Annual Report 2016-17

TROPICAL FOREST RESEARCH INSTITUTE
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Executive Summary

Executive summary of the report

Ecosystem Conservation and Management

Climate Change

Quantification of carbon stock and annual sequestration in vegetation, litter and soil in tree plantations of Rourkela Steel Plant, Odisha is in progress.

Studies on impact of forest cover change on stream flows of the Narmada River Basin using Macro Scale Hydrological Model is in progress.

Initiated studies on plant-water relations to annual weather fluctuations in deciduous tree species.

Initiated assessment of impact of constructed water harvesting structures on soil moisture/ vegetation in Bundelkhand region using Remote Sensing and GIS techniques.

Biodiversity

Established Arachnarium at TFRI, Jabalpur with live spiders.

Assessment of plant diversity in Medicinal Plant Conservation Area (MPCA) of Chhattisgarh with reference to medicinal plants and conservation priority is in progress.

Studies on biodiversity and regeneration in response to canopy openings under selection cum improvement felling system and life of forest communities is in progress.

Documented ento fauna and flora in mangrove ecosystems in Bhitarkanika National Park, Odisha.

Documented diversity of fungi from forests of Madhya Pradesh and Chhattisgarh.

Standardized the techniques for germination, collection and maintenance of maximum viability of seeds of *Bridelia retusa, Sterculia urens, Boswellia serrata* and *Saraca indica.*

Studies on maturation and viability of seeds of *Adina cordifolia, Mitragyna parviflora, Lannea coromandelica, Ougeinia oojeinensis* and *Anogeissus acuminata* for effective collection and seed storage is in progress.

Forest Botany

Preparation of user-friendly data-base of plant diversity in Satpura plateau of Madhya Pradesh is in progress.

Tribals and Traditional Knowledge System

Documented indigenous knowledge and extent of utilization of herbs in folk-medicines prevalent in tribal pockets of Chhatarpur, Panna, Satna, Jabalpur, Seoni, Chhindwara and Hoshangabad of Madhya Pradesh.

Forest Productivity

Silviculture

Standardized plantation techniques for major forestry species in Madhya Pradesh.

Collected seeds of *Dalbergia latifolia* and initiated ecophysiological studies.

Evaluated harvesting practices for collection of tendu leaves in Gondia and Gadchiroli of Maharashtra.

Social Forestry, Agro-forestry/Farm Forestry

Revived lac cultivation and established brood lac farm in 10 tribal villages.

Surveyed plantation of *Gmelina arborea* existing in farmer's field in Jabalpur for development of agroforestry model.

Genetic Improvement

Conservation of Forest Genetic Resources

Established germplasm bank of *Pterocarpus marsupium* Roxb in Naya Raipur, Chhattisgarh and Chhindwara, Madhya Pradesh.

Studied morpho-molecular characterization and genetic diversity of *Litsea glutinosa* germplasm through STRUCTURE analysis.

Evaluated five genotypes of *Rauvolfia serpentina* for their ability to respond under *in vitro* conditions and their regeneration procedure was standardized for economical yield.

Tree Improvement

Introduction of honey bee colonies in teak seed orchards revealed positive impact on seed production.

Selected plus trees of teak from Madhya Pradesh, Chhattisgarh and Odisha and collected seeds for raising progeny trials and establishing germplasm bank.

Management practices of teak seed production areas, seedling seed orchards and clonal seed orchards are under progress.

Conducted experiments for inducing shoot organogenesis/ somatic embryogenesis from different explants of teak under *in vitro* conditions.

Studies on genetic diversity of teak through marker-trait association mapping are under progress.

Carried out selection of candidate plus trees of *Dalbergia latifolia* and established progeny trial at TFRI.

Refined existing micro-propagation protocols of *Dalbergia latifolia* for production of improved planting stock.

Initiated work on evaluation of progeny trials of teak for production of improved planting stock tolerant to defoliator and leaf skeletonizer.

Vegetative Propagation

In vitro cultures of *Bambusa nutans, Bambusa tulda, B. vulgaris* var. *Green* and *Bambusa balcooa* were established for commercial production of quality planting materials.

Initiated studies on improving adventitious rooting in *Dalbergia latifolia* Roxb.

Maintained bamboo germ-plasm bank of *Bambusa tulda, Bambusa vulgaris, Dendrocalamus strictus* and *Bambusa bambos* for genetic evaluation, improvement and propagation.

Biotechnology

Studies on development of tissue culture protocols for important forestry species, viz., *Buchanania lanzan, Madhuca indica* and *Tamarindus indica,* are underway.

Surveyed National Teak Germplasm Bank, Chandrapur, Maharashtra, for assessment of genetic structure, linkage disequilibrium and marker-wood trait association in CPTs of teak using molecular markers.

Non-Wood and Forest Products (NWFPs)

Sustainable Harvesting and Management

Standardized non-destructive harvesting practices of *Commiphora wightii* (Guggal) gum.

Chemistry of NWFPs, Value Addition and Utilization

Developed six food products enriched with *M. oleifera* leaves powder viz. noodles, nuggets, urad papad, biscuits, rice papad and aonla pickle and upgraded skill of rural women through trainings.

Forest Protection

Insects pests, diseases and control

Causes of *Gmelina arborea* mortality in plantation studied and integrated management practices developed.

Studied distribution, field biology and IPM of white grubs in teak nurseries of Madhya Pradesh.

Evaluated biopesticides, ivermectin and spinosad against major insect larval defoliators in nursery and plantation.

Technique for field application of *Canthecona furcellata*, as biological control agent against major insect pests initiated.

Taxonomic studies on grasshopper belonging to the family Tettigoniidae (Orthoptera) initiated.

Collaborative research with Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur initiated and identified 25 spider species.

Mycorrhizae, rhizobia and other useful microbes

Formulated biofertilizers consortium and distributed to forest department.

Forest Fire and Grazing

Initiated work on developing a predictive fire model on forests of Maharashtra.

Summary of projects

Projects	Completed projects	Ongoing projects	New projects initiated during the year
Plan	5	1	15
Externally Aided	1	16	2
Total	**6**	**17**	**17**

Contents

1. Introduction

Tropical Forest Research Institute (TFRI), Jabalpur (M.P.) provides research support to State Forest Departments and other stakeholders in central India covering the states of Madhya Pradesh, Chhattisgarh, Maharashtra and Odisha. The Institute came into existence in April 1988, although its origin goes back to 1973 when a Regional Centre of FRI, Dehradun was established at Jabalpur to provide research support to the problems of forest management in central India. It has an area of 109 ha and maintains a constant liaison with state forest departments, NGOs working in the field of forestry and allied areas, universities imparting education in forestry and forest based industries. The institute has a satellite research centre, namely Centre for Forestry Research and Human Resource Development (CFRHRD) at Chhindwara (M.P.), to carry out research in the areas of forestry sector and imparting trainings on human resource leading to poverty alleviation through self employment.

2. Research Highlights

2.1 Ecosystem Conservation and Management

2.1.1 Overview

2.1.1.1 Summary of the achievements under the Theme

- Quantified carbon stock and annual sequestration in vegetation, litter and soil in tree plantations, Rourkela Steel plant, Odisha by developing allometric regression equations and maximum carbon was found in *Tectona grandis* (Sagaun) followed by *Alstonia scholaris* (Saptaparni) and *Cassia siamea* (Kassod) trees.
- Basin boundary and watersheds were delineated and channels were derived in Geographical Information System (GIS) to study on impact of stream flows of Narmada river basin on forest cover change by using macro scale hydrological model.
- Selected five deciduous tree species namely *Tectona grandis*, *Madhuca indica* (Mahua), *Sterculia urens* (Kullu), *Anogeissus latifolia* (Dhawa) and *Buchanania lanzan* (Chironji) and their locations were identified and marked to carry out studies on plant-water relations to annual weather fluctuations in deciduous tree species.
- Studies initiated on assessment of impact of constructed water harvesting structures on soil moisture/ vegetation in Bundelkhand using Remote Sensing & GIS techniques and identified 36 Satellite images.
- Arachnarium was established at TFRI, Jabalpur with spider display and interpretation centre.
- Collected plant specimens based on compartment history and grid map of Medicinal Plant Conservation Area (MPCA) of Chhattisgarh Forest Divisions to study medicinal plant diversity assessment and conservation priority.
- Surveyed Mandla and Dindori Forest Divisions and selected three representative compartments each in sal, teak and mixed forests to collect data and phytosociology to study biodiversity, regeneration history, feedback of forest communities in response to canopy openings under selection cum improvement felling system.
- Surveyed Bhitarkanika National Park, Odisha and documented 10 mangrove flora and 35 species of insect fauna.
- Collected 230 samples of fungi from forest areas of Madhya Pradesh and Chhattisgarh, identified 120 species out of which three fungi recorded for the first time on new hosts.
- The techniques for germination, collection and maintenance of maximum viability of seeds of *Bridelia retusa* (Kasai), *Sterculia urens*, *Boswellia serrata* (Salai) and *Saraca indica* (Sita ashok) were standardized and maturation index and storage of these seeds were determined on the basis of physical parameters, germination and desiccation tolerance test.
- Collected seeds of *Adina cordifolia* (Haldu), *Mitragyna parviflora* (Mundi), *Lannea coromandelica* (Gunja), *Ougeinia oojeinensis* (Tinsa) and *Anogeissus acuminata* (Phasi) and carried out germination studies with different pre-treatments.
- Collected primary data from working plan, generated digitized maps of study area at TFRI for the preparation of user-friendly data-base of phytodiversity in Satpura plateau of Madhya Pradesh and tabulated characters of 1335 species.

- Documented indigenous knowledge of 365 herbs in folk-medicines and recorded extent of utilization from 116 Vaidyarajs on various plant parts and their formulations in tribal pockets of Chhatarpur, Satna, Jabalpur, Seoni, Chhindwara and Hoshangabad districts of Madhya Pradesh.

2.1.1.2 Projects under the Theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	1	--	6
Externally Aided	--	6	--

2.1.2 Climate Change

(i) Carbon sequestration through afforestation at Rourkela Steel Plant, Odisha

Quantified carbon stock and annual sequestration in vegetation, litter and soil in tree plantations raised by Rourkela Steel Plant (RSP) in 1013 ha area. Raised plantation of 12 tree species having higher carbon sequestration potential at RSP in four hectare area and measured growth characteristics and survival rate of the planted tree species. Developed allometric regression equations and quantified carbon in trees, underground storey, litter, deadwood and soil. In the selected quadrats, maximum carbon was found in *Tectona grandis* (Sagaun) (30 t), followed by *Alstonia scholaris* (Saptaparni) (8.94 t) and *Cassia siamea* (Kassod) trees (7.26 t). The total carbon content in 1040 trees found in the selected quadrats belonging to 39 species has been calculated to be 78.02 t. In the soil of RSP, 32.19 t C/ha was observed. Atmospheric CO_2 was measured at different locations of RSP in different seasons. Carbon in shrubs and herbs in the plantation area and natural forest was quantified after rainy season in the month of August when herbaceous biomass is found maximum and was recorded as 0.12 t/ha. Litter and deadwood was collected in 0.5 m x 0.5 m size quadrats laid out in the tree quadrats and carbon in the form of deadwood and litter was recorded as 1.33 t/ha. This project will lead to understand Soil Organic Carbon (SOC) and carbon sequestration by different tree species in RSP.

Fig.1: Acre plantation raised at RSP

Fig.2: Measuring growth data of plantations raised at RSP

(ii) Impact of forest cover change on stream flows of the Narmada River Basin using Macroscale Hydrological Model

Basin boundary and watersheds were delineated and channels were derived in Geographical Information System (GIS). Soil, land use and meteorological, river discharge and sediment data etc were procured. Geographic coordinates of all gauging stations and groundwater observation wells were acquired. Major dam locations in Narmada basin were demarcated and their level data were acquired. India Meteorological Department (IMD) Pune's newly developed gridded climatological data (daily rainfall and temperature) was procured and processed. In addition, scanning, geo-referencing of soil maps of National Bureau of Soil Science and Land Use Planning (NBSS and LUP) were done. Soil parameters were estimated. This project will lead to understand effect of forest cover change on stream flows of the Narmada River Basin.

(iii) Understanding plant-water relations to annual weather fluctuations in five deciduous tree species - Project initiated in January 2017.

(iv) Assessment of impact of constructed water harvesting structures on soil moisture/ vegetation in Bundelkhand using Remote Sensing & GIS techniques - Project initiated in January 2017.

2.1.3 Ecology & Environment: Nil

2.1.4 Biodiversity

(i) Establishing Arachnarium at TFRI, Jabalpur, M.P.

The laboratory for rearing, breeding and identification of spiders, having image-analyzing-workstation was completed and is functional. The interpretation centre decorated with 50 colour laminated blowups (2 ft x 3 ft) of spiders which exhibit the magnitude of spider diversity of Madhya Pradesh, is ready for demonstration and training purpose. More than 250 species of spiders collected from different parts of India, were identified and preserved as museum specimens. The spider garden and a green trail having terrestrial and aquatic micro habitats were completed. About 25 species of spider including fish-catching spiders inhabited the arachnarium by raising their population.

Fig.3: Arachnarium under establishment at TFRI, Jabalpur

(ii) Ecological assessment of floral diversity in MPCA of Chhattisgarh with special emphasis on species of medicinal importance and conservation priority

Compartment history and grid map of the Medicinal Plant Conservation Area (MPCA) were collected from the respective forest divisions of Chhattisgarh. The preliminary list of species recorded in one season for each MPCA was prepared. A total 140 quadrats for tree (0.1 ha), 560 quadrats for shrub (3m x 3m) and 560 quadrats for herb (1m x 1m) were laid in one season for recording under-storey vegetation. Plant specimens were collected for preparation of herbarium. Geographical details were recorded in field book at the time of specimen collection. The list of vegetation of one season was prepared for all the seven MPCAs along with documentation of threatened species. The findings of this project will be useful to study floral diversity of MPCA with special reference to species of medicinal importance and conservation priority.

