Annual Report 2013-14

TROPICAL FOREST RESEARCH INSTITUTE
(Indian Council of Forestry Research and Education)
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Jabalpur – 482021 (M.P.)

EXECUTIVE SUMMARY

Executive Summary of the Report

- Documented 63 invasive plant species growing in the forest areas of Jabalpur Katni, Mandla and Seoni distrct. Their spread and density was determined. Life history traits determining the invisibility of the species in the studied forest community are profuse seed production and small seed size.
- Combining mechanical control with plant-competition offers was the most effective treatment for reclaiming invaded forest communities.
- Community dynamics with reference to forest floor diversity and regeneration in teak plantation of different age was studied. Species richness in herb layer was higher in new plantations, whereas in older plantations high species richness was recorded in tree layer.
- Vegetation change matrix determining change in the structure and composition of the vegetation in preservation plots of Bhimashankar, sub tropical hill forest of Maharashtra was prepared. The future trends in species composition were predicted based on the study.
- Density and distribution of two threatened medicinal plant species viz. *Uraria picta* and *Andrographis paniculata* in the buffer region of TATR was determined. Populations of these species were identified to study population dynamics.
- Foliar spray of a combination of 2% nitrogen and 1% phosphorus on seedlings was screened out as the best treatment in nitrogen deficient soils of Chhattisgarh to increase leaf surface area of *Diospyros melanoxylon*.
- A combined dose of 100 $kgha^{-1}$ nitrogen and 25 kg ha^{-1}phosphorus showed the maximum enhancement in tendu leaf size in Kotadol and Morga and an individual dose of 100 $kgha^{-1}$ nitrogen in Litipara (C.G.).
- A combined dose of 500 g ranker neem granules and 1000 g VAM per 5 m x 5 m size plot was found as the best treatment in Morga and an individual dose of 500 g neem granules per plot in Kotadol and Litipara (C.G.) to enhance tendu leaf size.
- Maximum size of tendu leaves was obtained in Chhattisgarh when seedlings of 2 – 4 cm diameter were pruned at ground level.
- Soil moisture was found more in Kanha National Park in comparison to Bandhavgarh and Madhav National Parks throughout the year.
- Specific Leaf Area (SLA) was found maximum in December and minimum in March for most of the tree species in Kanha, Bandhavgarh and Madhav National Parks.
- The Biodiversity Board, Government of India, designated insect reference collection of Forest Entomology Division of this Institute as National Repository under the Biological Diversity Act, 2002.
- Sal borer infestations were identified in four Forest Ranges of Dindori Forest Division, three Forest ranges of East Mandla Forest Division, one Forest Range of North Balaghat Forest Division, 13 Forest Ranges of Kanha Tiger Reserve and three Forest Ranges of Satpura Tiger Reserve. A total of 39554 sal trees were marked under different categories of borer attack in MP.
- Sal borer infestations were also identified in Chilpi Forest Range of Kawardha Forest Division, Amabeda Forest Range of Bhanupratappur Forest Division and Sargipal Timber Depo of

Jagdalpur, Chhattisgarh and a total of 9,699 sal trees were marked under different categories of borer attack.

- *Bacillus thuringensis* 1% and combination of Bt + neem based Gronim 1% were found to be most effective against defoliators *Anomis flava* recorded on *Abelmoschus moschatus* and *Polytela gloriosae* on *Gloriosa superba.*
- Predator *Chrysoperla cornea* followed by parasitoid *Trichogramma chilonis* was found to be most effective for reduction (79.44%) of the larval population of defoliator *Polytela gloriosae*.
- Neem based Gronim 1% followed by Bt 1% was found to be most effective against red cotton bug *Dysdercus cingulatus* on *A. moschatus* with 83.01% reduction of bug population recorded in treated plants.
- First pruning including control fire in tendu bushes in first week of March (06.03.2013) was found to be most effective for reduced incidence of gall fly *Trioza obsoleta* and also resulted in increased leaf weight and leaf area.
- Crude extract of *Cleistanthus collinus* + cow urine + vermiwash was found most effective against bark eating caterpiller *Indarbela quadrinotata*, in first trial. Solvent extract of *C. collinus* in petroleum ether was found most effective against *I. quadrinotata* in second trial. Application of Fungal suspension of *Fusarium moniliformae* $1.5x10^{-6}$ was found to be most effective against this pest in third trial in aonla plantation.
- Observations were recorded on predation behavior and life cycle of *C. furcellata* on larvae of *E. machaeralis* and *Caveria sericia* at different temperatures regimes in the laboratory.
- Predator, *Chrysoperla carnea* was collected through periodical surveys in teak, sal and bamboo forests of Madhya Pradesh, Chhattisgarh and Maharashtra.
- The laboratory culture of *Canthecona furcellata* was maintained on the respective host insects collected from the field at different developmental stages and the fictitious host.
- Investigation on biocontrol pontential of native EPNs against teak defoliators revealed teak defoliators to be susceptible to native EPNs not only in laboratory but also under field conditions, with 60-80% mortality obtained. Results were comparable with already known EPN populations**.**
- It was found that spraying gel formulation suspended with EPNs on teak leaves allows survival of EPNs under field conditions for more than 1 hrs even during sunny day.
- Combination of compatible insecticides with EPNs required half to one tenth of recommended concentration of chlorpyrephos, imidacloprid and monocrotophos, for the management of teak skeletonizer and defoliator.
- Genetics and Plant Propagation Division of the institute is engaged in genetic improvement of forestry species, encompassing conservation of genetic resources of various tree species like, *Boswellia serrata, Tectona grandis, Pterocarpus marsupium*, *Dalbergia latifolia*, *Litsea glutinosa* and various NTFP species like *Rauvolfia serpentina*, *Diospyros melanoxylon*, *Bauhinia vahlii* and *Madhuca indica* through collection of diverse germplasm across Central Indian and their propagation and screening of improved genotypes through biotechnological interventions, including molecular marker assisted evaluation of germplasm for future performance of these species.
- In *Boswellia serrata* DNA purity index and wood fibre length were analysed for 12 populations collected from M.P. Field trial of Ra was raised comprising five accessions of *in vitro* and *ex vitro* raised plantlets in the campus of TFRI. Phenotypically superior trees of *Pterocarpus marsupium* were selected from seven diverse areas of Chhattisgarh. Field data was collected for GBH, clear

bole and bark dry weight. Pods were collected from these localities for raising seedlings. The growth data of seedlings were also recorded. On the basis of maximum leaf number and largest leaf area (cm^2), two sites of Litipara and Lohattar were screened out as the best localities for collection of germplasm of *Diospyros melanoxylon* (tendu). For collection of germplasm of *Bauhinia vahlii*, locality Dugli significantly proved superior to all the other localities with respect to leaf number. Leaf area obtained in four localities of Kartala, Pali, Kasabel and Manora were statistically on par with each other. With respect to total area also locality Dugli was the best locality.

- For collection of critically endangered *L. glutinosa* germplasm, survey was conducted in the Chhindwara (West), Balaghat (South) Forest division and adjoining villages of TFRI. Total 60 trees have been located in the surveyed area and detailed morpho-metric data has been recorded on all trees along with GPS location. Survey and selection of Mahua trees was carried out at Balod, Bilaspur, Jashpur, Kanker and Jagdalpur in Chhattisgarh. Mahua trees were selected from five girth classes, viz., 61-90 cm, 91-120 cm, 121-150 cm, 151-180 cm and over 181cm. Around 1-2 kg flowers and seeds per tree were collected. In *D. latifolia,survey was conducted* and twelve trees were selected at different locations in Kalpi, three trees at Seoni and 7 trees at Udaypur. The morphological data on total height, clear bole height, GBH, crown diameter, number of primary branches, status of flowering and fruiting was noted. GPS data was also noted down. Half-sib seeds were collected from the trees.
- A multilocational trial comprising of 100 superior accessions of *Jatropha curcas* received from DBT network partners was established in July-August 2010 at GRC farm house Sita Pahad, Jabalpur. The experiment was established following RBD (Randomized Block design) with four replications. The trial performed well and the survival is more than 57.38%. Regular observations on growth attributes like height, collar diameter, number of branches, flowering, incidence of pests and diseases were recorded on quarterly basis and data sent to Biotech Park, Lucknow for compilation. On the basis of collar diameter, the best performing accessions are IC-555383, IC-569129, IC-561232, IC-561231, IC-569346, IC-558209, IC-471349, IC-471343, IC-566607 and IC-569349. However, accessions IC-471354, IC-566889, IC-569346, IC-561232, IC-566533, IC-558212, IC-566612, IC-565669, IC-566532 and IC-568554 performed better among 100 accessions on the basis of total number of branches.
- A study has been initiated to quantify the active ingredients of three Dashmoola species (*Solanum indicum, Solanum xanthcarpum* and *Uraria picta*) collected from different agroclimatic regions of Madhya Pradesh **to locate the best areas/populations.** Quantification of Rhoifoilin, a major active ingredient in root, stem & leaves of *Uraria picta* has been carried out. Quantification of total alkaloids (%) in different parts of *Solanum indicum* collected from two different agroclimatic regions, viz., Satpura Plateau (Chhindwara) and Chhattisgarh plains (Balaghat) was found to be 3.05, 2.93 (roots), 2.16, 2.17 (stem), 3.58, 3.48 (fruits), and 3.65, 3.58 (leaves) respectively.
- Seeds chemicals of *Sapindus mukrossi, Schleiochera oleosa. Pongamia pinnata and Jatropha curcas* were isolated and modified into saponified and diethanolamide products. The properties of modified products viz., solubility, surface tension, viscosity, foaming power, critical micelle concentration and alkalinity were assessed. The pesticidal activities of product formulations were assessed against forest insect pest of *Tectona grandis* and *Albizia spp*. i.e. *Eutectona machealaris* and *Spirama retorta, Heliothis armigera* and fungicidal activities against wood decaying fungai - *Pycnoporous sanguinius* by soil block method.

