with 4 other ICFRE institutes viz. IWST, Bengaluru; TFRI, Jabalpur; RFRI, Jorhat and IFP, Ranchi on ten priority species viz. *Dendrocalamus strictus*, *Bambusa bambos*, *B. vulgaris*, *B. tulda*, *B. nutans*, *B. balcooa*, *D. hamiltonii*, *Pseudoxytenanthera stocksii* (syn. *Dendrocalamus stocksii*), *D. brandisii* and *D. somdevai*. In the first phase the evaluation trials of selected bamboo species established in past were revisited across different locations in the country, and evaluated with a set of selection parameters. Promising superior clumps were identified through multi-trait evaluation. The rhizomes/offsets of the superior clumps were



Selected clumps of *D. strictus* at FRI



collected for further multiplication and for establishment of rhizome banks in different regions/states. This activity has resulted in identification of **357 superior clumps of ten selected bamboo species** across five ICFRE institutes.

Species	Institutes					Total
	FRI	TFRI	RFRI	IWST	IFP	
<i>Dendrocalamus strictus</i> (Roxb.) Nees	22	49	-	-	09	80
<i>Bambusa bambos</i> (L.) Voss	-	61	-	13	-	74
<i>Bambusa tulda</i> Roxb.	-	-	07	-	03	10
<i>Bambusa nutans</i> Wall. ex Munro	-	-	03	-	-	03
<i>Dendrocalamus hamiltonii</i> Nees	-	-	02	-	-	02
<i>Dendrocalamus somdevai</i> Naithani	8	-	-	-	-	08
Total	30	110	12	13	12	177



Propagation of improved clumps in mist chamber

In second phase of the project, out of the selected 357 clumps, 177 clumps were taken up for their multiplication based on their previous record of flowering and further screening.

The selected clumps have revealed higher selection differential for culm height, internode diameter, internode length and number of culms per clump which indicate their potential for achieving higher genetic gains once they are deployed in the field after multiplication in successive generations.

The propagation technique for selected clumps of different species was standardized/ refined as the selected clumps showed considerable variation in rooting response due their genotypic differences and different geographical origin. Different type of cuttings (culm, branch, juvenile serial cuttings, offset etc) along with different hormonal concentrations/ season/ rooting media and rooting environment was tested. The clumps propagated through standardized protocols are being mass multiplied through macro proliferation and established in rhizome banks. Till date a total of 15650 clonal plantlets of the selected 177 improved clumps have been propagated and are available for field planting/establishment of rhizome banks in different institutes.

MoU has been signed with Madhya Pradesh State Bamboo Mission by IWST, Bengaluru for transfer of protocol and tissue culture plantlets of 7 industrially important bamboo species. The work ultimately will help in making available improved planting material of bamboo species in different regions of the country for Improvement in productivity.



AICRP/MIP Projects

'Induction, evaluation and development of polyploids in *Azadirachta indica*'

Funding Agency:

Indian Farmers Fertiliser
Cooperative Limited

The Indian Farmers Fertiliser Cooperative Limited, New Delhi (IFFCO) funded a project entitled 'Induction, evaluation and development of polyploids in *Azadirachta indica*' (neem) jointly to the Forest Research Institute, Dehradun and Arid Forest Research institute, Jodhpur with following objectives.

- To induce polyploidy and their screening for higher growth rate and higher productivity of seed and their performance under field conditions
- To collect germplasm and evaluation for natural polyploids and their variants
- To analysis existing evaluation trials and other populations / genotypes to identify potential seed sources to supply quality seeds for immediate planting purposes
- To develop macro and micro clonal propagation protocol focommercial multiplication and cultivation

The survey of various natural stands and plantations in the states of Gujarat, Haryana, Punjab, Rajasthan, Madhya Pradesh, Bihar and Uttar Pradesh was carried out to assess pattern of growth and select the plus trees. About 100 kg seed from individual plus trees was collected and processed, and supplied to the funding agency. The IFFCO through its subsidiaries has raised the seedlings and planted in the states of Madhya Pradesh, Rajasthan, Gujarat and Uttar Pradesh

Moreover, experimentation on screening of natural polyploids was also started which has been progressing in right directions and cytological studies are also underway. Forty one seedlots were germinated in the laboratory and



Experimentation on polyploidy

their leaf and roottips were used for chromosomal studies to screen natural polyploidy. The experimentation on analysis of chromosomes among different progenies has also been



Tissue Culture of Neem

initiated and ample seeds have been germinated under aseptic conditions.