(iii) Biodiversity, regeneration and life history feedback of forest communities in response to canopy openings under selection-cum-improvement felling system

Survey was conducted in the forests of Mandla and Dindori, where felling was proposed in October 2016. Three representative compartments were selected each in sal, teak and mixed forests. Secondary data from the working plans and compartment history were collected. Permanent quadrats were established in two identified coupes. The findings of this project will be helpful to understand the phyto-sociology under selection-cum-improvement felling system.

(iv) Documentation of insect fauna and flora of mangrove ecosystems in Odisha.

Surveyed Bhitarkanika and Dangmal Forest Blocks of Kanika Forest Range and West Orasahi Forest Block of Rajnagar Forest Range, Bhitarkanika National Park located in Mangrove Forest (Wildlife) Division, Rajnagar, Kendrapara, Odisha, for documentation of flora and insect fauna. Regarding flora, documented 6 species of true mangroves, 2 species of mangrove associates and one species of back mangrove. *Strychnos nux-vomica* L. (Nux-vomica) (Family Loganiaceae) is a new record in Bhitarkanika mangrove forests. Regarding insect fauna, documented 21 species of butterflies, 7 species of moths, 3 species of dragon flies, one species of damsel fly, honey bee, ant, grasshopper and stick insect. Documented *Hibiscus tiliaceus* L. (Bania) (Family Malvaceae) – a new host plant record for leaf roller, *Sylepta derogata* Fabricius (Lepidoptera: Pyralidae). This project will lead to information on mangrove species and insect fauna existing in Bhitarkanika National Park, Odisha.

Fig.4: *Cerbera odollam* (Panamas)

Fig.5: *Rhizophora stylosa* (Rai)


Fig.6:*Strychnos nux-vomica* (Nux-vomica) Fig.7:*Xylocarpus mekongensis* (Pitamari)


Fig.8: *Danaus melanippus* Fig.9: *Hypolimnas bolina*


Fig.10: *Papilio polytes* Fig.11: *Tirumala limniace*

(v) Documentation of biodiversity of forest fungi of central India

Field tours were conducted to collect fungi from forest areas of MP and CG and 230 samples of fungi were collected. Microscopic study of collected samples resulted in identification of 120 forest fungi. Out of them three fungi were recorded for the first time on new hosts, namely *Phellinus badius* on *Pithecellobium dulce* (Jangal Jalebi), *Trametes lactinea* on *Terminalia arjuna* (Arjuna) and *Hexagonia tenuis* on *Ziziphus jujuba* (Ber). *Pseudoidium* state of *Erysiphe alphitoides* was recorded for the first time on phyllode of *Acacia mangium* (Mangium) from forest nursery of Koraput, Odisha. Fifty seven documents of forest fungi were prepared from already collected samples present in mycology herbarium. This project will help understand diversity of forest fungi in central India.

(vi) Standardization of the techniques for germination, collection and maintenance of maximum viability of four important tropical species: *Bridelia retusa, Sterculia urens, Boswellia serrata* and *Saraca indica*

Effect of temperature, light, soil type and quality on germination of *Sterculia urens* (Kullu), *Boswellia serrata* (Salai) and *Saraca indica* (Sita Ashok) was evaluated. Best pretreatment for germination of *S. urens* was standardized. Maturation index and storage of these seeds was determined on the basis of physical parameters and germination and desiccation tolerance test. Storage behaviour of these seeds of was evaluated. Seeds of these species were identified as orthodox category and those of *S. indica* was identified as recalcitrant seeds. Seeds of these species were stored at different conditions and stored seeds were sampled at intervals for evaluation of moisture content and viability. *Bridelia retusa* (Kasai) seed has physiological dormancy. Best temperature for germination is 35°C. The seeds can germinate in both light and dark conditions. This project will provide the technique of germination, collection and maintenance of seeds of threatened species.

(vii) Studies on maturation and viability of seeds of five important tropical species: *Adina cordifolia, Mitragyna parviflora, Lannea coromandelica, Ougeinia oojeinensis* and *Anogeissus acuminata* for effective collection and seed storage.

Seeds of *Lannea coromandelica* (Gunja) and *Ougeinia oojeinensis* (Tinsa) were collected and germination studies were conducted. Seeds of *L. coromandelica* may have dormancy, as 20-50% fresh seeds germinated without treatment. Seeds were subjected to different pre-treatments to get the best germination. The effect of constant temperatures, light and soil type and depth on germination of *O. oojeinensis* was evaluated. Survey was conducted to identify the plantation of *Anogeissus acuminata* (Phasi) for seed collection. This project will help in standardizing the time of collection, seed storage and germination of threatened forest tree species.

2.1.5 Forest Botany

(i) Preparation of user-friendly data-base of phytodiversity in Satpura plateau agro-climatic zone of Madhya Pradesh.

Secondary data was collected from literature survey and working plans of the forest division. Primary data from the field survey was collected for documentation of the flora of the region. Tabulation of characters of 1335 species is being carried out. Database structure is being designed based on the available information. A user friendly user interface for data entry, editing and retrievals is being developed using Dot net technology. The morphological characters of 100 species have been described. Programs are being written for performing various user interactive queries. This project will develop database of plant diversity in Satpura plateau of Madhya Pradesh.

2.1.6 Tribals and Traditional Knowledge System

(i) Study on indigenous knowledge and documentation of extent of utilization of herbs in folk-medicines prevalent in tribal pockets of Madhya Pradesh

The study was conducted to document folk-medicines prevalent in tribal pockets of Chhatarpur, Panna, Satna, Jabalpur, Seoni, Chhindwada and Hoshangabad districts of Madhya Pradesh. The

information was recorded from 116 Vaidyarajs on various plant parts and their formulations in cure of ailments based**.** Plant parts such as roots, rhizomes, tubers, stem, leaves, fruits and seeds utilized in folk medicines prevalent in tribal areas were documented. The distribution was documented in different clusters on herbs, shrubs, climbers and trees, which were found to be threatened, vulnerable and overexploited due to their uses in pharmacy, indigenous use and periodical collection for export from forest areas. Market survey was conducted to study the fluctuations in prices over a period of time. This project will provide indigenous knowledge on use of medicinal plants by tribal of Madhya Pradesh.

2.2 Forest Productivity

2.2.1 Overview

2.2.1.1 Summary of the achievements under the Theme

- Standardized plantation techniques of eight major forestry species, viz. *Dalbergia sissoo* (Sissoo), *D. latifolia* (Kala Shisham) , *Dendrocalamus strictus* (Lathi bans), *Gmelina arborea* (Khamer), *Tectona grandis, Terminalia bellerica* (Beheda) and *T. arjuna* in Madhya Pradesh.
- Collected seeds of *Dalbergia latifolia* and initiated ecophysiological studies.
- Evaluated harvesting practices for collection of tendu leaves with reference to their sustainability, natural regeneration of tree species and quality of leaves in Gondia and Gadchiroli forest divisions of Maharashtra.
- Revived lac cultivation, established brood lac farm in 10 tribal villages and identified the major causes of low yield of lac crop on the traditional hosts existing in the farmer's field.
- Surveyed plantation of *Gmelina arborea* existing in farmer's field in Jabalpur and initiated development of agroforestry model.

2.2.1.2 Project under the theme

Projects	**Completed Projects**	**Ongoing Projects**	**New Projects Initiated During the Year**
Plan	--	--	2
Externally Aided	--	3	--

2.2.2 Silviculture

(i) Standardization of plantation techniques for major forest plant species in Madhya Pradesh

A plantation comprising of eight species, *Dalbergia sissoo* (Sissoo), *D. latifolia* (Kala Shisham) , *Dendrocalamus strictus* (Lathi bans), *Gmelina arborea* (Khamer), *Tectona grandis, Terminalia bellerica* (Beheda) and *T. arjuna* was evaluated for growth data. Observations of eight species (30 months old) revealed that highest survival was achieved in *D. sissoo* and lowest in *G. arborea*. Maximum height was attained in *D. strictus* followed by *Dalbergia sissoo* while *T. bellerica* showed least height. Individually the best growth for *D. strictus* was recorded in the pit size of 60 x 60 x 60 cm at a spacing of 3 x 3 m under irrigated conditions, *D. sissoo* showed best

growth in the pit size of 45 x 45 x 45 cm at a spacing of 2 x 2 m under irrigated conditions, *G. arborea* performed best in the pit size of 60 x 60 x 60 cm at the spacing of 3 x 3 m under non irrigated conditions, *T. arjuna*, in the pit size of 60 x 60 x 60 cm in the spacing of 3 x 3 m under non irrigated conditions, *D. latifolia* in the pit size of 45 x 45 x 45 cm in the spacing of 3 x 3 m under irrigated conditions, *T. grandis* in the pit size of 30 x 30 x 30 cm in the spacing of 3 x 3 m in non irrigated conditions, and *T. bellerica* in the spacing of 5 x 5 m in the pit size 60 x 60 x 60 cm in irrigated conditions. The findings of this project will be useful for selection of suitable species for large scale plantations.

(ii) Study on ecophysiology of seed germination and seedling survival for restoration of natural regeneration of two threatened species of central India - Project initiated in January 2017.

(iii) Assessing the impact of pruning of *Diospyros melanoxylon* bushes on its yield, quality and natural regeneration of tree species in Maharashtra.

The project was conceptualized to evaluate harvest practices for collection of ***Diospyros melanoxylon*** **(**tendu) leaves with reference to their sustainability, natural regeneration of tree species and quality of leaves in Gondia and Gadchiroli forest divisions of Maharashtra. Selected seven each of pruned and unpruned sites, laid out twenty one quadrats, marked each tendu bush falling in the quadrat and collected baseline information. Specific Leaf Area (SLA), considered as quality of leaves was found higher (7.52 mm^2/mg) in pruned bushes compared to non-pruned bushes (6.39 mm^2/mg). Available nutrients in the soil were found in low to medium range, while organic carbon was found in high range in the selected sites of Maharashtra. Gall infested, diseased and defoliated tendu leaves were found more in unpruned sites while healthy leaves were found to an extent of 60.33% in pruned sites. Gall attack on tendu leaves was caused by the insect *Trioza obsoleta* and leaf blight disease by *Pestalotia diospyri*. Conducted control fire experiment to examine its effect on the productivity and quality of tendu leaves at Koshamtondi site of Gondia division. The results of this project are of immense importance to Forest Department for better production of tendu leaves and to collect quality leaves.

Fig.12: Tagging tendu bushes with unique ID No.

Fig.13: Control fire experiment conducted at Koshamtondi

2.2.3 Social Forestry, Agro-forestry/Farm Forestry

(i) Empowering tribal communities through lac cultivation in Madhya Pradesh.

Identified the major causes of low yield of lac crop on the traditional hosts existing in the farmer's field. The technique for improvement of crop production was demonstrated. Farmers are not aware how to maintain the lac crop during hot summer days. Training and demonstrations

were conducted to keep the lac crop healthy during summer. Discussed marketing issue of lac and its processing with Balaghat based lac merchant, who are ready to purchase the raw material from the farmers. Motivated and interacted with farmers who are hesitant to adopt lac cultivation on their lac host trees. This project will help tribal communities to get better economic returns through lac cultivation.

(ii) Development of *Gmelina* based agroforestry system in Madhya Pradesh-Project initiated in January 2017.

2.2.4 Forest Soils & Land Reclamation: Nil

2.2.5 Watershed Management: Nil

2.3 Genetic Improvement

2.3.1 Overview

2.3.1.1 Summary of the achievements under the Theme

- Progeny and seed source trials of *Pterocarpus marsupium* Roxb. (Bija sal) in Naya Raipur, Chhattisgarh and Chhindwara, Madhya Pradesh was conducted.
- Morpho-molecular characterization and genetic diversity of *Litsea glutinosa* (Maida chhal) germplasm was studied through STRUCTURE analysis.
- Evaluated five genotypes of *Rauvolfia serpentina* **(**Sarpgandha**)** for their potentiality to respond *in vitro* regeneration procedure and biological (reserpine content) and economical yield (root yield).
- Introduction of honey bees in teak seed orchards showed positive impact in respect to the quantity of seed production.
- Plus trees of teak from Madhya Pradesh, Chhattisgarh and Odisha were selected and seeds were collected for raising progeny trials and establishing germplasm bank.
- Management practices of teak seed production areas, seedling seed orchards and clonal seed orchards are under progress.
- Experiments were conducted for inducing shoot organogenesis/ somatic embryogenesis from different explants in teak.
- Genetic diversity studies on teak through marker-trait association mapping are under progress.
- Selection of candidate plus trees of *Dalbergia latifolia* was carried out and established progeny trial at TFRI, Jabalpur.
- Existing micro-propagation protocols of *Dalbergia latifolia* for production of improved planting stock was refined.
- Work on evaluation of progeny trials of teak for production of improved planting stock tolerant to defoliator and leaf skeletonizer was initiated with teak clones of Madhya Pradesh origin.
- *In vitro* cultures of *Bambusa nutans, Bambusa tulda, B. vulgaris* var. *Green* and *Bambusa balcooa* were carried out for commercial production of quality planting materials.