- To standardize sustainable harvesting limits of Mahul (*Bauhinia vahlii*), leaves were harvested as per different treatments [T_0 (No harvest/control), T_1 (50% harvest), T_2 (60% harvest), T_3 (70% harvest) and T_4 (80% harvest)] at each site. Observations were recorded in the month of May, November and March for emergence/presence of number of leaves. The quality of leaves collected from study area was assessed by measuring their size (length and width), insect and fungal infestation. Data revealed that best quality Mahul leaves with respect to leaf length and width were found at Balco, Korba. Average leaf length varied from 15.29-27.87 cm and width from 17.87-31.20 cm.
- Studies on standardization of sustainable harvesting limits of mahul leaves were undertaken and leaves were harvested as per different treatments T0 (No harvest/control), T1 (40% harvest), T2 (60% harvest) and T3 (80% harvest) with 4 replications and 4 treatments at different sites in Chhattisgarh. Total number of plants per blocks, leaves in initial stage, leaves remaining after harvesting and size of leaves was recorded.
- Samples were collected from Kymore plateau and Satpura Hills comprising of Katni, Umaria, Panna, Satna, Rewa and Seoni districts; Gir Region comprising of Gwalior, Shivpuri, Morena and Satpura Plateau comprising Chhindwara and Balaghat to standardize quality of some important medicinal plants of Madhya Pradesh.
- Prepared three value added products of *Schleichera oleosa* - Kusum concentrate, Kusum leather and Kusum katmith**.** Analyzed nutritional values of Kusum concentrate.
- Phytopolymers were isolated from *S. robusta, J. curcus*, *M. indica, C. aungustifolia* and *P. acularis* for the preparation of bioadhesives. Bioadhesives were prepared by alkali and acid hydrolysis at different concentration and its effect on adhesive properties were evaluated.
- A study has been initiated to standardize the processing and storage techniques of Malkangni *(Celastrus paniculatis*), Baheda (*Terminalia belerica)* and Baividang (*Embelia tsjeriam –cottam*) fruits/seeds.
- Experiments were laid out for standardization of plantation techniques of *Tectona grandis; Gmelina arborea; Dalbergia sissoo; Dalbergia latifolia; Terminalia tomentosa; Albizia procera; Terminalia bellirica; Dendrocalamus strictus.* Prelimanary observations (9 months) reveal that *Dalbergia sissoo* have highest survival percent and highest growth rate while lowest survival percent was recorded in *Gmelina arborea*.
- Studies on seed maturation were carried out in *Boswellia serrata* and *Sterculia urens.* Desiccation sensitivity test indicated that the seeds of *Boswellia serrata* and *Sterculia urens* seeds could be considered as orthodox seeds. However, viability of seeds of *Saraca indica* was lost if dried to 20% moisture content. Seeds may be of recalcitrant category. Seeds of *Sterculia urens* stored at all conditions were viable, thereby no deterioration occurs till six months of storage. Effect of temperature, light quality and type and depth of soil on germination of *Sterculia urens* was evaluated.
- The CFRHRD centre at Chhindwara has a rich collection of medicinal and aromatic plants consisting of 70 species approximately which are being maintained.
- Fifteen training programmes were conducted during the year. Target groups were farmers/NGOs/State forest department officials (Sawri range, West Division, Chhindwara**)** /school and college students/Women Self Help groups/Women Van Samiti members (Gadmau and Tansaramal villages, District Chhindwara), farmers sponsored by Social Forestry Department, Amravati, Maharashtra State and herbal practitioners of Chhindwara District.

- Analysis of organic carbon content in soil and forest floor samples received from Forest Survey of India, Nagpur was done and revenue was generated for ICFRE.
- One ICFRE funded research project was completed entitled "Integrated nutrient management of trees on overburden dumps." The project was to elucidate information on the effect of integrated nutrient management on growth of trees on overburden dump. Combined treatment with farm yard manure, VAM and nitrogen, phosphorus, potassium showed good result in survival of *Gmelina arborea, Mangifera indica, Moringa oleifera, Cassia siamea* and *Emblica officinalis.* Nutrient status of soil also improved at Haranbhata overburden dump (Shivpuri).
- One externally funded [Madhya Pradesh State Biodiversity Board (MPSBB), Bhopal] project was initiated entitled "Comparative field performance of seedling and clonal planting stock of *Buchnania lanzan* Spreng." *Buchanania lanzan* (Chironji) seeds were collected from thirteen selected candidate plus trees. Germination trial were conducted and it was observed that maximum 75% germination was recorded for clone number 12 (Delakhari).
- Protection of plantations and nurseries of the centre against insects and diseases.
- Production of vermi-compost is being done and revenue was generated.
- All the existing plantations viz. *Phyllanthus emblica, Buchanania lanzan, Tectona grandis* and *Gmelina arborea* of the centre are being maintained.
- Forest development agency evaluation work was conducted by the centre at West, North and South Divisions, Betul District (MP).
- Root-shoots of *Gmelina arborea* (silvi component*), Ravoulfia serpentina* and *Withania somnifera (*medicinal component*)* were transplanted and *seeds of Cajanus cajan* (agri crop) was sown in the farmer's field at Katoli- bahmni village of Chandrapur district of Vidharbh region of Maharashtra as an OFR and at TFRI, Jabalpur (M.P.) as an OSR for the establishment of silvi-agri-medicinal system and *Acorus calamus* was also intercropped with paddy for agri-medicinal system, simultaneously. Recorded growth data of all the components of the system and data indicates that 6 month old Gmelina plants are performing well attaining height of 35cm to 90cm in both the fields while *R.serpentina* and *W.somnifera* have shown poor performance with 20% survival. The agri crop component in OFR has also shown poor performance due to heavy and prolonged rains resulting in flooding where as in OSR field *C. cajan* showed 100 percent survival and registered good yield in all the combinations during the initial stage of the system. Under the Paddy-bach system both the crops are showing 100 % survival and good growth.
- Identified and selected lac host trees of *Butea monosperma* and Z*izyphus mauritiana* existing in the farmer's field bunds. They were pruned to cultivate lac as the first step of lac cultivation in Devri, Narai and Sohad villages of Jabalpur district. The pruned branches matured early due to heavy and prolonged rains which continued till September during the year. Experiment was done to infest the new shoots of kusumi trees selected in Tikariya village of Jabalpur. Assessed the yield data of kusumi lac, preliminary data indicates that the kusumi strains performed well . Collected baseline data of the farmers who are willing to take training on lac cultivation and keen to learn about this income generation activity.
- Explored possibilities to establish *Madhuca indica* based silvi-agri system for tropical region of Central India. Procured grafted strain of *M.indica* from the State Forest Research Institute, Jabalpur and seed originated seedlings were transplanted in the experimental area of TFRI, Jabalpur. Assessed the growth of these plants. The data indicates that the survival percent of the grafted *M.indica* is poor as compared to seed originated plants after one year of its

establishment. It appears that the grafted plants needs extra care. Further study is required in various locations of the tropical region to standardize this valuable species based agroforestry system equally important for tribals of this region.