The protocol to multiply desired genotypes of neem has now been established, and nodal cuttings of 5-6 mm length were treated with 1% Bavistein followed by 0.1 % HgCl_2 for sterilization. The cuttings were later inoculated on full and half strength MS (Murashige and Skoog) media, and

multiplied. The tissue culture propagation protocol for as many as eight genotypes has individually been established, and is in progress for other genotypes. Similarly, rooting protocol for two genotypes has been standardized and perfected, and is being tried for others. Progeny trials to understand G x E interactions for various genotypes have been established at eight geographical locations in the states Madhya Pradesh, Rajasthan, Gujarat and Uttar Pradesh. These trials would serve the purpose of basic experimental material for release of suitable genotypic materials for commercial cultivation in future



AICRP/MIP Projects

All India Coordinated Project on Genetic Improvement of *Melia dubia* Willd

Funding Agency:

Indian Council of Forestry Research and Education

Melia dubia Cav. (synonyms *M. composita* Benth.) is an important member of family Meliaceae, which thrives well upto an altitude of 1,800 amsl, and popularly known as Malabar Neem or Dreak or Gora Neem. The versatile tree is found to be suitable for various end uses as fodder, fuel, industrial wood and so on. Moreover, being deciduous in nature, it has immense potential to become an alternate species under agro-forestry systems. The Forest Research Institute, Dehradun started a systematic genetic improvement programme by initiating a project entitled 'Selection of plus trees from natural range of diversity and genetic evaluation of *Melia dubia* Willd.' during 2007-2010 with financial support from the Indian Council of Forestry Research and Education (ICFRE). The results were exceedingly encouraging, which led to execution of Phase II in the form of a multi-disciplinary and multi-institutional project entitled 'All India Coordinated Project on Genetic Improvement of *Melia dubia* Willd.' in 2011-2012 with financial support from ICFRE.

The research was therefore initiated on selection and assemblage of superior and genetically divergent germplasm so that quality planting materials could be supplied to the end users. Nonetheless, research was not only confined to genetic improvement and molecular characterisations but was also extended to other important aspects like seed germination, wood properties, pulping, seasoning, ply wood, agro-forestry and incidences for diseases / insects.

The species was seriously eclipsed with extremely poor seed germination of about 10 to 15 %. The seed processing and germination technology developed by FRI, Dehradun has now resulted in enhanced germination. In fact, it is

now routinely possible to achieve about 3 seedlings per stones, which could be contemplated to 300%. The initial analysis for wood properties on selected progenies revealed that wood density ranged from 0.33 to 0.50 g per cm³, and wood was less susceptible to drying defects. The plywood parameters for the species have been found to be encouraging for utilization of the species as an alternate raw material in plywood industry. A series of genotypes were evaluated (39), and found exceptionally good for



Melia dubia



both interior and exterior grade general purpose plywood. Nonetheless, gluehear strength was recorded to be exceptional to the extent of 200 kg/inch², which is double of threshold level of 100 kg/inch².

A series of genotypes were even evaluated across numerous geographical conditions, through G x E interactions, for analyzing productivity and stability. It was emphatic to record that some of the most promising genotypes, under moderately managed conditions, could attain productivity of 55.83 m³ha⁻¹ yr⁻¹ at the age of six years. It was therefore proposed to release selected genotypes as varieties in the states of Haryana, Punjab, Uttar Pradesh and Uttarakhand.

In this endeavour, 'Implementation Team', consisting experts from the fields of forestry, genetics, silviculture, entomology, pathology and statistics physically evaluated and verified performance of various genotypes, and recommended ten genotypes for commercial cultivation in Northern India. The productivity of recommended cultivars varied from 23.19 (FRI-MD-261) to 55.83 (FRI-MD-235) m³ha⁻¹yr⁻¹,



Implementation Team

with an average of 34.57 m³ha⁻¹yr⁻¹. The Regional Variety Testing Committee (RVTC) has also endorsed proposal of 'Implementation Team', and recommended Variety Releasing Committee (VRC) to release 10 cultivars.