- Studies on improving adventitious rooting in *Dalbergia latifolia* were initiated.
- Bamboo germplasm bank of *Bambusa tulda, Bambusa vulgaris, Dendrocalamus strictus* and *Bambusa bamboos* were maintained for genetic evaluation, improvement and propagation.
- Development of tissue culture protocols studies for important forestry species, viz., *Buchanania lanzan, Madhuca indica* and *Tamarindus indica,* are in progress.
- National Teak Germ Plasm Bank, Chandrapur, Maharashtra, was surveyed for assessment of genetic structure, linkage disequilibrium and marker-wood trait association in CPTs of teak using molecular markers.

2.3.1.2 Project under the theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	3	1	2
Externally Aided	1	4	1

2.3.2 Conservation of Forest Genetic Resources

(i) Germplasm collection and ex situ conservation of *Pterocarpus marsupium* Roxb

The progeny and seed source trials of *Pterocarpus marsupium* (Bija sal) was maintained in Naya Raipur, Chhattisgarh and Chhindwara, Madhya Pradesh. The growth data and casualty per cent were recorded. The mortality in progeny trials in Raipur and Chhindwara was recorded 17% and 28% respectively. The progeny of tree (No.6) belonging to Bilaspur was recorded highest in terms of height and girth followed by tree (No.11) of Hati in Raipur. The seed source trial established in Raipur also followed the pattern of progeny trial and highest length (1.47 m) was recorded in plants of Bilaspur followed by Hati (1.17 m). Girth also followed the same pattern with highest for Bilaspur (5.0 cm) followed by Hati (4.0 cm). A progeny trial was also established in Jabalpur comprising 10 families of Bija sal. This project will help in *ex situ* conservation of germplasm of this important vulnerable tree species.

(ii) Collection and morpho-molecular characterization of critically endangered *Litsea glutinosa* germplasm from Madhya Pradesh and Chhattisgarh

Surveys were carried out in Madhya Pradesh and Chhattisgarh for this critically endangered species *Litsea glutinosa* (Maida Chhal). Total 101 trees were located from 12 different forest divisions of Madhya Pradesh and Chhattisgarh. Detailed morph-metric data along with GPS location was recorded. Propagating material from the located trees was conserved in the form of germplasm bank at the campus of the institute. Propagation protocol using seed was developed. Molecular characterization of this conserved material was carried out. STRUCTURE analysis revealed four genetic clusters of this critically endangered species. The outcome of this project will help in locating the trees of this endangered species in the natural forests, their conservation and propagation.

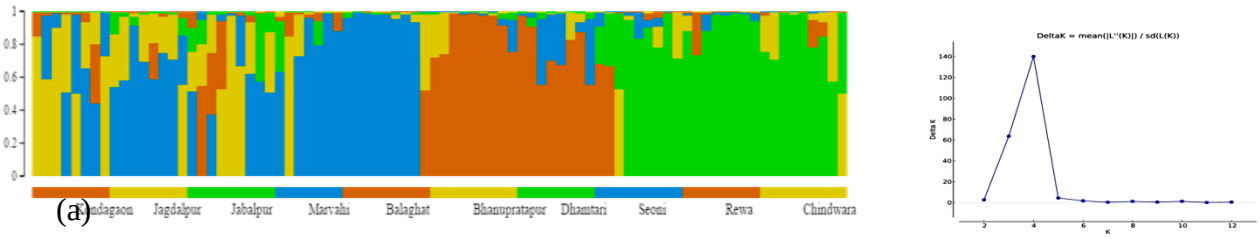

Fig.14: Bar plot showing genetic diversity of *Litsea glutinosa* (Maida Chhal) genotypes using program STRUCTURE. (a) Histogram showing four genetic pools in population-wise clustering (b) Population structure estimation in a set of *Litsea glutinosa* genotype. Estimated l n (probability of data) for each *K* value (*K*=1 to *K*=13). *delta* K calculated by the Evanno *et al.* (2005) method. Maximum value is observed at K=4.

(iii) Studies on variation in reserpine content in some high yielding genotypes of *in vitro* and seedling raised *Rauvolfia serpentina* Benth

Five genotypes of *Rauvolfia serpentina* were evaluated for their ability to respond under *in vitro* conditions and their regeneration procedure was standardized for economical yield. Among the genotypes tested, GO-MN genotype collected from Maina locality of Goa invariably emerged as the best genotype to produce maximum sprouting (84%), shoot number of 9.66 fold and 81% of rooting. Besides, GO-MN genotype registered a maximum caulogenic response, organ formation and root development in leaflet explants. The variation in *in vitro* and seedling raised plantlets was evaluated in terms of root yield and reserpine content. The highest content of 0.1% of reserpine was obtained in OR-AG genotype raised through *in vitro* procedure and reserpine content of 0.09% in seedling raised plants of this genotype. Similarly, highest root yield 26.61 g/plant was obtained in *in vitro* raised plantlets of GO-MN genotype as compared to the seedling raised plants (24.84g) of same genotype.

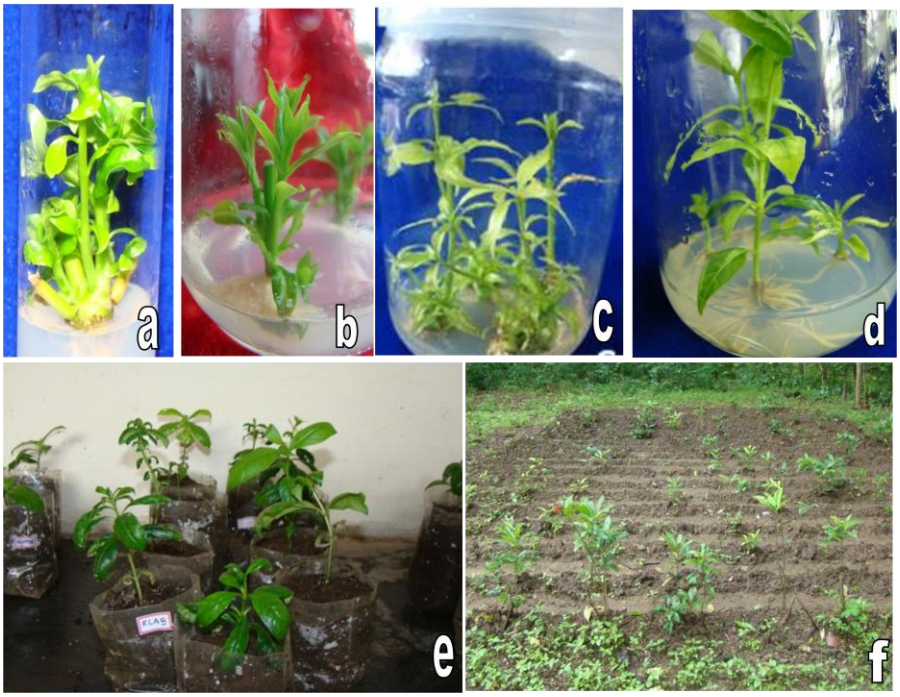

Fig.15: *In vitro* propagation and field trial of *Rauvolfia serpentina* plants (a-b) Maximum shoot initiation and regeneration in GO-MN genotype (c-D) maximum shoot number and rooting in GO-MN genotype (e-f) hardening and field transfer of *in vitro* and seedling raised plants of *R. serpentina*

2.3.3 Tree Improvement

(i) Studies on effect of introduction of honey bee on seed production of teak seed orchards.

A stock culture of honey bee, *Apis mellifera* was maintained at TFRI, Jabalpur. The colonies of *A. mellifera* were introduced in Teak Seed Orchard (TSO) at Ghisi, Behrai and Seoni just before the flowering season in the locality. The experimental field was visited periodically and honey bee colonies were introduced. Total 800 trees were marked and observations on flowering and fruiting status were recorded. Seeds were collected during the months of February-March, and subjected to detailed qualitative and quantitative observations like seed weight and size. Seeds were collected and data on number of seeds, seed weight and size were recorded. Based on the fruiting status and number of seeds, the introduction of honey bees has positive impact on seed production. The findings of this project will be useful for better production of quality seeds of known genotypes and production of honey as an income generation activity.

(ii) Improvement of teak for higher productivity in central/peninsular India: a multi-institutional All India Coordinated Project

Sub project 1: Selection of plus trees, raising their progeny trials and establishing germplasm bank

A total of 52 plus trees of teak (Sagaun) were selected from Madhya Pradesh, Chhattisgarh and Odisha. Seeds were collected from the plus trees marked in Devpur, Amarua and Mahraji in Chhattisgarh and Angul and Sambalpur in Odisha. Seeds from clonal seed orchard raised in the campus of TFRI were also collected. The collected seeds are under treatment for germination and raising their progeny. This project will help in selection of genetically superior trees of teak in central India.

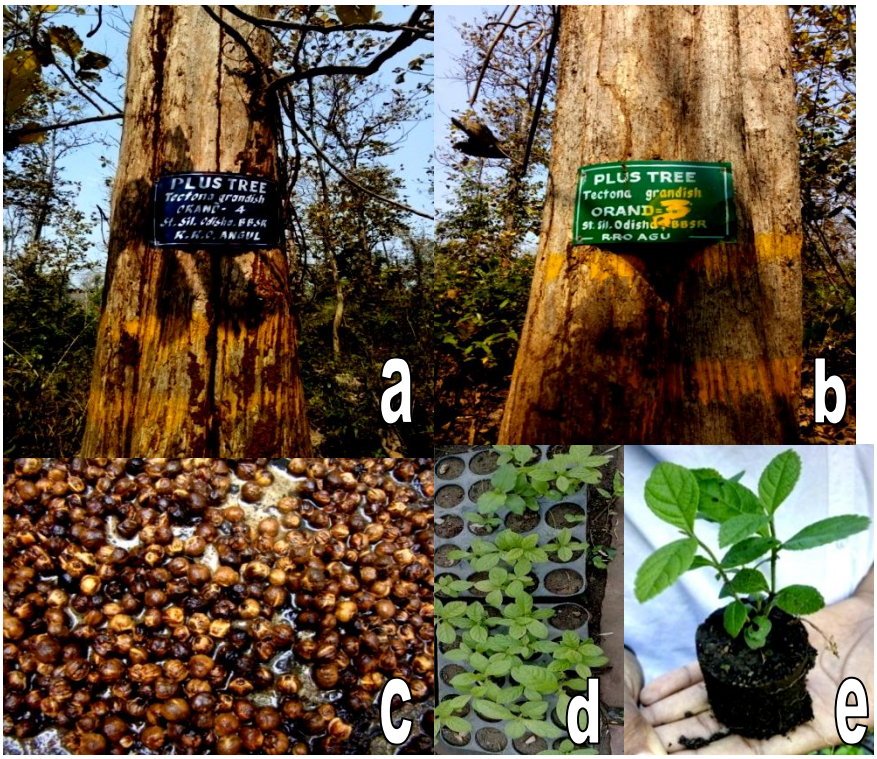

Fig.16: Selection of CPTs in Angul, Odisha (a-b) and (c-e) scarification treatment in seeds and raising seedlings

Sub-project 2: Development of management practices of teak seed production areas, seedling seed orchards and clonal seed orchards

Seed production areas (SPAs), Clonal seed orchards (CSOs) and Seedling seed orchards (SSOs) of teak (Sagaun) located in Madhya Pradesh, Maharashtra and Chhattisgarh were surveyed and existing management practices and flowering and fruiting status recorded. Effect of fertilizer application on seed production and manuring schedule was also recorded. Soil samples were collected from all the surveyed sites for analysis of their nutrient status. Seeds were also collected for morphological and germination studies. The observations on flowering pattern and fruiting behaviour of 40 clones of teak planted in CSO established at TFRI were also recorded. The outcome of this project will help in devising means of increasing flowering and fruiting in the SPAs, CSOs and SSOs of teak.

Sub project: 3 Production of transgenic teak tolerant to defoliating pests

Different experiments have been conducted for inducing shoot organogenesis/ somatic embryogenesis in teak (Sagaun). Various explants like internode segments, leaves, hypocotyl segments and cotyledons have been used. The effect of different concentrations of IBA (0.01 and 0.1 µM) and TDZ (0.1, 1.0 and 10.0 µM) and their interactions on callus induction in the leaf and hypocotyl explants was studied. Maximum callusing was obtained on MS medium supplemented with 1.0 µM TDZ and 0.01 µM IBA. Callus induced on MS medium supplemented with 0.1µM NAA and 0.1µM TDZ on internodes was maintained on same treatment for four sub-culture cycles. Afterwards it was transferred to MS Medium supplemented with 10µM BA for shoot formation. Shoot formation in very low frequency was obtained on internode and hypocotyl segments. This project will help in standardizing a method of organogenesis amenable to genetic transformation in teak.

Sub-project 4: Studies on population structure, linkage disequilibrium and marker-trait association mapping of Indian teak.

Leaf, wood radial core, soil samples and morpho-metric data of teak (Sagaun) was collected from two agro-climatic zones of Odisha i. e. Western Central Table Land -9 (Sambalpur-Laxmidongri) and Western Undulating Zone-8 (Khariar) along with GPS location (20 trees/zones). Genomic DNA was extracted, purified and quantified from the collected leaf samples. Wood core samples processed and wood density and fibre slides were prepared. Soil samples were analysed for pH, organic carbon, nitrogen and phosphorus. Fibre length and breadth (20 fibres/tree) was measured. Genotyping using fifteen microsatellite primers was completed. This project will help in assessment of population structure and linkage disequilibrium and marker-trait association mapping of teak of central India.