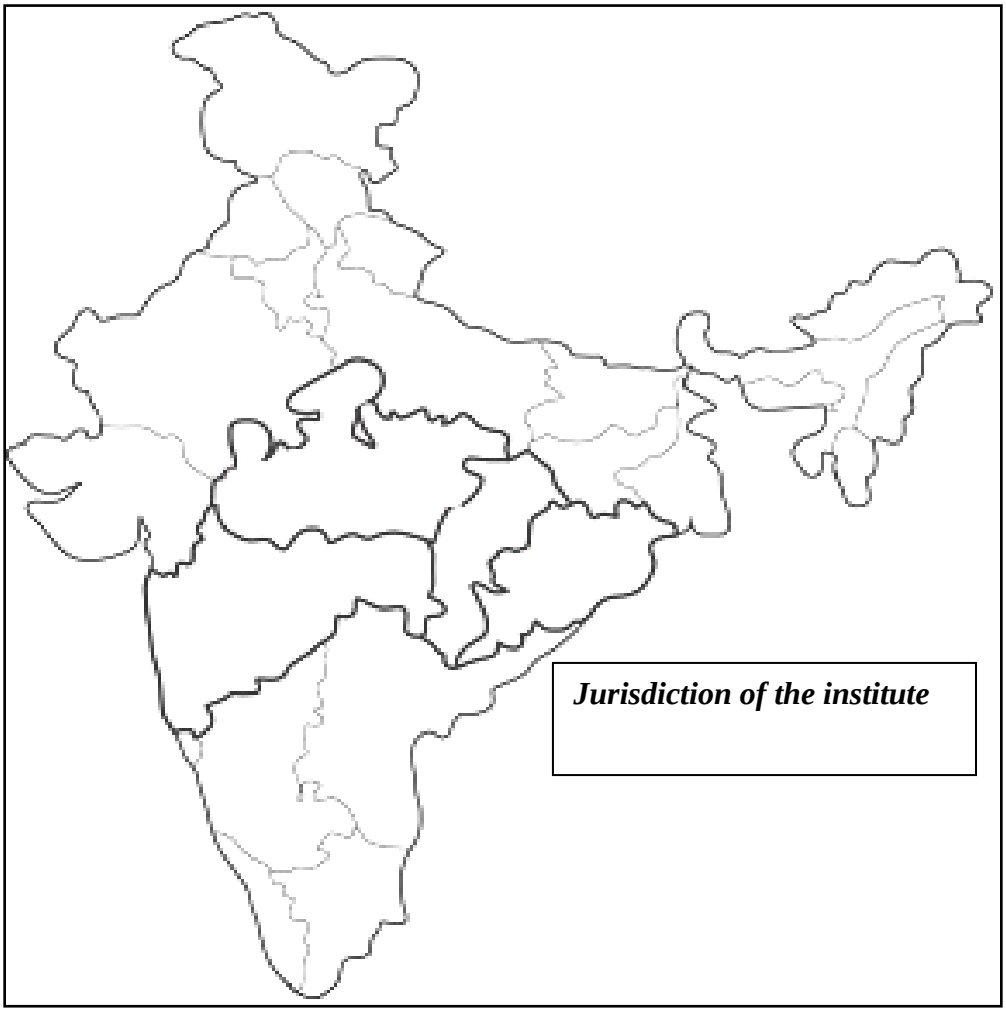
- Non- conventional lac host species i.e. *Flemingia semialata* and *F.macrophylla* were established for lac based agroforestry system as alternate income generation species on farmer's field bund, in case traditional lac host tree species i.e. *Butea monosperma* and Z*izyphus mauritiana* are not available in their fields.
- The study has been conducted in districts of Chhatarpur and Panna 6—8 villages cluster 2. The criteria of site selection being predominance of tribal and non tribal communities in each locality of sampling. The information on existing flora, species overexploited and at verge of extinction were recorded from local community and traditional healers for plant parts used in herbal medicines- name of indigenous flora local and scientific name, formulations prepared , dosage in cure of ailment . The information from local community for utilisation of plants (in JFM /protected /PPA's and other areas) and collection methods of plant parts , and method of collection of local flora . In Chhatarpur , Bijawar and Kishangarh clusters in Chhattarpur districts 32 plants were weekly collected from more than 10 kms away where as in Satna district in Chitarakot , Majhgawa Uchera (Maihar) Amarbeal , Gudmar , Rasna , Harsinghhar Kullu gum , species collected between 250-500gms are Ghritkumar and Munj ; species collected between 250 gms to 500 gms s are Kemanch , Pals bark , Rohan , Arjun bark, species collected more than 500 gms Dhawa Palas , Khair , Beal. **T**he species which are **Over exploited** : in Chhatatrpur district : Safed Musli , Kali musli , Kahira ,Satavar, Gi;loy ,Gattaran , Keokand, Bilarikand , Chitrak , Maida chal (bark) , Kahira , Shivlingi , seeds of Bavchi ; in Satna district Safed Musli , Kali musli and Palas , whereas species **At the verge of extinction** in Chhatatrpur district are Arjun , Vajradanti, Bechandi, Tikhur , and in Satna district are Malkangni, Tikur, Satavar, Safed Musli, Hara, Baheda, Kemach and Kali musli.

Summary of the Projects

Project type	**Completed projects**	**Ongoing projects**	**New projects initiated during the year**
Plan	6+1(dropped)=7	11+1(4 subprojects)=12	5+1(2 subprojects) = 6
Externally Aided	6	10+1(3 subprojects) = 11	4

1. ***INTRODUCTION***

Tropical Forest Research Institute (TFRI) Jabalpur, situated on the bank of Gour River on Mandla Road, is a premier R&D set up under Indian Council of Forestry Research & Education (ICFRE). The institute is headed by Director and has staff strength of about 200 including 33 Scientists and 7 officers. 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. It caters to the need of forestry research of four states of central India, viz., Madhya Pradesh, Chhattisgarh, Odisha and Maharashtra. Thrust areas of research of the institute relate to non-wood forest produce, rehabilitation of mined areas and other stress sites, development and demonstration in agroforestry models, planting stock improvement, sustainable forest management, biodiversity conservation and control of forest diseases and pests.



Centre for Forestry Research & Human Resource Development (CFRHRD), Chhindwara came into existence on 30th March 1995 under TFRI, Jabalpur. The mandate of the centre is to take up forestry research in the specialized areas like biodiversity conservation, non-wood forest products, forest protection, silviculture and tree improvement. In addition to this, the centre has also been assigned to develop human resource in forestry sector by imparting vocational training leading to poverty alleviation through self employment in central India.

2. Managing Forest and Forest Products for Livelihood Support and Economic Growth

(i) Standardization of pruning practices and optimum doses of organic and inorganic fertilizers to increase leaf surface area of tendu. (a sub project of "Standardization of technique to enhance the quality and sustainable production of *Diospyros melanoxylon* leaves in Chhattisgarh".)

Three sites in Chhattisgarh state, namely (i) Morga, Katghora division, (ii) Kotadol, Baikunthpur division and (iii) Litipara, East Raipur division, were selected in consultation with the officers of C.G. MFP Federation, in tendu bearing areas.

Experiments on foliar spray of chemical fertilizers were conducted at the selected sites using different doses (0.5%, 1% and 2%) of nitrogen and phosphorus and their combinations in 5 m x 5 m sized quadrats. A combination of 2% nitrogen and 1% phosphorus was found to be the best treatment in Kotadol and Morga and 2% nitrogen (no phosphorus) in Litipara. The results are in agreement with soil nutrients status as soil samples collected from all three sites are nitrogen deficient and the mean value of phosphorus in soil samples collected from Kotadol (13.47) and Morga (11.24) is less than Litipara (19.26).

To observe the effect of chemical and biofertilizers, different doses of urea, single super phosphate (chemical fertilizers), vermicompost and neem based biofertilizer were applied after soil working to the rhizosphere of tendu in 5m x 5m sized quadrats. Results showed that a combined dose of 100 kg/ha nitrogen and 25 kg/ha phosphorus showed the maximum enhancement in tendu leaf size in Kotadol and Morga and an individual dose of 100 kg/ha nitrogen in Litipara. The results are similar to experiments conducted for foliar spray as the phosphorus content in Litipara is higher in comparison to Kotadol and Morga. A combined dose of 500 g ranker neem granules and 1000 g VAM per 5 m x 5 m size plot was found as the best treatment in Morga and an individual dose of 500 g neem granules per plot in Kotadol and Litipara. The results could be due to nitrogen deficient soils of all study sites and minimum amount of phosphorus recorded in soil of Morga.

Experiments on pruning practices of tendu were conducted, in three sets of treatments including 18 combinations *viz.* time interval of pruning, height of pruning and girth classes. Results show that maximum size of tendu leaves was found when seedlings having 2 – 4 cm diameter were pruned at ground level.

Surface and sub-surface soil samples from the selected sites were randomly collected and analyzed in TFRI laboratory for their physico-chemical characteristics *viz.* pH, EC, organic carbon, available N, P, K, exchangeable cations (Ca, Mg, Na, K) and mechanical composition by conventional methods.

Foliar spray of chemicals at Litipara (C.G.)

Pruning experiment conducted at Kotadol (C.G.)

(ii) Biological control of insect pests of medicinal plants-*Abelmoschus moschatus, Gloriosa superba* and *Withania somnifera"*

Survey was conducted in different localities in Madhya Pradesh, Chhattisgarh and Maharashtra for collection of insect pests of target species of medicinal plants. Five insect pests viz., defoliator *Anomis flava, Sylepta derogate*; shoot borer *Earias vitella*; red cooton bug *Dysdercus cingulatus* on *A. moschatus*. Four insect pests viz. defoliator *Polytela gloriosae*, *Amsacta lactineus, Diacrisia oblique*; banded blister beetle *Malabris pastulata* on *G. superba* and two insect pests viz. bug *Plautia crossota* and aphid *Aphis gossypi* on *W. somnifera* were recorded and identified. Seasonal history of key insect pests was studied. Sampling of natural enemies was also studied. Two parasites *Ichneumon spp* and *Stermia spp*. were recorded on *P. gloriosae*. Laboratory experiments were laid out against *P. gloriosae* and *A. flava*. *Bacillus thuringensis* 1% and combination of BT + neem based Gronim 0.5% were found to be most effective against these insect pests. Field experiments were laid out against *P. gloriosae* and *A. flava*. After 7 days of treatments, *B. thuringensis* 1% and combination of Bt + neem based Gronim 1% were found to be most effective against these insect pests. Field experiment was laid out to study the effect of two parasites *Trichogramma raoi*; *T. chilonis* and one predator *Chrysoperla cornea* against *P. gloriosae*. and *A.flava*. Predator *C. cornea* followed by parasite *T. chilonis* was found to be most effective for reduction of the larval population. Field trial was laid out in Randomized Block Design. Seven treatments including control- untreated (T1. *Bacillus thuringensis* 0.5% ; *Bt* 1% ; Neem based Gronim 0.5% ; Neem based Gronim 1% ; *Beauvaria bassiana* 0.7% ; *B. bassiana* 1%) with three replications were taken. Reduction in bug population after 3 and 7 days of treatment were recorded. Neem based Gronim 1% followed by Bt 1% was found to be most effective against *D. cingulatus*. One day training programme on "Insect pests of important medicinal plants and their biological control measures" was organized at CFRHRD, Chhindwara, M.P. on 19th December, 2013 to SFD officials and farmers. 20 trainees participated in the training programme. Field visit was also conducted. Training materials in Hindi were distributed to the trainees.