The efforts were finally endorsed successfully by the Ministry of Environment, Forest and Climate Change, Government of India (MoEF&CC) when Variety Releasing Committee (VRC) ratified proposal, and released ten varieties of *Melia dubia* for commercial cultivation in Northern India.

It is pertinent to mention that *Melia* has become an extremely important industrial wood, and being grown largely now even by the farmers under various agro-forestry systems. The multipurpose tree is becoming popular among the growers as suitable plywood and pulp tree when harvested at an early age of 6 to 8 years and a timber tree when grown for more than 10 to 12 years.

Table-1: Productivity of ten released varieties of *Melia dubia* at seven years of age under irrigated conditions

Cultivar No.	Commercial Name	TRAITS							Volume (per tree)	Productivity (m ³ ha ⁻¹ yr ⁻¹)
		Height (cm)	CD (cm)	DBH (cm)	CBH (cm)	Str.	NB	BB		
FRI/MD/235	SHARAD	1433.33	31.00	25.73	790.00	3.67	4.33	3.33	0.2513	55.83
FRI/MD/349	SHASHI	1618.17	29.26	24.38	779.10	3.69	2.94	3.51	0.2546	40.41
FRI/MD/032	BAHUMUKHI	1233.33	28.67	23.33	666.67	3.33	2.33	3.00	0.1791	39.79
FRI/MD/232	VARSHA	1216.67	28.33	22.67	616.67	3.67	4.67	3.00	0.1670	37.11
FRI/MD/241	KARTIK	1521.40	28.88	22.93	892.54	6.41	5.09	6.11	0.2124	33.71
FRI/MD/075	KSHITIZ	1233.33	28.00	21.33	740.00	4.00	3.33	3.00	0.1504	33.43
FRI/MD/262	AMAR	1619.03	28.91	21.33	880.55	3.69	2.94	3.51	0.1960	31.10
FRI/MD/231	MEGHA	1216.67	25.33	19.13	650.00	3.67	2.67	3.00	0.1203	26.73
FRI/MD/256	DEV	1366.67	22.33	17.20	890.00	4.00	3.67	4.00	0.1096	24.36
FRI/MD/261	RITU	966.67	24.80	19.93	513.33	3.00	2.67	3.00	0.1044	23.19
Mean		1342.53	27.55	21.80	741.89	3.91	3.46	3.55	0.17	34.57
Min		966.67	22.33	17.20	513.33	3.00	2.33	3.00	0.10	23.19
Max		1619.03	31.00	25.73	892.54	6.41	5.09	6.11	0.25	55.83



Table-2: Region-wise recommendations of the varieties

S. No.	Cultivars	Commercial Name	Region	District	Evaluation Location
FRI/MD/032	BAHUMUKHI	<ul style="list-style-type: none"> Western Haryana Northeastern Punjab Western Uttarakhand 	<ul style="list-style-type: none"> Western Haryana Northeastern Punjab Western Uttarakhand 	<ul style="list-style-type: none"> Hissar Hoshiarpur Dehradun 	<ul style="list-style-type: none"> Bithmera, Hisar, Haryana Mehuwala, Dehradun, Uttarakhand PandoriMindo Mind, Hoshairpur, Punjab
FRI/MD/075	KSHITIZ				
FRI/MD/231	MEGHA				
FRI/MD/232	VARSHA	<ul style="list-style-type: none"> Northeastern Punjab Southern Uttarakhand Central Haryana 	<ul style="list-style-type: none"> Northeastern Punjab Southern Uttarakhand Central Haryana 	<ul style="list-style-type: none"> Hoshiarpur Udham Singh Nagar Rohtak 	<ul style="list-style-type: none"> Khadkan, Hoshairpur, Punjab Tanda, Udham Singh Nagar, Uttarakhand Rohtak, Haryana
FRI/MD/235	SHARAD				
FRI/MD/241	KARTIK				
FRI/MD/256	DEV	<ul style="list-style-type: none"> Northern Uttar Pradesh Southern Uttarakhand 	<ul style="list-style-type: none"> Northern Uttar Pradesh Southern Uttarakhand 	<ul style="list-style-type: none"> Saharanpur Udham Singh Nagar 	<ul style="list-style-type: none"> Chutamalpur, Saharanpur, Uttar Pradesh Tanda, Udham Singh Nagar, Uttarakhand
FRI/MD/261	RITU				
FRI/MD/262	AMAR	<ul style="list-style-type: none"> Western Haryana Western Punjab Southern Uttarakhand 	<ul style="list-style-type: none"> Western Haryana Western Punjab Southern Uttarakhand 	<ul style="list-style-type: none"> Fatehabad Firozpur Udham Singh Nagar 	<ul style="list-style-type: none"> GillaKhera, Fatehabad, Haryana Chak Sarkar, Firozpur, Punjab LalKuan, Udham Singh Nagar, Uttarakhand
FRI/MD/349	SHASHI				