(iii) Genetic improvement of *Dalbergia latifolia* Roxb. through selection and evaluation of germplasm in central India

Sub project 1: Survey and selection of plus trees and establishment of progeny trials of *Dalbergia latifolia*.

A progeny trial of *Dalbergia latifolia* (Kala Shisham), a vulnerable species was established at TFRI, Jabalpur. The progeny trial was established in Randomized Block Design in three replications. Nine plants per plot were planted at a spacing of 2m x 2m. Regular soil working and

irrigation is being carried out. Plant height, collar diameter and survival % of plants was noted down after three months. The plants are growing well with 95% survival. Trees were selected and collection of half-sib seeds was carried out from two locations in Maharashtra. viz., from the seed plot located at Azra range, Kolhapur Forest Division and Allapalli range, Chandrapur Forest Division. The morphological data on total height, clear bole height, GBH, crown diameter, number of primary branches, status of flowering and fruiting was noted down. Physical parameters of pods, viz., pod length and number of seeds present were noted in 3 replications. 100 seed weight was noted down. This project will help in selection of superior trees and assemblage of germplasm of *D. latifolia.*

Fig.17: Establishment of progeny trial of *Dalbergia latifolia* (Kala Shisham) at TFRI Jabalpur

Sub project 2: To refine existing micro-propagation protocols of *Dalbergia latifolia* for production of improved planting stock.

A number of experiments were conducted for *in vitro* rooting of shoots of *Dalbergia latifolia* (Kala Shisham). In the first experiment various auxins viz., Indole Acetic Acid (IAA), Napthyl Acetic Acid (NAA) and Indole Butyric Acid (IBA) and coumarin in different concentrations (1, 2 and 4 mg l^{-1}) was tried for rooting on half strength MS medium. *In vitro* rooting was obtained on 2 mg l^{-1} IBA supplemented medium. In the second experiment various strengths of MS medium were tested. Rooting was obtained on half strength MS medium. The third experiment was a pulse treatment experiment in which shoots were pulse treated on MS medium supplemented with 1mg l^{-1} NAA and 1mg l^{-1} IBA for 48 hours and 72 hours. Rooting was obtained in shoots which were pulse treated for 48 hours. *In vitro* shoot cultures were multiplied and maintained on MS medium supplemented with 0.5 µM BA. This project will help in refining the micro-propagation of this species.

(iv) Evaluation of progeny trials of *Tectona grandis* and production of improved planting stock tolerant to defoliator and leaf skeletonizer - Project initiated in January 2017

2.3.4 Vegetative Propagation

(i) Commercial production of quality planting material of bamboo species

The *in vitro* cultures of four assigned bamboo (Bans) species viz., *Bambusa nutans, Bambusa tulda, B. vulgaris* var. *Green,* and *Bambusa balcooa* are being maintained. The process of shoot multiplication in four species was continued. The bi-nodal cuttings in *B. balcooa* and mini cuttings in *B. vulgaris* were tried for propagation through macropropagation. So far 200 plants of *B. tulda* and 350 plants of *B. nutans* and 150 plants of *B. balcooa* were produced. Using micro propagation and macro propagation techniques, different bamboo species are being multiplied.

Fig.18: Production of *Bambusa balcooa* using binodal culm cuttings

(ii) Studies on improving adventitious rooting in *Dalbergia latifolia* Roxb. and field performance of its rooted plantlets.

Seeds of *Dalbergia latifolia* (Kala Shisham) were collected from 10 selected trees and seedlings were raised. Shoot cuttings from progenies of 10 selected trees was planted in sand in polypropagators and in root trainers with treatment of 500 ppm of Indole Acetic Acid (IAA), Indole Butyric Acid (IBA) and Napthyl Acetic Acid (NAA). Data on shoot proliferation and rooting performance was recorded. Cuttings were planted during the month of April and September and variation was recorded in sprouting and rooting. This project will help in improving the rooting potential of *Dalbergia latifolia* through cuttings.

(iii) Bamboo genetic evaluation, improvement and propagation

Germplasm bank of bamboo established in the Silviculture nursery of the institute was maintained. So far 5175 plants of four species viz., *Bambusa tulda*, *Bambusa vulgaris, Dendrocalamus strictus* and *Bambusa bamboos* using different germplasm has been produced. The propagation of four species from the rhizomes assembled in germplasm bank is continued. The propagated plants are maintained by further process of macro-proliferation. So far 450 plants of *B. vulgaris*, 750 plants of *B. bambos*, 200 plants of *B. tulda* and 300 plants of *B. nutans* have been supplied to National Environmental Engineering Research Institute (NEERI), Nagpur, FRI,

Dehradun and Madhya Pradesh State Forest Department. Under this project quality planting material of different bamboo species is being produced and supplied to various user agencies.

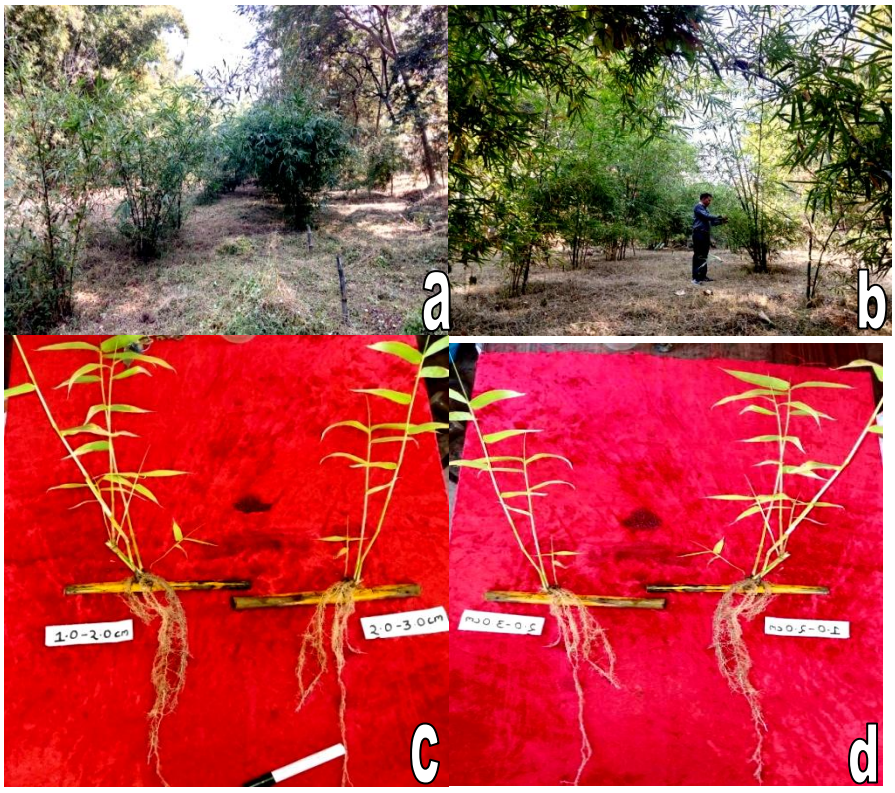

Fig.19: (a & b) View of germplasm bank in the campus (c & d) production of *Bambusa tulda* using cuttings of different girth class

2.3.5 Biotechnology

(i) Development of tissue culture protocols for important forestry species, viz., *Buchanania lanzan, Madhuca indica* and *Tamarindus indica*.

Experiments were conducted to standardize sterilization treatment of explants, nutrient medium and plant growth regulators for *in vitro* establishment of cultures and shoot multiplication in *Buchanania lanzan* (Chironji), *Madhuca indica* (Mahua) and *Tamarindus indica* (Imli). The nodal segments and cotyledonary nodes of *T. indica* were inoculated on MS medium supplemented with different concentrations of Benzyl 6-adenine (BA), kinetin and NAA. Shoot multiplication was obtained on 1mg l^{-1} BA and 0.5 mg l^{-1} kinetin. Nodal segments of *B. lanzan* and *M. indica* were surface-sterilized with 0.1% $HgCl_2$ for 7 min and inoculated on Murashige and Skoog (MS) semisolid medium supplemented with 3mgl^{-1} BA and kept in culture room at controlled environmental conditions. This project will help in developing tissue culture protocols of these three commercially important species.

Fig.20: Nodal segment inoculated on MS medium supplemented with 3mgl^{-1} BA (a) *Buchanania lanzan* (Chironji), (b) *Madhuca indica* (Mahua).

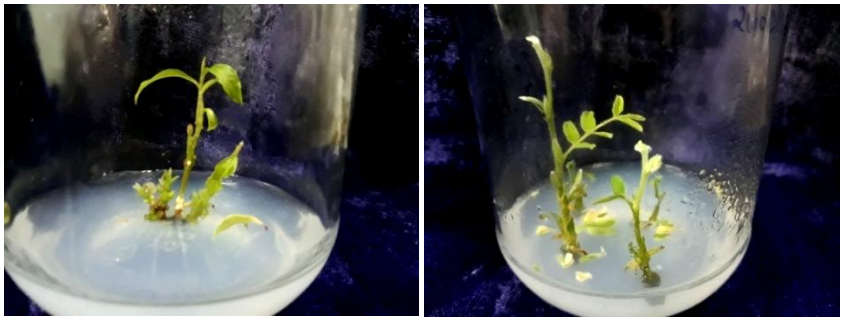

Fig.21: *In vitro* shoot multiplication in (a) *Buchanania lanzan* (Chironji), (b) *Tamarindus indica* (Imli).

(ii) Assessment of genetic structure, linkage disequilibrium and marker-wood trait association in CPTs of teak (*Tectona grandis* L.f.) maintained at National Teak Germplasm Bank, Chandrapur (M.S.), using molecular markers.

Surveyed National Teak Germplasm Bank (NTGB), Chandrapur. Leaf samples from 217 Candidate Plus Trees (CPTs) of teak (Sagaun) were collected and subjected to DNA extraction. Extracted genomic DNA was further subjected to purification using phenol chloroform extraction procedure. DNA quantification was carried out by Spectro-photometric method. Dilutions of the DNA samples (50ng/3ul) were prepared for PCR reactions. Samples of the extracted genomic DNA of 217 CPTs were provided to IFP, Ranchi. Total 52 microsatellite primers were screened with selected set of DNA samples and after critical perusal 28 primers were selected for final implication. Genotyping of 120 CPTs was carried out using 11 SSR primers. Pilodyn penetration value was recorded for 218 CPTs. This project will help is assessment of genetic structure, linkage disequilibrium and marker-wood trait association in CPTs of teak at NTGB, Chandrapur.

2.4 Forest Management: Nil

2.4.1 Overview

2.4.1.1 Summary of the achievements under the Theme

2.4.1.2 Project under the theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	--	--	--
Externally Aided	--	--	--

2.4.2 Sustainable Forest Management (SFM)

2.4.3 Forest Economics

2.4.4 Forest Biometrics

2.4.5 Participatory Forest Management

2.4.5 Policy and Legal Issues

2.4.7 Information and Communication Technology (ICT)

2.5 Wood Products: Nil

2.5.1 Overview

2.5.1.1 Summary of the achievements under the Theme

2.5.1.2 Project under the theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	--	--	--
Externally Aided	--	---	--

2.5.2 Wood and other Lignocellulosic Composites

2.5.3 Wood Processing

2.5.4 Value Addition and Utilization

2.5.5 Wood Chemistry

2.5.6 Pulp and paper

2.6 Non-wood and Forest Products (NWFPs)

2.6.1.1 Summary of the achievements under the Theme

- Standardized non-destructive harvesting practices of gum from *Commiphora wightii* . It was observed that the time of tapping, method and girth size affect resin production, which showed an increasing trend with increase in girth size.

- Developed six value added products viz., noodles, nuggets, urad papad, biscuits, rice papad and aonla pickle from *Moringa oleifera* leaves with increased nutritional value and upgraded skill of rural women through trainings.

2.6.1.2 Project under the theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	-		1
Externally Aided	-	1	-

2.6.2 Resource Development of NWFPs: Nil

2.6.3 Sustainable Harvesting and Management

(i) Standardization of non-destructive harvesting practices of *Commiphora wightii* (Guggal) gum oleogum resin in Madhya Pradesh

Surveyed different regions of Madhya Pradesh for identification of potential areas to conduct experiments for sustainable harvesting of Guggul. Different girth size (10-20, 21-30, 31-40 cm) plants were selected at Piprai, Amba (Murena), Kankura, Barhi, Oosad (Bhind) in Madhya Pradesh. A total number of 160 plants were selected and tagged for tapping. Experiments were laid out using different type of incision and quantity and quality of oleogum resin were evaluated to standardize harvesting technique. It was observed that the time of tapping, method and size of girth affect resin production. The quantum of gum yield showed an increasing trend with increase in girth size. The quantity of total Guggulsterone was found to decrease after storage. Maximum deterioration was observed in jute bags under both light and dark conditions. Maximum quantity of Guggulsterone Z and E were observed in samples stored in glass bottles under dark conditions. The non-destructive harvesting method developed under the project is of great value in the sustainable management of Guggul.

Fig.22: Oozing of resin in guggul. Fig.23: Oozing of resin in multiple slants and V shape cuts in guggul.