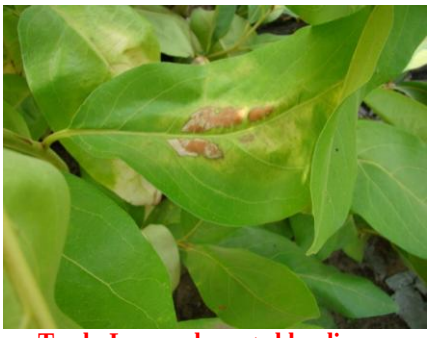
Larvae of *Anomis flava* feeding on leaves of *Abelmoschus moschatus*.

Training programme on "Biological control of insect pests of medicinal plants" at CFRHRD, Chhindwara

(iii) "Standardization of management practices for tendu leaf gall forming insect and diseases" (a sub project of "Standardization of technique to enhance the quality and sustainable production of *Diospyros melanoxylon* leaves in Chhattisgarh")

Survey was conducted in nine different sites viz., Litipara (Gariyabad, East Raipur), Raipur, Lohattar (East Bhanupratppur, Kanker), Kotadol (Korea), Kota, Bharni (Bilaspur), Morga (Kathghora, Bilaspur), Chichola (Rajnandgaon) and Kawardha Chhattisgarh for monitoring the status of gall forming insect, *Trioza obsoleta* and foliar/leaf spot disease, *Pseudocercospora helleri* and *Pestolotiopsis versicolor* on, *Diospyros melanoxylon*(tendu). About 50-60% incidence of *T. obsoleta* was recorded. Disease incidence was recorded during pre monsoon shower. Blighted area appeared from the leaf margin and covered entire lamina with brown oval, irregular patches. On the basis of field observation 13-33 % plants were affected with blight disease during the first incidence of disease. *P. versicolor* is a major pathogen which causes leaf blight in tendu. It creates several minor cushion shaped ascervulous which produces bulk of dark septate, fusiform conidia bearing typically hyaline one basal end and three apical appendages. These conidia are sometimes found in a chain as well as irregularly produced. During advanced stage of infection several dark brown to black ascervulii developed over the lamina and resulted premature defoliation. Field experiment was laid out in compartment no. 1920, Bhulsibhawana, Madanpur circle (Range- Kendai-Morga, Katghora forest division) in randomized block design to study the effect of different pruning period i.e. cultural practices against *T. obsoleta* / foliar diseases. The results revealed that first pruning including control fire in first week of March (06.03.2013) was found to be most effective in less incidence of *T. obsoleta* and also increases the weight and leaf area.

Leaves damaged by tendu gall forming insect



Tendu Leaves damaged by diseases

Showing leaf Size of tendu

Bundles of leaves

Bundles in diff pruning period of tendu

(iv) Status of sal heartwood borer, *Hoplocerambyx spinicornis* Newman and its management

Surveyed sal forest areas of Madhya Pradesh for monitoring of sal borer and collection of information on borer incidence, and abiotic and biotic factors. Investigated sal borer incidence in MP. Identified sal borer incidence in Bajag, East and West Karanjia and South Samnapur ranges of Dindori Forest Division, Baihar range of North Balaghat Forest Division, and Mobai, Motinala and Bichia ranges of East Mandla Forest Division. Collected information on sal borer incidence in 7 ranges of core zone and 6 ranges of buffer zone of Kanha Tiger Reserve, Mandla. A total of 39554 sal trees were marked under different categories of borer attack in MP. Demonstrated categorization of intensities of sal borer infestation to the front line staff of Forest Department. Collected borer attacked logs, mature grubs and wood dust. Recorded ant as a predator found feeding on grubs of borer inside the sal tree. Carried out Trap Tree Operation for management of sal borer beetles in Dindori Forest Division. Laid out sample plots in sal forest areas to examine borer incidence and further observations and subsequent management of sal borer. Distributed leaflet on sal heartwood borer to front line staff of M.P. Forest Department. Attended workshop-cum-meeting on sal borer at Kanha Tiger Reserve, Kanha and presented “Recent sal borer incidences in Madhya Pradesh”.

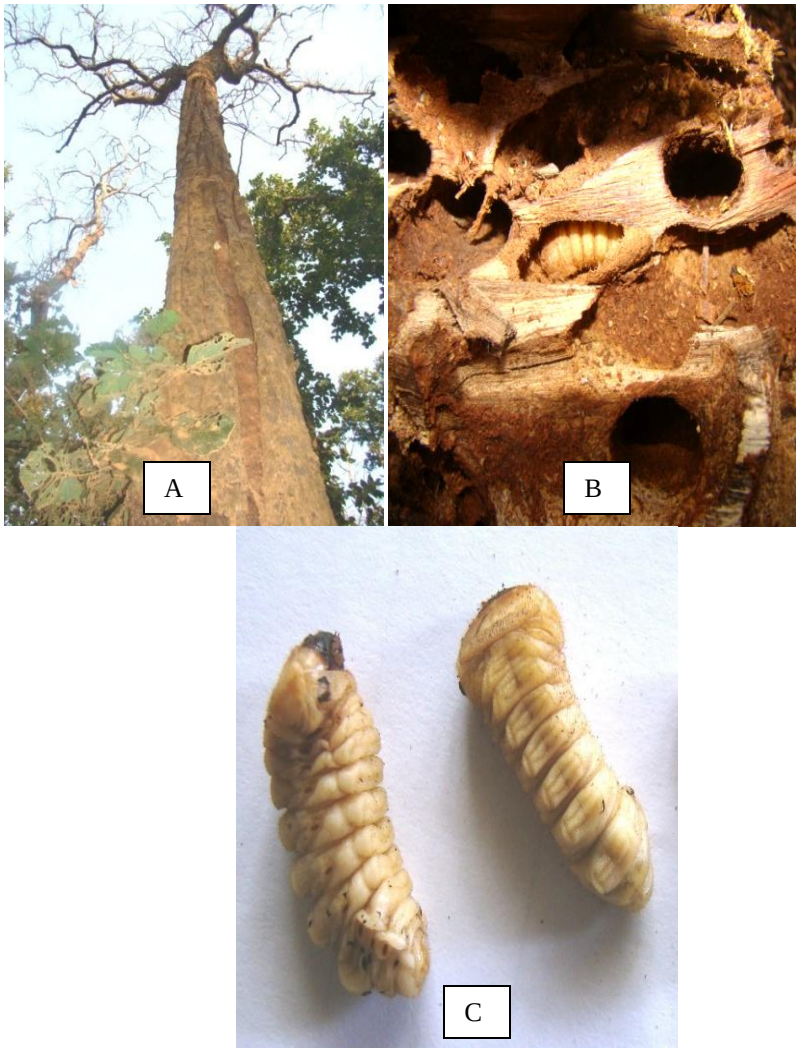


Fig : Infestation of Sal heart wood borer. A- Sal borer affected tree of T_3 category, B-Sal borer grub in heartwood of tree, C-Sal borer grub.

(v) Eco-friendly management of bark eating caterpillar, *Indarbela quadrinotata* on aonla (*Emblica officinalis*) in plantations

Survey was conducted in TFRI, campus Jabalpur, Balaghat, Chhindwara, Research Extension circles Seoni, Rewa, Betul, Indore for recording the incidence of bark eating caterpillar, *Indarbela quadrinota* in aonla plantations. Infected larvae of *I. quadrinotata* were collected for laboratory study. Three entomopathogenic fungi were isolated, purified and identified. Thirteen varieties viz., Kanchan, Krishna, NA-7, Hathijhola, NA-6, Chakaiya, NA-10, Francis, Banarasi, BSR-1, Anand-1, Anand-2 and Wild variety of *E. officinalis* were screened against *I. quadrinotata* in Clonal Seed Orchards and Gene Bank in five different localities (Badwaha, Seoni, Balaghat, Betul and Indore) of M..P. Observations were recorded on the seasonal incidence of *I. quadrinotata.* Field experiments were laid out in randomized block design in TFRI, campus Jabalpur. Microbial (fungal suspension) and four biopesticides (*Beauvaria bassiana*, *Bacillus thuringensis*, Neem based gronim, crude extract of *Cleistanthus collinis* and combination of crude extract of *C. collinis* + cow urine + vermiwash) were applied against the *I. quadrinotata.* Field experiments were also laid out for efficacy of three microbials (*Fusarium oxysporum*, *F. moniliformae* and *Aspergillus niger*) and one biopesticide (*Cleistanthus collinus* in three

different solvents-methanol, acetone and petroleum ether) against *I. quadrinotata*. Observations were recorded on the per cent reduction of bark eating caterpillar, *I. quadrinotata*. The results showed that crude extract of C. collinus + cow urine + vermiwash was found most effective against *I. quadrinotata* in first trial. Solvent extract of C. collinus in petroleum ether was found most effective against *I. quadrinotata* in second trial. Application of Fungal suspension of *Fusarium moniliformae* $1.5x10^{-6}$ was found to be most effective against this pest in third trial.