AICRP/MIP Projects

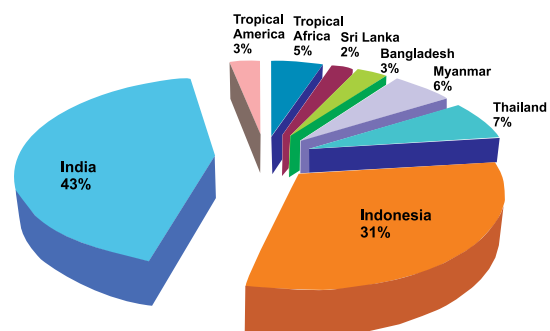
All India Coordinated Programme on Genetic Improvement of Teak

Funding Agency:

Indian Council of Forestry
Research and Education

Teak (*Tectona grandis* L. f.), an important source of paragon tropical timber famous for its superior quality, the durability and the decorative grains, grows naturally in forests of India, Myanmar, northern Thailand, Laos and Indonesia. The natural teak forests in India are the largest in the world, occupying an area of 8.9 million ha in central and peninsular region of the country. Further, teak of central India, comprising the states of Maharashtra and Madhya Pradesh, is pure/mixed dry forests, possesses beautiful decorative grains and is commercially exploited more than moist teak of peninsular and coastal region. Teak plantations in India claim to be the largest share (43%) of the world. Paradoxically, the teak productivity in the country is the second lowest in the world. Therefore, an intensive integrated programme has been launched for genetic improvement on teak that encompasses selection and cloning of superior genotypes, i.e. candidate plus trees (CPTs) from different natural/ plantation teak populations, raising their progeny trials, developing package of practices for the existing seed production areas/ clonal seed orchards for augmented production of quality seeds and, thereby, improved planting stock and evaluation of genetic diversity of teak populations.

A total of 78 teak CPTs has been selected from states of Chhattisgarh (44), Madhya Pradesh (23) and Odisha (11). The GPS location and passport data of the selected teak CPTs has been documented. The seeds of these CPTs have been collected and their seedlings as half sib (maternal) progenies raised for field trial in order to judge their genetic worth. The clones of these CPTs will be raised for assemblage as germplasm bank at multi-locations keeping in view the agro-climatic zones. The teak CPT clones of



India's teak (*Tectona grandis* L.f) plantation share in the world

proven genetic worth would be released for commercial plantations as interim measures for amelioration of timber productivity and quality in different agroclimatic zones.



Teak (*Tectona grandis* L.f.) CPTs selected from Angul, Odisha (a, b), their seeds (c) and progeny (d, e)



The same teak CPT clones would be either incorporated in clonal seed orchard for production of quality seeds or used as parents for advanced generation breeding programme aimed at several fold improvement of timber productivity and quality.

As for genetic diversity analysis, the teak populations from 15 agro-climatic zones belonging to Chhattisgarh and Orissa were collected. Each population was represented by 20 trees along with their soil samples, meteorological data and GPS locations which were sampled for extraction of leaf genomic DNA and wood core samples for measurement of wood density and fiber / vessel length in the macerated core samples. The microsatellite co-dominant primers were used for amplification/ detection of marker loci to be used for genetic diversity assessment and association mapping between wood traits and molecular markers. The detailed analysis is in progress.



a



b

A field visit to locate and collect teak populations, (a) extraction of wood core sample and recording of GPS location and (b) tree marking