2.6.4 Chemistry of NWFPs, Value Addition and Utilization

(i) Development of fast food products enriched with *Moringa oleifera* (Drumstick) leaves and skill upgradation training to rural women

Surveys were conducted for availability of *Moringa oleifera* (Munaga). Leaves were collected from available sources, processed and stored for further biochemical analysis and product development work. Biochemical analysis of *M. oleifera* leaves was conducted for proximate composition like moisture, ash, carbohydrates, fat, pH, macro-elements and ascorbic acid. Surveys were also conducted in Anganwadi at Poama, Chhindwara for collection of information on the menu provided during breakfast, mid day meal and third meal. Six food products enriched with *M. oleifera* leaves powder were developed viz., noodles, nuggets, urad papad, biscuits, rice papad and aonla pickle. Developed food products were analyzed for their nutritional value from Standard Food Testing Laboratories (SFTL), Nagpur. Total 13 products were analyzed viz., crude leaves powder, developed food products and control food products for parameters viz., carbohydrates, proteins, fats, energy value, sodium, potassium, calcium and iron contents. Two training cum awareness programmes on "Nutritional benefits of *M. oleifera* leaves and prospects for its value addition" were conducted for Anganwadi women workers in Kundalikala and Parasia villages. Study will be useful as an income generation activity and help to overcome malnutrition.

2.6.5 Biofuels and Bioenergy: Nil

2.7 Forest Protection

2.7.1 Overview

2.7.1.1 Summary of the achievements under the Theme

- *Gmelina arborea* mortality in plantations was studied, found out the causes and developed integrated management.
- Distribution and field biology of white grubs in nurseries of Madhya Pradesh were studied and developed IPM strategy.
- Biopesticides, ivermectin and spinosad against major insect larval defoliators were evaluated in nursery and plantation.
- Strains of bacterial biofertilizers and Arbuscular mycorrhizal (AM) fungi were isolated for selected tree species of Madhya Pradesh and biofertilizers consortium were formulated and distributed to different forest divisions of Madhya Pradesh State Forest Department.

2.7.1.2 Projects under the Theme

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	1	--	4
Externally Aided	--	2	1

2.7.2 Insects pests, diseases and control

(i) Studies on the causes of *Gmelina arborea* mortality in plantation of MP, CG and its integrated management.

Disease and insects are found to be the causes of substantial mortality in *Gmelina arborea* (Khamer) plantations. TFRI studied plantations in MP and CG which showed that only 16.5% trees were healthy while rest 83.5% trees were infested to different degrees (40.4% trees showed low infestation, 30.1% medium and 13.0% showed heavy infestation). The pest and disease complex comprising 8 insects and 8 fungi were found associated with mortality of Khamer. Field experiments were conducted for management of *Gmelina* mortality. Treatments applied in these experiments include fungicide (Ridomil 0.2%) and insecticide (Monocrotophos 0.05%) along with nutrient management. Mulching followed by application of vermicompost along with Ridomil and Monocrotophos treatments was found to be effective. In standing trees branches showing die back due to disease/insect attack or physical damage were cut and the cut ends were painted with modified Chaubattia paste which prevented any further fungal invasion and insect attacks. These findings can be used by forest department for management of Khamer mortality occurring in plantations.

(ii) Distribution, field biology and integrated pest management of major white grub species infesting teak seedlings in Madhya Pradesh.

Based on surveys and observations of 26 forest nurseries of Madhya Pradesh, Obery Forest Nursery (Rewa-Sidhi Project) MPFDC, Saraswahi, Katni and Darauli, Jabalpur were selected for further detailed investigations. Incidence of white grubs recorded and remedial measures were suggested. Conducted experiments on IPM measures and related data on incidence, density and occurrence of immature and mature stages, host range within the nursery area and in surroundings, and activity period of the major species were recorded. Wax moth, *Galleria mellonella* was reared regularly in laboratory for maintaining the culture of Entomo Pathogenic Nematodes (EPNs) for field experiment during the season. For management of white grub adults light traps, manual collection and chemical treatments were also carried out as a component of IPM. Field experiment was carried out in Saraswahi Forest Nursery by introducing EPNs in nursery beds in Saraswahi, Katni on management of beetles, white grubs and related observations were recorded. The results of this project can be used by nursery managers for management of white grubs.

(iii) Field evaluation of biopesticides, ivermectin and spinosad against major insect larval defoliators.

Toxicity tests of biopesticide, Ivermectin (IVECOP-12) was carried out against the larvae of teak defoliator (*Hyblaea puera*) in nursery and 100% larval mortality was obtained at a concentration of 0.03%. Efficacy of biopesticides, Ivermectin and Spinosad (CONSERVE) 45% Soluble Chemical (SC) were evaluated against the larvae of teak leaf skeletonizer (*Eutectona machaeralis*), Khamer defoliator (*Hapalia aureolalis*) and *Ailanthus* web worm (*Atteva fabriciella*) in plantations. Results revealed 100% larval mortality by 0.03% Ivermectin and 0.003% Spinosad, irrespective of insect pests. Experiments on persistent effects of these

biopesticides against the larvae of teak leaf skeletonizer were carried out through field-cum-laboratory tests. The findings of this project will confirm the recommended dose of biopesticides, Ivermectin and Spinosad for eco-friendly management of larval defoliators of forestry species.

(iv) Development of delivery system for field application of *Canthecona furcellata,* as biological control agent against major insect pests - Project initiated in January 2017.

(v) An All India Coordinated Project on "Taxonomic (AICOPTAX) study of Tettigoniidae (Orthoptera) of India" -Project initiated in December 2016.

(vi) Determining bio-control efficacy of spiders against insect pests of rice agro-forestry system -Project initiated in January 2017.

2.7.3 Mycorrhizae, rhizobia and other useful microbes

(i) Formulation of biofertilizers consortium and their distribution to forest department.
Strains of bacterial biofertilizers and Arbuscular mycorrhizal (AM) fungi were isolated for selected tree species of Madhya Pradesh. Inoculants of bacterial biofertilzers and consortium of AM fungi were prepared for selected species. Carrier material being used for making packets of bacterial biofertilizers are: activated charcoal powder, saw dust, grinded and filtered soil (clay loam), vermicompost and calcium carbonate. Carrier based packets of selected bacterial biofertilizers were prepared for distribution to forest department. Inoculants of AM fungi were also prepared in bulk (25 bags of 40kg each). Soil, sand and Farmyard Manure (FYM) in 2:1:0.5 ratios were used as carrier for production of AM inocula for Bija sal, Sissoo and Teak. Biofertilizers were supplied for application in 11 nurseries of Research & Extension Circles, Madhya Pradesh, which included 661 packets of *Rhizobium*, 668 of *Azatobacter*, 308 of *Azospirillum*, 544 of Phosphate Solubilizing Bacteria (PSB) and 24 bags of Vesicular Arbuscular Mycorrhizae (VAM) fungi. The application of these biofertilizers will enhance the growth of tree species.

2.7.4 Weeds and Invasive species: Nil

2.7.5 Forest Fire and Grazing

(i) Developing a predictive fire model on forests of Maharashtra with relation to various factors and to delineate suitable strategies - Project initiated in January 2017.

3. Education Vistas/Activities

3.1 FRI University (Applicable for FRI, Dehradun only): ----

3.2 Trainings Organized

S. No.	Institute/ Centre	Duration and dates	Title of Training	Venue	Target Group
1.	TFRI Jabalpur	One day 24/6/2016	Application of Biofertilizers in Forest Nurseries under the project "Formulation of Biofertilizers consortium and their distribution to Forest Department"	Malwa Demo Nursery of Research and Extension Circle at Indore	Frontline staff of SFD
2.	CFRHRD, Chhindwara	One day 29/06/2016	Environmental Awareness	Govt. Higher Secondary School, Guraiya, Chhindwara	PG students and teachers
3.	TFRI Jabalpur	One day 05/07/2016	Application of Biofertilizers in Forest Nurseries under the project "Formulation of Biofertilizers consortium and their distribution to Forest Department".	Shahri Ropani of Research and Extension Circle Jabalpur	Frontline staff of SFD
4.	TFRI Jabalpur	Three day 28-30/7/2016	Assessing and recording the impact of damage caused by Insects-pests and diseases to tree species in forests of Central India.	FSI Nagpur	Field Staff of FSI, Nagpur
5.	CFRHRD, Chhindwara	One Day 29.8.2016	Training programme on Nursery techniques of Chironji.	Forest Research Nursery, JB Science College campus, Wardha	State Forest Department officials of Wardha, Maharashtra
6.	CFRHRD, Chhindwara	One Day 29.8.2016	Training programme on Diseases and insect pests in forest nurseries and plantations and their control measures.	Forest Research Nursery, JB Science College campus, Wardha	State Forest Department officials of Wardha, Maharashtra
7.	CFRHRD, Chhindwara	One Day 29.8.2016	Training programme on Biofertilizers and Organic farming.	Forest Research Nursery, JB Science College campus, Wardha	State Forest Department officials of Wardha, Maharashtra
8.	CFRHRD, Chhindwara	One Day 31.8.2016	Training programme on Nursery techniques of Chironji.	Forest Research Office, Rangers College	State Forest Department officials of

				campus, Chandrapur	Chandrapur, Maharashtra
9.	CFRHRD, Chhindwara	One Day 31.8.2016	Training programme on Diseases and insect pests in forest nurseries and plantations and their control measures.	Forest Research Office, Rangers College campus, Chandrapur	State Forest Department officials of Chandrapur, Maharashtra
10.	CFRHRD, Chhindwara	One Day 31.8.2016	Training programme on Biofertilizers and Organic farming.	Forest Research Office, Rangers College campus, Chandrapur	State Forest Department officials of Chandrapur, Maharashtra
11.	TFRI Jabalpur	Three days 22-24 Sept 2016	पौध उत्पादन एवं रोपणी प्रबंधन For Iora Ecological Solutions.	TFRI	Members of SHG from Iora Ecological Solutions
12.	CFRHRD, Chhindwara	One Day 23 Sept 2016	Training programme on Nursery techniques of Chironji.	Bijagoura village, Chhindwara	Farmers, Villagers and Women
13.	CFRHRD, Chhindwara	One Day 23 Sept 2016	NTFP Harvesting, processing and Value Addition/Food from Forests.	Bijagoura village, Chhindwara	Farmers, Villagers and Women
14.	TFRI Jabalpur	One week 26-30 Sept 2016	Training programme on instrumentation.	TFRI	Students
15.	TFRI Jabalpur	Two Days 13-14 October 2016	Training on Selection of Candidate Plus Trees.	Nagpur	SFD Maharashtra
16.	TFRI Jabalpur	Three days 13-15 October 2016	Training on statistical applications in entomological and other biological experiments.	TFRI	PG students
17.	TFRI Jabalpur	One week 17-21 October 2016	Taxonomy of Plant Kingdom.	TFRI	PG students
18.	CFRHRD Chhindwara	17 October 2016	Training programme on Environmental Awareness.	Govt. Primary School, Poama, Chhindwara	Students
19.	CFRHRD, Chhindwara	20.10.2016	Training programme on Agroforestry with special reference to medicinal plants.	B.Sc (Agriculture) students, JNKVV, Jabalpur	Students
20.	CFRHRD, Chhindwara	21.10.2016	Training programme on Environmental	Govt. Middle School, Partala,	Students

			Awareness.	Chhindwara	
21.	CFRHRD, Chhindwara	25.10.2016	Training programme on Agroforestry with special reference to medicinal plants	Siregaonkala, Chhindwara District (MP)	Farmers/villagers/women
22.	CFRHRD, Chhindwara	27.10.2016	Training programme on Environmental Awareness	Govt. Middle School, Lonia Karbal, Chhindwara (MP)	Students
23.	CFRHRD, Chhindwara	2 November 2016	Training programme on Environmental Awareness.	Govt. Middle School, Poama, Chhindwara	Class 7 & 8 students
24.	CFRHRD, Chhindwara	3November 2016	Training programme on Environmental Awareness.	Govt. Middle School, Khanswada, Chhindwara	Class 7 & 8 students
25.	TFRI Jabalpur	8 November 2016	वन रोपणियों तथा वृक्षारोपणों के कीटों तथा रोगों का समन्वित प्रबंधन	Under VVK DV programme at R&E Circle, Bilaspur	Officials from Chhattisgarh State Forest Department, NGOs
26.	CFRHRD, Chhindwara	8 November 2016	Biofertilizers & Organic Farming	Village-Mankadehi-khurd, Chhindwara	Farmers
27.	TFRI Jabalpur	9 November 2016	उन्नत नर्सरी तकनीक एवं कृषि वानिकी पर प्रशिक्षण	Under VVK DV programme at R&E Circle Bilaspur	Officials from Chhattisgarh State Forest Department, NGOs,
28.	TFRI Jabalpur	7-18 November 2016	Training Programme on forestry	TFRI	B.Sc. Forestry VII Semester students from Guru Ghasidas University, Bilaspur
29.	TFRI Jabalpur	8-9th Dec., 2016	उन्नत नर्सरी तकनीक, वृक्ष सुधार, कृषिवानिकी, वनरोपणियों/ वृक्षारोपणों के कीटों तथा रोगों का समन्वित प्रबंधन	Under VVK DV programme at TFRI Jabalpur	Frontline staff from MP State Forest Department, 35
30.	CFRHRD, Chhindwara	07.12.2016	Environmental Awareness and Biodiversity and	Govt. Middle School, Rajakhoh,	School students