Emblica officinalis **tree damaged by bark eating caterpillar,** ***Indarbela quadrinotata***

(vi) Development of rearing technique for production of insect predator, *Canthecona furcellata,* as biocontrol agent for larval defoliators

Literature on *C. furcellata* was surveyed and updated. Nurseries and natural forests of Teak at Bhadari, Sakri, Maneri, Kharibabliya, Niwas, Bakori and Phoolsagar were surveyed. Nursery and plantation of Shisham, Khamer, Anjan at Katra, Moiyanala, Maharajpur, Mandla Forest Division, Bamboo and teak plantation at Ramnagar, Sal forest in Ghota, Medha, Saida Mawai Sijhora forest range, Khudarhi, Motinala, Dalko, Sarai, Shapura forest range, Dindori Forest Division were also surveyed and collected eggs, nymph and adult of *C. furcellata.* Also surveyed teak SPA compartment no. 421 range Rukhar and Dudhiya nursery, social forestry nursery, natural forest teak and bamboo, Mul road Chandrapur, Chamorshi, Ashti, Muktapar, Badsa, Bhandra visited biological lab, Entomology Division, Punjab Rao Deshukh Agriculture University, Nagpur and TFRI nurseries and plantations. Observations recorded on predation behavior and life cycle of *C. furcellata* on larvae of *E. machaeralis* and *Caveria sericia* at different temperatures regimes (20±1, 27±1 and 35 ± 1^{0}C) in the laboratory.

(vii) Studies on insect biocontrol agent, *Chrysoperla carnea* and its potentiality as insect predator

Periodical surveys were carried out in teak, sal and bamboo forests of Madhya Pradesh, Chhattisgarh and Maharashtra, for collection of predator, *Chrysoperla carnea* and its habit and habitat were recorded. The specimens were identified with the help of available literature and preserved in insect reference collection of Forest Entomology Division, TFRI, Jabalpur and ZSI, Jabalpur. The rearing of this predator carried out on the respective host insects collected from the field at different developmental stages in the laboratory. Investigations on predation potential along with the detailed life cycle of the predator has been initiated. Further work is in progress.

(viii) Studies on effect of introduction of Honey Bee on seed production of teak seed orchards.

Project was approved in Oct., 2013 and transferred to Dr. N. Kulkarni, Scientist – F in January (Appointment of Field Assistant is still pending).

Selection of Teak Seed Orchards (TSOs) has been initiated for artificial establishment and further monitoring the bee hives, established artificially in these sites.

(ix) Biocontrol potential of native isolates of entomopathogenic nematodes for the management of insect pests of teak.

Maintained laboratory culture of EPN host waxmoth, *Galleria mellonella* round the year. Maintained separate laboratory culture of native EPN isolates from central India and *H. indica, S. carpocapsae* (NABII populations). Determined and compared biocontrol potential of six native Steinernematid and Heterorhabditid EPN isolates against teak defoliator and skeletonizer and compared efficacy with *H. indica* and *S. carpocapsae*. Results obtained against teak leaf feeders were comparable with *S. carpocapsae* at all the doses tested. While all the native populations were effective, EPN 50, 56 and 57 were infective at and above 10 IJs/ Larvae dose in laboratory. However, at higher doses at and above 30 IJs/ Larva, all native and exotic EPNs were at par. Experimented innovative method of field application of EPNs. Results revealed IJs in 1% and 2% gel had more survival and infectivity in field. Field experiments carried out with individual and combination of EPNs with insecticides proved that EPNs were tolerant to insecticides and thus can be combined with desired concentration of insecticides for spraying in field on seedlings. Combination of insecticides and EPNs required half to one tenth of the recommended concentration of chlorpyrephos, monocrotophos and imidacloprid for achieving effective management of teak skeletonizer and defoliator incidences.

(x) Standardization of sustainable harvesting practices of Mahul Patta (*Bauhinia vahlii*)

To standardize sustainable harvesting limits, leaves were harvested as per different treatments T0 (No harvest/control), T1 (40% harvest), T2 (60% harvest) and T3 (80% harvest) with 4 replications and 4 treatments at each site. Initial population was recorded for each quadrate. 5 plants per quadrates were selected and harvested as per treatments. Experiments were initiated in the month of June-July 2013 and observations were recorded in the month of July and October, 2013.Total number of plants per blocks, leaves in initial stage, leaves remaining after harvesting and average leaves remaining, rate of change increase or decrease leaves of *Bauhinia vahlii* plants, size of leaves such as small, medium and large size and also treatment wise size of leaves observed after harvesting were recorded. Overall densities of *Bauhinia vahlii* was observed and recorded at all experimental sites i.e. Keechi, Lamani core area and Sapalwa (Pali) in different months- July (2013), Oct (2013), December (2013) and Feb (2014) .

Maximum density was recorded in the month of Oct, 2013 at Lamani core area experimental area and minimum density in the month of Dec, 2013 and Feb, 2013 at Sapalwa experimental sites. The leaves were harvested from selected plants as per experimental design. Average % increase of *Bauhinia vahlii* leaves observed after harvesting at Keechi (Marvahi)and Sapalwa (Pali) Katghora (C.G.) experimental sites the month of July to Oct (2013), July to Dec (2013), July to Feb (2014), October to December (2013) and Dec to Feb (2014).On the basis of average % increase of *B. vahlii* leaves , it was observed that T3 i.e., 80% harvesting treatment was found to be the best followed by T2 i.e.60% harvest, T1 i.e.40% harvest and T0 i.e. no harvest/Control harvesting at both the experimental sites . Similar observation was recorded at Lamani (Achankmar biosphere reserve core area) in the month of

Dec., 2013 and Feb., 2014. Efforts were also made to prepare Dona with different type of layering materials to avoid utilization of plastics to prepare eco-friendly donas.

(xi) Studies on harvesting time of some medicinal plants for their natural antioxidants constituents

Surveyed different regions of Maharashtra i.e. Nasik, Akola, Wardha, Buldana and Amravati for the collection of selected species. Standardized method for the estimation of antioxidant activity. Total phenol, flavonoids and antioxidant activity were assessed in fresh and dried samples of *Asparagus racemosus, A. officinalis, A. speciosa,* and *C. orchioides.* Total phenols and flavonoids in fresh and dried root and shoot samples of *A. racemosus* varied from 0.57 to 1.19 %, 0.22 to 0.95%, respectively. No flavonoid content was detected in *A. racemosus* root samples. However, flavonoids percentage in shoot samples varied from 0.065 to 0.22%. IC50 value ranged from 0.30 to 0.75, 0.47 to 4.96 mg/ml in methanol and ethanol extractives of fresh and dried root and shoot samples respectively. *A. officinalis,* shoot samples (fresh and dried) were analyzed for total phenols and flavonoids, varied from 0.28 to 0.90 % and 0.11 to 0.44% respectively. IC50 value ranged 0.52 to 3.99 mg/ml in methanol and ethanol extractives of fresh and dried shoot sample. *A. speciosa,* total phenols and flavonoids in fresh and dried leaves, shoot, and root samples varied from 0.42 to 1.36, 0.14 to 1.02, and 0.17 to 0.90 % and 0.14 to 1.61, 0.026 to 1.61, and 0.064 to 0.47 %, respectively. IC50 value ranged from 0.77 to 4.67, 0.56 to 4.49, and 0.97 to 4.77 mg/ml in methanol and ethanol extractives of fresh and dried shoot sample. *C. orchiodes,* total phenols and flavonoids in fresh and dried leaves, and root samples varied from 0.19 to 1.69, 0.19 to 4.15 % and 0.18 to 1.52, 0.10 to 0.39, respectively. IC50 value ranged 0.37 to 5.14, 0.38 to 0.93, mg/ml in methanol and ethanol extractives of fresh and dried leaves and root sample.

(xii) Quality standardization of some important medicinal plants of Madhya Pradesh

Literature survey was carried out with regard to the target project samples of *Gymnema sylvestre, Ocimum sanctum, Phyllanthus amarus* and *Tinospora cordifolia* and HPTLC technique. Samples were collected from Gwalior, Guna, Shivpuri, Satna, Panna, Rewa, Sidhi, Shahdol, Umariya, Chindwara Balaghat, Narsingpur, Hoshangabad, Bhopal, Vidisha and Sagar districts. The collected samples were processed for chemical analysis and phenol, flavonoid and antioxidant property was estimated in all the collected samples.

Starch content in *T. cordifolia* varied from 5.4 % to 15.74 % and was found to be higher in stem of diameter 16-18 mm, collected from Jabalpur.

The concentration of Phyllanthin in P. amarus samples varied from 0.005% to 0.051% and highest concentration (0.051%) was found in samples collected from Shivpur.

The concentration of ursolic acid in *O.sanctum* varied from 0.016% to 0.128% and highest concentration was found in Satna samples.

The concentration of gymnemic acid in *G. sylvestre* varied from 1.45% to 21.5% and highest in samples from Umariya district.

Fingerprints of the samples collected from above mentioned regions were generated using HPTLC. Harvesting and processing experiments were laid in NWFP nursery. Harvesting techniques were standardized for *O.sanctum* and *T. cordifolia*.

(xiii) Evaluation of of non edible oil seeds for development of surfactants and their utilization in pest management

Seeds of *Pongamia pinnata, Schleiochera oleosa, Jatropha curcas* and *Sapindus mukrossi,* were collected and processed. Seed biochemicals were isolated and modified by saponification, sulphation and diethanolamine reactions. Amide formation was standardized at different temperature and free amine content was estimated. The properties of surfactants viz., electrical conductivity, solubility, surface tension, viscosity, foaming power, cloud point, and alkalinity of modified products and triton – X-100 at different dilution were assessed.

The surface tension of diethanolamides varied from 0.068-0.05645 N/m at 0.1-10% concentration while viscosity of different dilutions varied from 0.84-2.26 mPa.s.

Sapindus amide emulsifying power varied 1.68 to 8.45 min**.** at different dilutions (0.1%- 10%) while foaming power varied 10.13 to 10.8 cm at different dilutions. The cloud point, pH and viscosity of different dilutions were also assessed. The pH value ranged 9.38 to 11.23. Physico-chemical properties of Sodium lauryl sulphate (SDS) were also determined.

The phytotoxicity of different surfactant dilution were assessed on the basis of ocular observation and estimation of chlorophyll.

The pesticidal activities of product formulations were assessed against forest insect pest of *Tectona grandis* and *Albizia spp*. i.e. *Eutectona machealaris* and *Spirama retorta, Heliothis armigera* and fungicidal activities against wood decaying fungai - *Pycnoporous sanguinius* by soil block method.

(xiv) Chemo-profiling of some Dashmoola species (*Solanum indicum, Solanum xanthcarpum* and *Uraria picta*) in Madhya Pradesh

A study has been initiated to quantify the active ingredients of three Dashmoola species (*Solanum indicum, Solanum xanthcarpum* and *Uraria picta*) collected from different agroclimatic regions of Madhya Pradesh **to locate the best areas/populations**. Under the above said study, forest area was surveyed and the different plant parts of *Solanum xanthocarpum* and *Solanum indicum* were collected from eight agroclimatic regions i.e. Kymore Plateau & Satpura Hills (Jabalpur), Chhattisgarh plains (Balaghat), Satpura Plateau (Chhindwara) , Malawa Plateau (Indore), Central Narmada Valley (Narsingh pur & Hoshangabad), Northern Hill Zone of Chhattisgarh (Mandla), Grid zone (Gwalior) and Bundelkhand Zone (Datia).The plant material of *Uraria picta* was collected from six agroclimatic regions i.e. Satpura Plateau (Chhindwara), Central Narmada Valley (Hoshangabad), Malawa Plateau (Dewas), Vindhyan Plateau (Sehore), Nimar Valley (Khandwa) and Jhabua Hills (Alirajpur). The collected plant materials were shade dried & processed. The preliminary phytochemical screening (alkaloids, terpenoids, flavonoids, carbohydrates, phenols, saponins, cardiac glycosides, steroids & tannins) of different plant parts of *Solanum indicum* & *Solanum xanthocarpum* and *Uraria picta* were carried out. Quantitative analysis of total phenols in different plant parts of above said species have been carried out by using methods of Mc Donald *et al,* (2001). So far, chemical analysis of plant material collected from seven agroclimatic zones has been carried out in which phenols was found in the range (%):

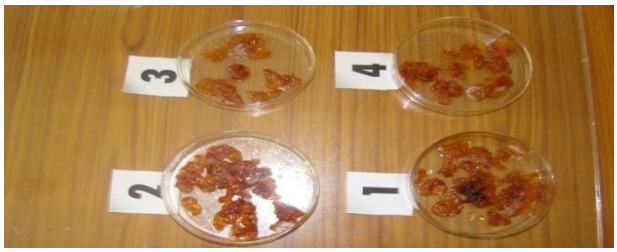
Solanum xanthocarpum - Fruits: 2.38 to 2.87, Roots: 0.23 to 0.51, Leaves: 2.18 to 2.79 & Stem: 0.44 to 1.32.

Solanum indicum – Fruits: 1.64 to 2.84, Roots: 0.73 to 0.87, Leaves: 0.57 to 0.34 & Stem: 0.50 to 0.36.

Quantitative analysis of total phenols in different plant parts of *U. picta* collected from six agroclimatic zones has been carried out and found in the range (%): Roots: 3.06 to 2.30, Leaves: 3.48 to 1.86 & Stem: 1.77 to 0.63. Quantification through HPTLC is under progress.

(xv) Evaluation of *Schleichera oleosa* (Kusum) fruits for their nutritional value and development of value added products for economic development of local people

Prepared 3 value added products as Kusum concentrate, Kusum leather & Kusum katmith. Nutritional values in Kusum concentrate was analysed and total carbohydrates 67.5 %, ascorbic acid 0.71, CFC 7.3 % and protein 0.17 %. was noted. In Kusum leather total carbohydrates 86.0 %, ascorbic acid 0.73, CFC 7.9 % and protein 0.17%. In Kusum katmith total carbohydrates 77.5 %, ascorbic acid 0.76, CFC 7.5 % and protein 0.17 %. Sensory test analysis was carried out by following Hedonic scale. Further work as per action plan is under progress.



(xvi) Standardization of processing and storage techniques of Malkangni *(Celastrus paniculatis*), Baheda (*Terminalia belerica)* & Baividang (*Embelia tsjeriam –cottam*) fruits/seeds

A study has been initiated to standardize the processing and storage techniques of Malkangni *(Celastrus paniculatis*), Baheda (*Terminalia belerica)* & Baividang (*Embelia tsjeriam –cottam*) fruits/seeds. Under the above said study, the fruits/ seeds of Malkangni, Baividang and Baheda were collected from the forest areas of Chhindwara district of Madhya Pradesh. The collected fruits/ seeds were dried and processed. Dried seeds of Malkangni were analyzed for oil percentage by Soxlet apparatus and yield was found 58%. Baividang seeds will be analyzed for embelin content and baheda fruits for gallic acid content. Dried fruits/ seeds of all the species were stored in different containers (jute, polythene and markin bags, tin, glass and plastic containers and Matki). Some of the samples of fruits/ seeds were also stored at 4-5^{o}C in the freezer to examine the effect. Quantification of major active ingredients is under progress.

(xvii) Evaluation on phyto-polymers as eco-friendly bioadhesives

Samples of *Shorea robusta (*seeds*),Jatropha curcas(*seeds*), Madhuca indica* (seeds)*, Mangifera indica* (seeds)*, Curcuma aungustifolia (*tubers*), Amorphophallus companulatus* (tubers) and *Pheonix acularis* (tubers) were collected. Starch and crude protein were isolated from *S. robusta, J. curcus*, *M. indica, C. aungustifolia* and *P. acularis* for the preparation of bioadhesives. Bioadhesives were prepared by alkali and acid hydrolysis at different concentration and its effect on adhesive properties were evaluated. The effect of type and quantity of stabilizer/ filler i.e. formaldehyde, urea, urea-formaldehyde, SDS, and $CaCO_3$ were assessed. The properties of adhesives i.e. pH, solid content, ash, viscosity and density were assessed. Water holding capacity of *M. indica* and *A. companulatus* were

determined. Viscosity and pH of the adhesives ranged from 1.55 -4.70 m Pas. and 5.18- 13.72, respectively. Adhesiveness was assessed on different substrates viz., paper-paper, glass-glass, wood-paper, wood-wood. Drying time and effect of storage on different adhesives were observed. The pH and viscosity of protein adhesives were found to be increased after storage while adverse result was observed in starch adhesives. Similarly effect of quantity of different additives were also assessed.

(xviii) Establishment of multilocational trials of 100 superior accessions of *Jatropha curcas* under the network programme of DBT

A multilocational trial comprising of 100 superior accessions of *Jatropha curcas* received from DBT network partners was established in July-August 2010 at GRC farm house Sita Pahad, Jabalpur. The experiment was established following RBD (Randomized Block Design) with four replications. The experimental field was divided in 400 equal sized plots and 9 plants were planted per plot at a spacing of 3m x 3m. The trial is performing well and the survival is more than 57.38%. Regular observations on growth attributes like height, collar diameter, number of branches, flowering, incidence of pests and diseases has been recorded on quarterly basis and data sent to Biotech Park, Lucknow for compilation.

Morphological growth characteristics of different superior accessions of *Jatropha curcas* growth were recorded. The average plant height was recorded maximum in accession no IC-468907 (125 cm) followed by accession no IC-569355 (93.14 cm). The plant height ranged 14.19-125 cm. The average diameter (at 15 cm height) of different accessions was recorded maximum in accession IC-566614 (14.66 cm) followed by accession no IC-558221 (5.63 cm). The diameter ranged 0.71-14.66cm

Maximum number of primary branches (at 50 cm height) were recorded in accession no IC-471349 (1.33) followed by accession no IC-558217 (1.19) and minimum in accession IC-471126 (0.194). The number of branches ranged 0.194-1.36 with a mean value of 0.77.

(xix) Standardization of non-destructive harvesting practices of *Commiphora wightii* oleogum resin

This project was started and is in initial phase.

(xx) Potential Pathogens and Insects responsible for the low seed production in teak seed orchards and their management

Spermoplane micro flora of Teak (*Tectona grandis)* seeds was recorded in the inflorescence, immature and mature stages of fruits. During the seed setting process *Fusarium* sp. shows systemic infection. Simultaneously some seed boring insects like *Pagyda salvalis, Dichocrosis punctiferalis and D. pendamalis* were also found associated with the teak fruits. Due to attack of these pathogens and insects, the fruiting in TSO's and SPA's are very less. One field experiment, using biopestcides (*Bacillus thuringiensis, B. amyloliquefaciens*), insecticides (Monocrotophos), fungicide (Bavistin), trace elements (Rallis tracel-2) and growth hormone (Planofix) in different combinations were applied in 16 years old TSO in Nandigram (Seoni), (M.P.) (Fig. 1). The result of the experiment showed maximum number of fruits and weight of teak fruits in the treatment of Monocrotophos (0.05%) + Bavistin (0.2%), the insect and fungal damage was also less in the treatment. Whereas other treatment does not show significant result (Fig.2). Therefore, application of Monocrotophos (0.05%) + Bavistin (0.02%) in the month of July and 2nd dose during 1st week of August can enhance fruit productivity in TSO's.