			Biodiversity Conservation	Chhindwara	
31.	CFRHRD, Chhindwara	08.12.2016	Environmental Awareness and Biodiversity Conservation	Govt. Middle School, Jamunia, Chhindwara, District	School students
32.	TFRI Jabalpur	9-13 Jan 2017	Agroforestry Systems	TFRI, Jabalpur	UG students of Forestry
33.	TFRI, Jabalpur	12Jan, 2017	Awareness programme on Digital Payments	TFRI, Jabalpur	All officials of the institute
34.	CFRHRD, Chhindwara	12 Jan, 2017	Awareness programme on Digital Payments	CFRHRD, Chhindwara	All officials of the centre
35.	TFRI, Jabalpur	9-13 Jan, 2017	One week training programs for B.Sc. students	TFRI, Jabalpur	B.Sc. students of Government Science College, Jabalpur
36.	TFRI, Jabalpur	16-20 Jan, 2017	One week training programs for B.Sc. students	TFRI, Jabalpur	B.Sc. students of Government Science College, Jabalpur
37.	TFRI, Jabalpur	23-27 Jan, 2017	One week training programs for B.Sc. students	TFRI, Jabalpur	B.Sc. students of Government Science College, Jabalpur
38.	TFRI, Jabalpur	23-24 Jan, 2017	उन्नत नर्सरी तकनीक, वृक्ष सुधार, कृषि वानिकी एवं वन रोपणियों / वृक्षारोपणों के कीटों तथा रोगों का समन्वित प्रबंधन".	VVK Maharshtra at Jalna	Farmers and frontline staff of Maharshtra State Forest Department
39.	TFRI, Jabalpur	30 Jan- 3 Feb, 2017	One week training programs for B.Sc. students	TFRI, Jabalpur	B.Sc. students of Government Science College, Jabalpur
40.	TFRI, Jabalpur	6 - 10 Feb, 2017	One week training programs for B.Sc. students	TFRI, Jabalpur	B.Sc. students of Government Science, College,

					Jabalpur
41.	TFRI, Jabalpur	7-9 Feb., 2017	पौध उत्पादन एवं रोपणी प्रबंधन For Iora Ecological Solutions	TFRI, Jabalpur	Members of SHG from Iora Ecological Solutions
42.	CFRHRD, Chhindwara	02.02.2017	Nutritional potential of *Moringa oleifera* leaves and prospects of its value addition	CFRHRD, Chhindwara	Anganwadi workers (women) at Vaishnavi College, Parasia, Chhindwara District
43.	CFRHRD, Chhindwara	15 - 16 Feb, 2017	Environmental Awareness and Biodiversity Conservation	CFRHRD, Chhindwara	Students of Govt. Middle School Dhotki, Waghoda (Sausar), Chhindwara and farmers of Gram Panchayat Kelvad, Nagpur (MS)
44.	TFRI, Jabalpur	22-23 Feb, 2017	Tree Planting (Agroforestry) and its Management	TFRI, Jabalpur	Farmers from Hoshangabad (MP).
45.	CFRHRD, Chhindwara	28 Feb, 2017	Pollinators/Farmer friendly Insects and Biopesticides (IPM)	Gram Panchayat, Bhavan, Jamunia village, Chhindwara	Farmers
46.	CFRHRD, Chhindwara	28 Feb, 2017	Pollinators/Farmer friendly Insects and Biopesticides (IPM)	Govt. Primary School, Khairibhopal village under Lahegadua Gram Panchayat, Chhindwara	farmers
47.	TFRI	28 Feb, 2017	उन्नत नर्सरी, वृक्ष सुधार तकनीक, कृषि वानिकी एवं वृक्षारोपणों द्वारा कार्बन सिक्वेसट्रेशन	VVK Odisha at Koraput	Farmers and frontline staff of state forest department
48.	TFRI	1 March, 2017	महत्वपूर्ण औषधीय पौधों की कृषि तकनीक, मूल्य संवर्धन तथा वन	VVK Odisha at Koraput	Farmers and frontline staff of state forest department

			रोपणियों के कीटों तथा रोगो का समन्वित प्रबंधन		
49.	CFRHRD Chhindwara	22 March, 2017	Improved collection and processing methods of *Madhuca indica* flowers and prospects of its value addition	CFRHRD, Chhindwara	Karer, East Chhindwara Forest Division, under Direct to Consumers (DTC) Scheme
50.	CFRHRD Chhindwara	24 March, 2017	Improved collection and processing methods of *Madhuca indica* flowers and prospects of its value addition	CFRHRD, Chhindwara	Karer, East Chhindwara Forest Division, under Direct to Consumers (DTC) Scheme
51.	TFRI	10-21 April, 2017	Two week training programme for M.Sc. Forestry students from Guru Ghasidas University, Bilaspur	TFRI, Jabalpur	Students of Guru Ghasidas University, Bilaspur

Fig.24: A view of training one week winter course on agroforestry systems for the student of SHIATS, Allahabad (UP) at TFRI, Jabalpur

Fig.25: Training for forest officials of M.P.F.D. at farmer's field, Devri village (Jabalpur)

Fig.26: A group of farmer's of Hoshangabad District during USAID sponsored agroforestry training

Fig.27: College students visiting medicinal plants nursery at TFRI, Jabalpur

Fig.28: A group of farmer's of Mandla District during IORA sponsored training on nursery techniques.

Fig.29: Training on collection and processing of *Madhuca indica* (Mahua) flowers and its value addition under DTC scheme at Karer village Chhindwara district

Fig. 30: Inaguration of one week training course on Instrumentation at TFRI, Jabalpur

Fig. 31: Demonstration of functioning of Gradient Polymerase Change Reaction (PCR) to the Post Graduate (PG) students during one week training course on Instrumentation at TFRI, Jabalpur

3.3. Visit Abroad: Nil

3.4 Participation in Seminars/Symposia/Workshops/Trainings

- Dr. Nanita Berry, Scientist 'E', attended and presented a paper on *Flemingia semialata* based silvi-agri-lac system in Jabalpur district of Madhya Pradesh in the National Symposium on ' Agroforestry for environmental challenges, sustainable land use, biodiversity conservation and rural livelihood options', held from 3rd – 5th December, 2016 at Central Agroforestry Research Institute, Jhansi (U.P.).
- Dr. Nanita Berry, Scientist 'E', attended one week training on 'Biodiversity conservation' organized by Wild life Institute of India under DST sponsored programme for Women scientists held from 13th – 17th February,2017.
- Dr. Sanjay Singh, Scientist 'C' attended and presented paper on Sustainable Harvesting of Bamboo at Global Bamboo summit at Indore orgnized by MPSBM from 8-10 April 2016.
- Dr. N. Roychoudhury, Scientist-G attended as a member of 58th meeting of Research Coordination Committee (RCC) of Central Silk Board (CSB), Ministry of Textiles held on 2nd and 3rd August, 2016 at Bangalore and presented "Observations of Chairman SAC BTSSO, Bilaspur.
- Dr. U. Prakasham, Director and Dr. N. Roychoudhury, Scientist 'G' attended 4th Scientific Advisory Committee (SAC) meeting, Central Silk Board, Ministry of Textiles, at Bilaspur on 07.09.2016, as Chairman and Member, respectively.
- Dr. N. Roychoudhury, Scientist 'G', attended and presented status and achievements of Achanakmar-Amarkantak Biosphere Reserve and carried out duty as Team Leader for preparation of National Action Plan of Biosphere Reserve based on Lima Action Plan (LAP) in Workshop on Strategy for National Action Plan for Biosphere Reserve, held at Pachmarhi (M.P.), 20-21 February, 2017, organized by Ministry of Environment, Forests and Climate Change, New Delhi.
- Dr. N. Roychoudhury, Scientist 'G', delivered lecture on "Scope of Sericulture in Agforestry" in two days orientation programme on "Tree plantation (Agroforestry) and its Management" at TFRI, Jabalpur on 22nd February, 2017.
- Dr. P.B. Meshram, Scientist 'F' delivered lecture on "Scope of vermi-compost in Agforestry" in two days orientation programme on "Tree plantation (Agroforestry) and its Management" at TFRI, Jabalpur on 22nd February, 2017.
- Dr. Nitin Kulkarni, Scientist 'G', delivered lecture on "Biological management of Insect in Agforestry" in two days orientation programme on "Tree plantation (Agroforestry) and its Management at TFRI, Jabalpur on 22nd February, 2017.
- Dr. Nitin Kulkarni, Scientist-G, delivered lecture on "Integrated Pest Management of Forest Nurseries" in training programme at Van Vigyan Kendra, Koraput, Odhisa from 28/02/2017 to 01/03/2017.
- Dr. Nitin Kulkarni, Scientist 'G', delivered guest lecture on "Forest Insect pest and their management under IPM concept" to UG, PG and Ph.D. students of Department of Forestry, JNKVV, Jabalpur on 30.03.2017.
- Poonam Verma, Ph.D. scholar attended International seminar on ; Advances in Biomedical engineering…. held at JNU, New Delhi on 21.5.2016 and presented a paper, 'Cellalase

activity of soil fungi (*Aspergiluus, Fusarium, Penicillium, Trichoderma*) isolated from iron mine overburden soil'.

- Dr. R.K. Verma, Scientist 'F' delivered four lectures to field staff of Forest Survey of India at Nagpur, 28-29.07.2016 in a training programmae.
- Dr. R.K. Verma, Scientist 'F' delivered lecture to members of Iora Ecological Solution, New Delhi on the topic "Forest nursery diseases and their management" on 24.9.2016.
- Dr. R.K. Verma, Scientist 'F' delivered one lecture to trainees in a training programme entitled "Instrumentation' at TFRI Jabalpur on "Pathological instruments" on 26.09.2016.
- Dr. R.K. Verma, Scientist 'F' delivered one lecture to trainees in a training programme entitled "Short term training programme on 'Systematic of Plants' at TFRI Jabalpur on "Fungal flora of TFRI campus" on 17.10.2016.
- Dr. R.K. Verma, Scientist 'F' delivered four lectures to trainees of VVK (72 participants) at Cony, Bilaspur on 8.11.2016.
- Dr. R.K. Verma, Scientist 'F' delivered four lectures to trainees of VVK (30 participants) at TFRI, Jabalpur on 9.12.2016.
- Mukur Ganguly, PhD scholar attended "Student conference on conservation science' at Bengalure on 21-24, Sept. 2016 and presented a poster entitled "Fungal Herbarium and Collection Centre at TFRI: a step towards conservation of fungal diversity of central India'.
- Dr. R.K. Verma, Scientist 'F' delivered four lectures to trainees of VVK at Jalna, MS on 23.01.2017
- Dr. R.K. Verma, Scientist 'F' delivered a lecture on diseases damaging forest nurseries and their management to trainees of 'Kasusal Vikas' at TFRI, Jabalpur on 6/2/2017
- Dr. R.K. Verma, delivered 4 lectures to trainees of VVK at Koraput, Odisha on 01.03.2017
- Smt. Neelu Singh, Scientist 'F' participated as resource person in workshop on "Medicinal Plants and NWFPs Processing, Value addition and Marketing" held on 03/09/2016 at Eco-centre Bichiya, Mandla (M.P.)
- Smt. Neelu Singh, Scientist-'F' participated in review meeting at MFPFed, Bhopal on 08/09/2016 and presented findings of the project entitled "Quality Standardization of some important medicinal plants of M.P." project funded by MFP Federation, Bhopal
- Smt. Neelu Singh, Scientist 'F' participated in review meeting at Ayush Bhawan,New Delhi dated 27-9-16 and presented achievements of project –"Standardization of non-destructive harvesting practices of *Commiphora wightii* (Guggal) gum oleogum resin in Madhya Pradesh '' funded by National Medicinal Plant Board, New Delhi
- Smt. Neelu Singh, Scientist 'F' participated as resource person in training programme on "Training on Instrumentation" from 26-30 Sept., 2016 held at TFRI, Jabalpur.
- Dr. M. Kundu, Scientist 'F' trained the field workers on seed handling techniques in 'Production of seedling and sowing techniques' program held on 7-9 Feb, 2017
- Dr. M. Kundu, Scientist 'F' participated in teaching the interested students in One week special winter course on Agroforestry systems from 9th January to 13 January 2017.
- Dr. M. Kundu, Scientist 'F' participated in teaching programme on Seed Technology for the foresters under VVK, MP on 8-9 December, 2016.
- Dr. M. Kundu, Scientist 'F' delivered lectures on 'Advances in Research and Technology in handling tropical forest seeds' in the teaching program for B. Sc. Forestry VII Semester

students of Guru Ghasidas University, Bilaspur from 7 November 2016 to 18 November 2016.

- Dr. M. Kundu, Scientist 'F' participated in teaching programme on Seed Technology for the participants of a NGO IORA Ecological Solutions on 22 November 2016.
- Dheeraj Gupta, Scientist 'B' delivered a lecture on 'Overview of Remote Sensing & GIS in Forestry' in the training program on Training on ecological field techniques organized from 28 February 2017 to 2 March 2017.
- Dr. S. N. Mishra, Scientist 'B' attended one week training programme on "Economics and Marketing of Forest Produce" at IIFM Bhopal during 13-17 February 2017.
- Dr. Y. Mishra, Scientist 'F' participated in "Global Bamboo Summit" held in Indore from 8-10 April 2016.
- Dr. Pramod Kumar, Scientist 'B' participated in "Induction training for Scientists" held in Dehradun from 19th November 2016 to 13th January 2017.
- Dr. F. Shirin, Scientist 'F' participated in training on" Biodiversity Conservation" held at Dehradun from 13th February 2017 to 17th February 2017.
- Dr. Pramod Kumar, Scientist-B participated in training on "Forest Genetic Resources Management and Conservation" held in Coimbatore from 13th February 2017 to 17th February 2017.
- Shri Yogesh Pardhi, Research Assistant-I participated in training on "Germplasm Conservation and Documentation" held at Coimbatore from 20th March to 24th March 2017.
- Shri. N.D. Khobragade, Scientist 'C', CFRHRD participated in "Global Bamboo Summit" at Brilliant Convention Centre, Indore (MP) from 8 April 2016 to 10 April 2016.
- Dr. Vishakha Kumbhare, Scientist –D, CFRHRD delivered lecture on "Value Addition of Mahua Flowers" during the two days workshop on "Review Meeting of Divisional Works" held during 26th – 27th May 2016 in Patna (Bihar).
- Dr. Vishakha Kumbhare, Scientist –D, CFRHRD delivered lecture on "Sustainable Harvesting of Medicinal Plants Guidelines" during the three days workshop on "NTFPs processing and marketing" organized by State Forest Department, Chhindwara during 3 October -5 October 2016 at Panchvati, Poama on 3 October 2016.