Fig- 1. Spraying in teak seed orchard with biopestcides, insecticides, fungicide, trace elements and growth hormone for enhanced seed production at Nandigram, Seoni, MP

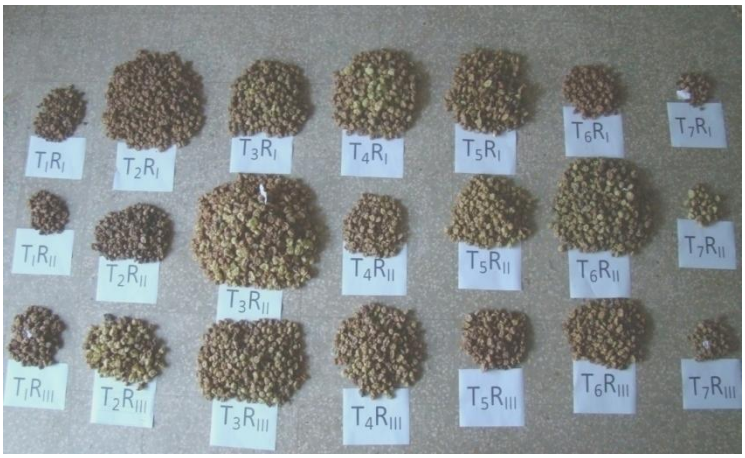


Fig-2. Comparative seed yield in different treatments

(xxi) Development of certification criteria and production of microbial inoculants for application in forest nurseries and plantations

Inocula of AM fungi, Rhizobium and PSB were developed and used for development of certification criteria of microbial inoculants. The inocula were stored at ambient room conditions and regularly monitored for presence of infective propagules per unit volume. Certification criteria for plant growth promoting microbes (*Azospirillum*, AM fungi, PSB and *Rhizobium*) were developed. The total numbers of infective propagules of these microbes required for proper infection/colonization of target host plant were standardized. One thousand infective propagules of AM fungi per plant are required for proper root colonization in tree species. Pot experiments were conducted on bael, beeja sal, mahua and tinsa to test the effect of biofertilizers on these species. Such study was not conducted on these species earlier. It was concluded that application of AM fungi along with *Azospirillum* sp., enhance dry biomass and shoot P content of bael seedlings. In beeja sal application of growth promoting microbes significantly produced more height, maximum in seedlings treated with *Aspergillus nigrer*. In mahua application of microbes produced significant increase in plant height and diameter of seedling at collar height, which was maximum in *Azospirillum* sp. followed by AM fungi and *Trichoderma harzianum* treatments. In case of tinsa application of microbes produced higher biomass (Fig. 3). Height, and diameter at collar height of tinsa saplings planted in the field treated with plant growth promoting

microbes produced higher plant height and diameter in saplings treated with *Trichoderma harzianum* and AM fungi, application of vemicompost during planting further enhanced these parameters.

Figure 3. Effect of growth promoting microbes on tinsa (*Ougenia oojeinensis*) seedlings. (From left to right: Control, *Aspergillus niger*, *Trichoderma harzianum*, AM fungi, *Azospirillum* sp.)

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

Site was cleaned and staking work was carried out at the selected site. Eight species viz., *Tectona grandis; Gmelina arborea; Dalbergia sissoo; Dalbergia latifolia; Terminalia tomentosa; Albizia procera; Terminalia beleirica; Dendrocalamus strictus* were chosen for the experiments. Treatment of 3 pit size (30 cmx30 cm, 45 cm.x45 cm and 60 cmx60 cm) and 3 spacing (2 mx2 m, 3 mx3 m and 5 mx5 m) with 2 replication under irrigated and non irrigated conditions were applied to all the species. 432 plants of each species were planted at the selected site, total 3456 plants were planted in the experiment. Irrigation system for irrigation was established and basin preparation work was completed. Irrigation work was started from March, 2014. The plantation is being maintained. Data for growth (quaterly) and Rate of photosynthesis (half yearly) is being recorded.

Pit Digging at site

Placement of earthen pot

Fixing of earthen pot (Surahi)

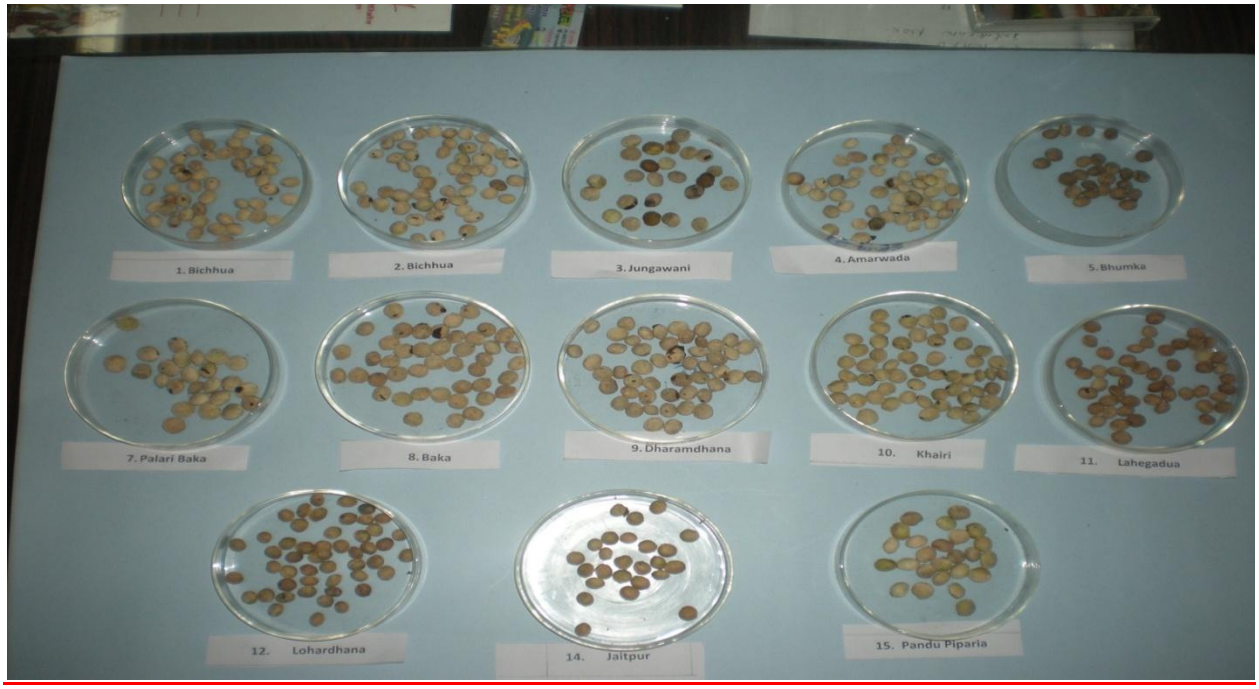
Fixed earthen pot (Surahi)

Plant of *D. sissoo*- March 2014

Plant of *A.procera* - March 2014

(xxiii) Integrated nutrient management for improved growth of trees on overburden dumps

Shivpuri open cast mine-1 was selected for taking up the experiment. Field visits were conducted to Shivpuri open cast mine-1 for collection of overburden samples and the samples were analyzed for its physico-chemical properties *viz*, texture, bulk density, pH, electrical conductivity (EC), organic carbon, available nitrogen, phosphorus, potassium, cation exchange capacity, exchangeable calcium, magnesium and available micronutrients. Plantation was done with 10 tree species. Leaf samples were analysed for nitrogen, phosphorus and potassium (NPK). Physicochemical analysis of overburden dump showed nutrient status of the spoil increased gradually with the increase in age of the plants with respect to EC, organic carbon and available N, P, K. Combined treatment with farm yard manure (FYM), vesicular arbuscular mycorrhiza (VAM) and NPK showed good result in survival of *Gmelina arborea, Mangifera indica, Moringa oleifera, Cassia siamea* and *Emblica officinalis.*



Seeds collected from different CPTs of *Buchanania lanzan* (chironji)

***B. lanzan* seedlings**

(xxiv) Development of Lac based Agroforestry (Silvi- Agri-Lac) system

Efforts were made to revive the plants of *F.semialata* with the application of organic manure FYM @ 1 kg/plant and vermicompost @ 500g/plant to the *F.semialata* and *F.macrophylla*. It shows the positive impact on the growth of *F.semialata* and it indicates that the plants need irrigation during excessive heat in the summer season and avoid waterlog situation because both the species i.e *F.semialata* and *F.macrophylla* are sensitive to these extreme conditions. Procured broodlac of kusumi strains from the Kanker forest department and inoculated on the succulent branches of the species in the month of January. Lac insects started emerging and settled on the respective branches but due to the heavy and

continuous rains which extended upto the month of August – November of current year resulting to the damage of lac crop . The recorded growth data of species revealed gradual increase in height - maximum 2.5m in *F.semialata* and 2.4m in *F. macrophylla* and intercropped with oleri crop viz. *Lycopersicon esculentum* as summer crop. The system is maintained with regular irrigation and other cultural operations. Data for nutrient status of soil was monitored at quarterly interval. Results indicates increasing level of the nitrogen ranged from 235.4 kg/ha to 247.4 kg/ha, Phosphorus 7.94-8.11kg/ha, Potassium 86.98- 185.8 kg/ha and pH value ranged 6.92 – 6.95 during 2012 and 2013 respectively.