4. Extension Panorama/Activities

- **National Forest Library and Information Centre (NFLIC) (Applicable for FRI, Dehradun only) : ----**
- **Environmental Information system (ENVIS) (Applicable for FRI, Dehradun only) : ----**

4.1 Report on Van Vigyan Kendras (VVKs) and Demo Village (DVs)

Eight training programmes, two in each VVK i.e. Madhya Pradesh, Chhattisgarh, Odisha and Maharashtra under the institute were organized by Forest Extension Division.

8 November 2016	वन रोपणियों तथा वृक्षारोपणों के कीटों तथा रोगों का समन्वित प्रबंधन	VVK, Raipur, Chhattisgarh	Officials From Chhattisgarh State Forest Department, NGOs
9 November 2016	उन्नत नर्सरी तकनिक एवं कृषि वानिकी पर प्रशिक्षण	VVK, Raipur, Chhattisgarh	Officials From Chhattisgarh State Forest Department, NGOs,
8 Dec., 2016	उन्नत नर्सरी तकनीक, वृक्ष सुधार, कृषिवानिकी	VVK, Jabalpur, Madhya Pradesh	Frontline Officials From MP State Forest Department, 35
9 Dec., 2016	वनरोपणियों/ वृक्षारोपणों के कीटों तथा रोगों का समन्वित प्रबंधन	VVK, Jabalpur, Madhya Pradesh	Frontline Officials From MP State Forest Department, 35
23 Jan. 2017	उन्नत नर्सरी तकनिक, वृक्ष सुधार, कृषि वानिकी	VVK, Jhalna, Maharshtra	for the farmers and frontline staff of Maharshtra state forest department
24 Jan. 2017	वन रोपणियों / वृक्षारोपणों के कीटों तथा रोगों का समन्वित प्रबंधन	VVK, Jhalana, Maharshtra	for the farmers and frontline staff of Maharshtra state forest department
28 Feb, 2017	उन्नत नर्सरी, वृक्ष सुधार तकनिक, कृषिवानिकी एवं वृक्षारोपणों द्वारा कार्बन सिक्वेसट्रेशन	VVK, Korapur, Odisha	No. participants were 65 including farmers and frontline staff of state forest department.
1 March, 2017	महत्वपूर्ण औषधीय पौधों की कृषि तकनिक, मूल्य संवर्धन तथा वन रोपणियों के कीटों तथा रोगो का समन्वित प्रबंधन	VVK, Korapur, Odisha	No. participants were 65 including farmers and frontline staff of state forest department.

4.2 Technologies transferred

- Two types of solar dryers designed and developed by the institute were transferred to processing centers of State Forest Department of Madhya Pradesh for processing of medicinal plants.
- Processing Techniques of medicinal plants using solar dryers was demonstrated to Forest Officials of Madhya Pradesh Minor Forest Produce Federation, Bhopal.

- Low cost technology for raising of seedlings of *Buchanania lanzan* (chironji) and by giving demonstrations on preparation of Jivamrut (biofertilizer) and plant based biopesticides.

- Developed value added products from Mahua (*Madhuca indica*) and Bamboo. The Govt. of Bihar evinced interest in the non-alcoholic value added products of Mahua post prohibition and the technology was extended to the forest department through invited lecture/demonstration.

4.3 Research Publications

International Journals

Kulkarni, N. and Paunikar, S.D. (2017). Evaluation of some biopesticidal formulations against teak (*Tectona grandis* Linn.f.) skeletonizer, *Eutectona machaeralis* Walker (Lepidoptera: Pyralidae) in India. *American Journal of Agriculture and Forestry*, **5**(1): 12-15.

Rai, R. (2016) . Ethno-medicinal uses of promising plants in various formulations in cure of ailments in Chhindwara district, Madhya Pradesh. *Pharmacy and Pharmacology Interntional Journal*, **4** (7) : 00100.

Sett, R. and Kundu, M. (2016). Epiphytic lichens: their usefulness as bio-indicators of air pollution. *Donnish Journal of Research in Environmental Studies*. **3**: 17-24.

Verma, P. and Verma, R.K. (2016). Screening of cellulase production by fungal isolates from rhizosphere region of mine degraded land of Dalli-Rajhara (Chhattisgarh). *International Journal of Basic and Applied Biology*, **3**(2): 162-165.

Verma, P. and Verma, R.K. (2016). Cellulase activity of soil fungi (*Aspergillus, Fusarium, Penicillioum, Trichoderma*) isolated from rhizosphere region of iron ore mine over burden soil. *International Journal of Basic and Applied Biology* **3**(2): 115-120.

Verma, P., Singh, S. and Verma, R.K. (2017). Impact of plantation on iron ore mined overburden at Durg in Chhattisgarh, India. *International Research Journal of Environmental Sciences*, **6**(1): 1-12.

Verma, P., Singh, S. and Verma, R.K. (2017). Heavy metal biosorption by *Fusarium* strains isolated from iron ore mine overburden soil. *International Research Journal of Environmental Sciences and Toxicology Research*, **4**(4): 61-69.

Verma, P., Soni, K.K., Verma, R.K. and Shirin, F. (2016). Seedling die-back of *Dalbergia latifolia* in Central India caused by *Colletotrichum capsici* - a new record. *International Journal of Current Microbiology and Applied Sciences*, **5**(6): 350-356.

National Journals

Ganguly, M. and Verma, R.K. (2016). Isolation and screening of potassium and phosphorus solubilising bacteria in stressed soils of different regions of Madhya Pradesh for production of biofertilizers. *Journal of Tree Sciences*, **35**(2): 1-6.

Koshta, S., Kesarwani, S. and Meshram, P.B. (2017). Diversity and abundance of dragonflies and damselflies (Order-Odonata) of Gauriyaghat region, in Gaur river at Jabalpur, M.P. *Journal of Multidisciplinary Research*, **4**(1): 115-119.

Kulkarni, N., Mishra, V.K., Daksh, S. and Paunikar, S.D. (2016). Response of native entomopathogenic nematode, *Steinernema* spp. (TFRIEPN-57) isolated from central India to variation in temperature and soil moisture. *Journal of Environmental Biology*, **37**(3): 399-406.

Kundu, M. and Singh, S. (2016). Color as maturation indicator for maximum seed quality of *Sterculia urens*. *Seed Technology*, **37**(2): 185-194.

Maini, H., Meshram, P.B. and Karim, M.R. (2016). Studies on the diversity of butterflies in adjoining areas of Jabalpur. *Journal of Aquatic Science and Technology*, **4**(1): 13-28.

Mehta, N., Singh, N. and Shirin, F. (2016). Flower morphometry of *Madhuca indica* : inter and intra population variations in eastern Madhya Pradesh. *Indian Journal of Tropical Biodiversity*, **24**(2): 171-175.

Mohammad, N., M., Dahayat, A. and Mishra, Y. (2016) Effort of seed treatments and potting medium in seed germination and associate parameters in critically endangered *Litsea glutinosa*. *Indian Journal of Forestry*, 39(2): 111-115.

Mohammad, N., M., Mahesh, S., Jain, Y. and Ansari, S.A. (2017). Effect of discrete (individual) and mixed (bulk) genomic DNA on genetic diversity estimates and population structure in teak (*Tectona grandis*). *Indian Journal of Experimental Biology*, 55(1): 49-54.

Mohammad, N., M., Vaishnav, V., Mishra, Y., Mahesh, S., Kumar, P. and Ansari, S.A. (2016). Genetic fidelity testing in micropropogated plantlets of *Albizia procera* using RAPD and ISSR markers. *Indian Forester*, 142(6): 558-562.

Prakasham, U., Meshram, P.B., Khatri, P.K., Singh, S. and Singh, J. (2016). Influence of canopy gap on regeneration of sal (*Shorea robusta*) borer affected area of Dindori forest division, M.P. *Indian Journal of Tropical Biodiversity*, **24**(1): 57-63.

Rai, R. (2016). Ethno-botanical studies on plants used in folk medicines in cure of diabetes in Gondwana region of Madhya Pradesh. *Asian Journal of Pharmacological Research*, **6**(2): 72-78.

Rai, R. (2016). Herbal remedies in cure of tuberculosis prevalent among ethnic communities of central India. *Tropical Plant Research*, **3**(2): 344-353.

Rai, R. (2016). Traditional indigenous knowledge prevalent in folk herbal medicine in cure of various pains in Chhattarpur district, Madhya Pradesh. *Journal of Non Timber Forest Products*, **23**(3): 143-182.

Rai, R. (2017). Ethno-medicinal uses of plants in folk medicines in cure of dysentery in central India. *Journal of Tropical Forestry*, **33**(1): 56

Roychoudhury, N. (2015). Emergence of sal heartwood borer, *Hoplocerambyx spinicornis* Newman (Coleoptera : Cerambycidae), in Satpura Tiger Reserve, Madhya Pradesh. *My Forest*, **5**1(1-2): 33-42.

Roychoudhury, N. (2016). Efficacy of chemical pesticides against *Eucalyptus* gall insect, *Leptocybe invasia* Fisher and LaSalle (Hymenoptera:Eulophidae). *Pestology* **40**(3): 40-47.

Roychoudhury, N. (2016). Gall insect menace in *Eucalyptus*. *Indian Jounal of Forestry* **39**(4): 349-357.

Roychoudhury, N. (2016). Search for natural enemies of defoliator, *Hyblaea puera* Cramer and leaf skeltonizer, *Eutectona machaearlis* (Walker), in teak forests of Madhya Pradesh. *Journal of Tropical Forestry* 3**2**(4): 51-83.

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4.4 Seminar/Symposia/Workshops Organized

Organized Inception Workshop at NTPC Ramagundam (Telengana) on "Use of ash-pond decant water for agricultural purpose around NTPC Ramagundam Super Thermal Power Station" on 18th May 2016.

4.5 Consultancies

- Controlling fugitive dust emission through biological reclamation of flyash lagoons in Shri Singaji Thermal Power Project, Khandwa (M.P.) (Funding agency – SSTPP, Jabalpur, M.P.; Cost – Rs. 30 lakh)
- Use of ash pond decant water for agriculture purpose around NTPC Ramagundam Super Thermal Power Station (Funding agency – NTPC Ramagundam, Talangana; Cost - Rs. 40 lakh).
- Raising plantations in the campus of IIITDM in sync with the ecology of the area, IIITDM and TFRI (March 2016 to March 2018).
- Environmental Audit of 20 open cast mines of Coal India Limited, ICFRE is coordinating the project.

- Biodiversity study under Marki Barka East Block (1000 Ha) of Singrauli Coalfield Area under Mahan Reserve Forest, Singrauli, Madhya Pradesh, ICFRE, IFP and TFRI.
- Evaluation of plantation carried out under FDA by MPSFD from 2013-14 to 2015-16, evaluated in 2016-17.
- A consultancy project on "Inspection and development of a management plan for SSOs, CSOs and SPAs of Chhattisgarh" is being carried out.

4.6 Technical Services

The Institute provides technical services related to different problems in the field of forestry to the stakeholders, such as Forest Department, Forest Development Corporations, Non-government Organizations (NGOs) and farmers of four states under jurisdiction. The services include problem of insect infestation/ damage and diseases caused by pathogens, their investigations and recommendations for management. Besides all these, Institute provides advisories on various issues like seed production areas, seed testing, agroforestry models for increasing forest productivity.

4.7 Activities of Rajbhasha

उष्णकटिबंधीय वन अनुसंधान संस्थान,(टी.एफ.आर.आई), जबलपुर में वर्ष 2016 –17 के दौरान संचालित राजभाषा गतिविधियों की सचित्र सूचना

उष्णकटिबंधीय वन अनुसंधान संस्थान, (टी.एफ.आर.आई), जबलपुर में संघ की राजभाषा नीति का अनुपालन सुनिश्चित करने की दिशा में वर्ष 2016-17 के दौरान निम्नलिखित राजभाषा गतिविधियाँ संचालित की गई । संस्थान में निदेशक की अध्यक्षता में गठित राजभाषा कार्यान्वयन समिति की तिमाही बैठकें अनुबद्ध समय पर आयोजित की गई और राजभाषा कार्यान्वयन कार्य संबंध में आई.सी.एफ.आर.ई. मुख्यालय द्वारा दिये गये दिशा-निर्देशों का समुचित पालन सुनिश्चित करने हेतु निर्णय लिये गये और आयोजित बैठकों की कार्यवाही आई.सी.एफ.आर.ई. मुख्यालय तथा अन्य संबंधित कार्यालयों को सूचना एवं अपेक्षित कार्रवाई हेतु तय समय पर प्रेषित की गई ।

इस संस्थान द्वारा राजभाषा अधिनियम 1963 की धारा 3(3) का शतप्रतिशत अनुपालन सुनिश्चित किया गया तथा निर्धारित किये हिन्दी पत्राचार के लक्ष्य को प्रति तिमाही के दौरान संस्थान द्वारा हासिल किया गया ।

संस्थान की राजभाषा हिन्दी के प्रगामी प्रयोग से संबंधित अवधिक रिपोर्टें जैसा कि हिन्दी के प्रगामी प्रयोग की तिमाही, अर्द्धवार्षिक तथा वार्षिक मूल्यांकन रिपोर्टें तय समय पर संबंधित कार्यालय के सूचना एवं अपेक्षित कार्रवाई हेतु प्रेषित की गई । भारत सरकार के मार्गदर्शी रूपरेखा के अनुरूप, संस्थान द्वारा वर्ष 2016 के दौरान सितम्बर माह, 2016 के दौरान हिन्दी दिवस, हिन्दी पखवाड़ा समारोह आयोजित किया किया गया । इस दौरान हिन्दी की विविध प्रतियोगिताएँ आयोजित की एवं प्रतियोंगिता में सफलता प्राप्त पदाधिकारी वर्ग को पुरस्कार-पत्र प्रदान कर किये गये ।

वर्ष 2016 -17 के दौरान आयोजित राजभाषा कार्यान्वयन समिति की बैठक, हिन्दी पखवाड़ा समारोह के दौरान आयोजित हिन्दी प्रतियोगिता एवं हिन्दी प्रतियोगिता पुरस्कार वितरण के आलोकचित्र

The following Rajbhasha activities were conducted at the Tropical Forest Research Institute (TFRI), Jabalpur during the year of 2016 -17 in order to ensure the compliance of the official

language policy of the union. The Meetings of the official language implementation committee which already existed in this institute under the chairmanship of the Director were held regularly in each quarter and decisions were taken on the directives issued from time to time by the ICFRE head quarter with regard to official language implementation work and decisions were also taken to comple with the same and the proceedings of the meetings were sent to ICFRE head quarter and other relevant offices within the stipulated time for their information & necessary action.
The documents which fall under section 3(3) of the Official Language Act 1963 were issued in bilingual viz Hindi and English simultaneously and the prescribed target of Hindi correspondence in each quarter was achieved by this institute.

The periodical reports such as quarterly, half yearly progressive reports pertaining to the official language implementation work of this institute were sent to the respective offices for information and necessary action. The Hindi Day and Hindi fortnight celebration was celebrated by this Institute during September, 2016 as per the guidelines issued by the Govt. of India and several Hindi competitions were also conducted for institute's staff and prizes were awarded to the winners of the competitions.

4.8 Awards and Honours: Nil

4.9 Special Activities (Such as Van Mahotsava, Forestry Day and Other occasions):

- The institute participated in International Herbal Mela organized by The Madhya Pradesh State Minor Forest Produce Federation at Bhopal from 20 – 24th Dec., 2016. The institutional activities were displayed and explained to all the visitors in a stall.
- International Biodiversity day (22 May 2016), World Environment Day (5 June 2016), International Yoga Day (21 June 2016) Independence Day (15 August 2016), Sadbhawna Pakhwara (19 August- 3 September 2016), Hindi Pakhwara (1 - 14 September 2016), Republic Day 26 January 2016) and International Day of Forests (21 March 2017) were celebrated.

5. Administration and Information Technology

Introduction

5.1 Information Technology

The institute has 100 MBPS NKN link provided under the National Knowledge Network (NKN) scheme of NIC project. The NKN comprises an ultra-high speed CORE (multiples of 10 Gbps), complimented with a distribution layer at appropriate speeds to support Overlay, Dedicated and Virtual Networks. The institute has a 100 MBPS fast Ethernet fiber optic backbone LAN, which is used for Internet access and other online activity. Video Conferencing facility also been used throughout the year.

Under IFRIS project, various modules including Personal Information Management System (PIMS), Research Information System (RIMS), Payroll Management System (PMS), and Financial Accounting System (FAS) have been in operation successfully. The web site of the institute and it's satellite centre CFRHRD, Chhindwara are frequently updated to showcase various activities of the institute. Web pages have been updated for the institute's online open access e-magazine *'Van Sangyan'* (ISSN 2395 - 468X) linked with institute's web site on regular basis and issues have been uploaded on monthly basis over it for easy access to the users. Reports have been generated for all the activities undertakan at the institutes level - conferences/seminars/workshops/trainings/visits of dignitaries/visits etc. are uploaded on institute's web site and also sent to the headquarter for uploading on ICFRE web site. The pages earlier generated for Achanakmar-Amarkantak Biosphere Reserve and institute's bi-annual journal 'Indian Journal of Tropical Biodiversity (IJTB)' have been updated with latest information on regular basis. The contents of the IJTB along with abstracts have been uploaded over web site for access by the users. A link has also been provided for the lectures delivered by the speakers during weekly seminar for the users on intranet, from where they can access the lecture Power Point at any time within the institute.

5.2 Sevottam : Activities relating to the Citizens/Clients Charter as detailed below has to be included in the Annual Report 2010-2011.

5.2.1 Action taken to formulate the Charter the Department and its subordinate formation:

Provision for Annual Review of the Charter after approval is as:

- The Services provided by the Institute as per the charter will be reviewed annually.
- The timely redressal of public grievances is being monitored by the Public Grievance Officer.
- Steps are initiated to take remedial measures for quick disposal of complaints.

5.2.2 Action taken to implement the Charter

Action will be taken for implementing the Charter, after its finalization.

5.2.3 Details of Training Programmes, Workshops, etc. held for proper implementation of Charter: --------

5.2.4 Details of publicity efforts made and awareness campaigns organized on Charter for the Citizen/Clients: ----------

5.2.5 Details if internal and external evaluation of implementation of Charter in the Organization and assessment of the level of satisfaction among Citizen/Clients :

Evaluation of implementation of Charter will be initiated, after finalization.

5.3 Welfare measures for the SC/ST/Backward/minority communities :

The interests of the above sections are being safeguarded and as per the guidelines of Government of India (GoI), a Liasion Officer is in position who monitors the promotions/recruitment processes as per the roaster.

6. Annexures

1. RTI

Names and Addresses of Public Information Officers and Appellate Authorities under the Right to Information Act 2005 in the Institute

Headquarter / Institute	Appellate Authority	Public Information Officer	Subject matter(s) allocated
Tropical Forest Research Institute, Jabalpur	Dr. U. Prakasham, Director, TFRI, Jabalpur	Shri A. K. Sharma, Under Secretary, TFRI, Jabalpur	As per provision and guidelines provided under RTI Act, 2005.
Centre for Forestry Research & Human Resource Development, Chhindwara	P. Subramanyam, Director, CFRHRD, Chhindwara	Director, CFRHRD, Chhindwara	As per provision and guidelines provided under RTI Act, 2005

2. Email and Postal addresses

a. Director
TROPICAL FOREST RESEARCH INSTITUTE
(*Indian Council of Forestry Research & Education*)
P.O. – R.F.R.C, Mandla Road, Jabalpur – 482021 (M.P), India
Phones: 0761 – 4044002, 2840483(O)
Fax: 0761 – 4044002, 2840484
e-mail – dir_tfri@icfre.org

b. Director
Centre for Forestry Research & Human Resource Development, (*Indian Council of Forestry Research & Education*)
Poama, P.O. Kundalikala, Parasia Road, CHHINDWARA - 480 001 (M.P)
Phones: 07162 – 2920613(O)
e-mail – dir_cfrhrd@rediffmail.com

3. Intellectual Property

3.1 **Patents Granted –** Awaited two patents.

3.2 Others

Two varieties of *Rauvolfia serpentina* (Sarpgandha) were released by National Variety Release Committee, New Delhi in February 2017 as improved varieties in terms of high reserpine, total alkaloid and root yield. The variety named as TFRI-RS 1 gives high root yield whereas TFRI-RS 2 contain high alkaloid and reserpine as compared to check varieties *viz.*, RS-1(JNKVV, Indore) and CIM-Sheel (CIMAP, Lucknow). Both the varieties can be exploited for cultivation in central India.

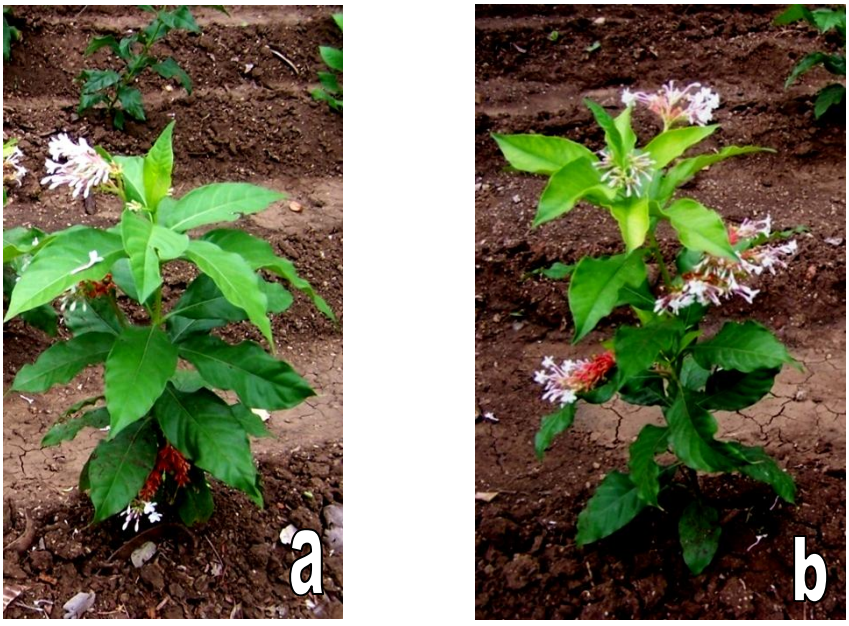

Fig.32: Plants of two improved varieties of *Rauvolfia serpentina* (Sarpgandha) name, as (a) TFRI-RS 1 and (b) TFRI-RS 2 in nursery of T.F.R.I, Jabalpur

List of Abbreviations

ACF – Assistant Conservator of Forests

AM- Arbuscular Mycorrhiza

APCCF – Additional Principal Chief Conservator of Forests

BA- Benzyl Ademine

CCF – Chief Conservator of Forest

CEDMAP – Centre for Entrepreneurship Development Madhya Pradesh

CFRHRD-Centre for Forestry Research & Human Resource Development

CG - Chhattisgarh

CII – Confederation of Indian Industry

CIMAP – Central Institute of Medicinal and Aromatic Plants

CPT- Candidate Plus Tree

CSB – Central Silk Board

CSO - Clonal Seed Orchard

DFO – Divisional Forest Officer

DNA- Deoxyribonucleic acid

DST – Department of Science and Technology

DTC – Direct to Consumers

EPN- Entomopathogenic Nematode

FAS – Financial Accounting System

FDA – Forest Development Agency

FRI- Forest Research Institute

FSI- Forest Survey of India

FYM - Farmyard Manure

GA – Gibberllic Acid

GBH- Girth at Breast Height

GIS- Geographical Information System

GNSS - Global Navigation Satellite System

GoI – Government of India

GPS- Global Positioning System

IAA- Indole Acetic Acid

IBA - Indole Butyric Acid

ICFRE – Indian Council of Forestry Research and Education

IFRIS – Integrated Forest Resource Information System

IFS – Indian Forest Service

IIFM – Indian Institute of Forest Management

IIITDM – Indian Institute of Information Technology and Design and Manufacturing

IJTB – Indian Journal of Tropical Biodiversity

IMD- India Meteorological Department

IPM- Integrated Pest Management

IRS- Indian Remote Sensing

ISSN - International Standard Serial Number

JNKVV- Jawaharlal Nehru Krishi Vishwavidyalaya

LAN – Local Area Network

LAP – Lima Action Plan

LDC – Lower Division Clerk

LISS- Linear Imaging Self Scanning

MBPS – Megabits Per Second

MFP – Minior Forest Produce

MP- Madhya Pradesh

MPCA- Medicinal Plant Conservation Area

MPCST - Madhya Pradesh Council of Science and Technology

MPFDC - Madhya Pradesh Forest Development Corporation

MPSBB – Madhya Pradesh State Biodiversity Board

MPSFD – Madhya Pradesh State Forest Department

MS- Maharashtra

MS- Murshige and Skoog

NAA – Napthyl Acetic Acid

NBSS & LUP- National Bureau of Soil Science and Land Use Planning

NEERI- National Environmental Engineering Research Institute

NGOs - Non-government Organizations

NIC – National Informatics Centre

NKN – National Knowledge Network

NRSC- National Remote Sensing Centre

NTFP- Non-Timber Forest Produce

NTGB-National Teak Germ Plasm Bank

NTPC – National Thermal Power Corporation

NWFP –Non-Wood Forest Produce

PCR - Polymerase Chain Reaction

PG- Post Graduate

PIMS – Personal Information Management System

PMS – Payroll Management System

PMS – Payroll Management system

PSB- Phosphate Solubilizing Bacteria

RA- Research Assistant

RCC – Research Coordination Committee

RFRC - Regional Forest Research Centre

RIMS – Research Information System

RO – Research Officer

RSP - Rourkela Steel Plant

SAC – Scientific Advisory Committee

SC- Soluble Chemical

SFD – State Forest Department

SFTL - Standard Food Testing Laboratories

SLA – Specific Leaf Area

SOC - Soil Organic Carbon

SPA- Seed Production Area

SSO - Seedling Seed Orchard

SSR – Simple Sequence Repeat

SSTPP - Shree Singaji Thermal Power Project

TA- Technical Assistant

TDZ - Thidiazuron

TFRI- Tropical Forest Research Institute

TFRI-RS – Tropical Forest Research Institute - *Rauvolfia serpentina*

TSO – Teak Seed Orchard

UDC – Upper Division Clerk

VAM- Vesicular Arbuscular Mycorrhizae

VVK- Van Vigyan Kendra