Raising of seedlings for casualty replacement

Seedlings ready for transplantion *F.semialata*

Flemingia intercropped with oleri crop

Flemingia intercropped with oleri crop

Flemingia intercropped with agri crop

Lac crop on *Flemingia macrophylla*

(xxv) Evaluation of *Madhuca indica* based silvi-agri system in arid and semi arid region of India (AICP project)

Grafted plants and seedlings of *M.indica* were transplanted in the experimental area of TFRI during July, 2012 and growth data on survival % was recorded. Data revealed 50% survival of grafted plants as compared to seedlings. Experiment was conducted to revive the grafted plants one with the application of organic manure but thay exhibited very poor growth performance (18 cm in height) as compared to seedlings(30 cm). Data of growth and nutrient status at the initial stage of the study and

one year after its plantation were recorded. Data indicates that all the parameters of soil were decreased from the initial stage i.e pH value from 8.36-7.96, EC value 0.25-0.21 but OM value increased from 0.86 to 1.376, N and 169.34-287.89.

Grafted plants of *M.indica*

One year old grafted *M.indica* at OSR, TFRI

(xxvi) Development of Silvi-agri-medicinal and agri-medicinal system in Vidharbh region of Maharashtra.

For the establishment of Silvi-agri-medicinal and agri – medicinal system, two sites viz., farmer's field at Katoli-bahmni village of Chandrapur was selected as an OFR and experimental area of agroforestry division was selected as an OSR. Site was prepared by tractor ploughing and pits were dug to transplant the root-shoots of the *Gmelina* (silvi crop) plants at the 5m x 5m spacing in 7 treatments with three replications in the month of June,2013. But due to the excessive rainfall (20% excess in Chandrapur district) recorded during June - July of current year, 70-80% of root shoots were washed away. Nevertheless, the plants of Gmelina were again transplanted in the month of September 2013 and seedlings of *R.serpentina and Withania somnifera* in three replications and rhizome of *A.calamus* at two spacing of 30cm x 30 cm and 45 cm x 45cm were transplanted as an intercrop in the interspaces of Gmelina seedlings and with *Oryza sativa*. Data on survival and growth parameters were recorded initially at monthly intervals which shows the 80% survival of Gmelina and only 20% of *R.serpentina* and *W.somnifera* . *A.calamus* crop is also performing well. The system is being maintained by weeding and timely irrigation at both the sites.

Pit Digging and staking before plantation at site

Farmer at his farm with *Gmelina* seedlings, Chandrapur district

Layout of the Agri-medicinal system in Paddy field

Raising of rhizomes of *A.calamus* intercropped with *Oryza sativa* at OFR,Chandrapur (M.S.)

W.somenifera at OFR

Scale leaves of *A.calamus* at OFR

Six month old *Gmelina* intercropped with *R.serpentina* at TFRI campus

A.calamus at OSR,TFRI, Jabalpur(M.P.)

Cajanus cajan intercropped with *Gmelina*

Fruits of *R.serpentina* grown in the system

(xxvii) Empowering Tribal Community Through Lac Cultivation in Madhya Pradesh

Farmers of the selected sites of Jabalpur district were motivated and trained towards adoption of lac cultivation. Experiment was conducted to cultivate lac as baisakhi crop of rangini strain after the pruning of lac host trees i.e. *Butea monosperma and Zizyphus mauritiana* existing in farmer's field. The data was recorded and phunki removed and the lac was scrapped. Excessive rain and unfavourable weather conditions adversely affected the crop growth however, the crop is maintained and data shows 30% survival of the crop. Simultaneously, broodlac of kusumi strain was also cut and inoculated on the remaining branches of the *S.oleosa* as aghani crop in study site. Village profile was prepared and the data of farmers field was recorded. The crop is maintained and monitored through constantly motivating the farmer towards conservation and protection .

Training of pruning of lac host trees

Quality broodlac

Broodlac sticks

Preparation of bundles of broodlac

Baisakhi strain on the new shoots

New lac crop growing on the host

(xxviii) Biological control of teak leaf skeletonizer *Eutectona machaeralis*.

Different compartments of Choral Range of Indore Forest Division were surveyed. Large scale epidemic defoliation of leaf skeletonizer in teak forests was observed. Recorded presence of larvae and pupae of defoliator and leaf skeletonizer in teak trees. Observed plenty of adult moths of leaf skeletonizer on ground flora and natural enemies of teak pests, such as larval parasitoid, entomopathogenic fungus (EPF) and insect predator. Release of biocontrol agent, *T. raoi,* @ 1.25 lakh ha^{-1}, effectively reduced the larval, pupal and adult population of teak leaf skeletonizer in TFRI Tricho cards released sites of teak forests. Further, it was observed that good leaf flushing in most of the teak trees growing in TFRI Tricho cards released sites. These findings clearly demonstrated the potentiality of egg parasitoid, *Trichogramma raoi*, as biocontrol agent for management of teak pest.

3. ***Biodiversity Conservation and Ecological Security***

(i) Investigation on floristic diversity in teak plantation of various age groups in Barnwapara Project division, Raipur, Chhattisgarh.

Plantations promote understorey regeneration by shading out grasess and other light demanding species, changing under storey microlimates, imporving soil properties and increasing vegetation structural complexity. Studies were carried out to determine the changes in plant diversity and soil properties in teak plantations of different ages. Phyto-sociological studies were undertaken in teak plantations by laying out quadrats in 25 compartments of Rawan, Raikera and Sirpur Range of Barnawapara project division, Raipur Chhattisgarh. 48 trees, 12 shrubs abd 36 species of herbs were recorded from these plantations.

The results indicate species richness and diversity in tree layer of the plantations increases with the age of plantations. The compartment wise dominant trees of Rawan range are *Tectona grandis, Lagerstroemia parviflora, Cleistanthus collinus, Terminalia tomentosa, Buchanania lanzan, Pterocarpus marsupium, Madhuca indica, Diospyros melanoxylon, Anogeissus latifolia, Bridelia retusa, Semecarpus anacardium, Schleichera oleosa, Lannea coromandelica, Terminalia bellerica, Careya arborea, Cassia fistula, Grewia tiliifolia, Ziziphus xylopyra* and *Bauhinia pururea.* In Raikera range dominant tree species are *Tectona grandis, Largerstroemia parviflora, Anogeissus latifolia, Diospyros melanoxylon*, *Cleistanthus collinus, Madhuca indica, Chloroxylon swietenia, Lannea coromandelica* and *Wrightia tinctoria*. In Sirpur range, compartment wise dominant species are *Tectona grandis, Chloroxylon swietenia, Largerstroemia parviflora, Terminalia tomentosa, Anogeissus latifolia, Madhuca indica, Cliestanthus collinus, Gardenia latifolia* and *Bridelia retusa.*

Team at work in Barnwapara forest division

Teak plantation with under growth in Barnwapara

Species richness and diversity in herb layer was found to be higher in younger plantations. Physico-chemical properties of soil collected from different aged plantation were analysed however, there was no significant impact on the physico-chemical properties of soil. The project is completed report writing is in progress.

(ii) Population dynamics of threatened medicinal plants species growing in Buffer and Transition zone ofTadoba –Andheri Tiger Reserve

Matrices have emerged as an important tool to study age structured populations. Simulation and elasticity analysis for population projection matrices help us predict the fate of populations. The population dynamics of endangered species will help in devising effective conservation strategies. The study is being undertaken on population dynamics of two vulnerable species growing in the buffer region of Tadoba Andheri Tiger Reserve.

For the selection of species, surveys were conducted in the villages of buffer zone of Tadoba-Andheri Tiger Reserve. Medicinal plant harvested by the villagers and local traditional healers were enlisted. Information on the availability of the medicinal plants was also gathered. Based on the survey two medicinal plants viz., *Uraria picta* and *Andrographis paniculata* were selected for the study.

Density of *Andrographis paniculata* and *Uraria picta* in the study area was determined using adaptive cluster sampling. Populations were identified for the study. Permanent plots were marked in belt transect along the gradient in the identified populations. Five permanent quadrats were laid in each population (9 populations). All the individuals in the sample were marked, and monthly growth data was recorded from each quadrat. Seed production of marked individuals in the population was determined, soil samples were collected and analysed for the physicochemical properties. Experiments to determine seed viability and soil seed bank is being carried out. Population growth rate will be determined using matrix projection models

Marking of permanent plots for the study

Collection of growth and survival data

(iii) Monitoring the impact of Climate variables on plant diversity in Bhimashankar permanent plot of Sub-tropical hill forest of Maharashtra

One of the goals of the ecology is to study the succession in the forest community and predict future trends. Premanent preservation plots provide such an opputunity. Studies were conducted on vegetation parameters in Bhimashankar permanent preservation plot of Sub tropical hill forest of Maharashtra. Enumeration of vegeation was carried out in three permanet preservation plots. 30 quadrats of 20x20 m were laid out for the enumeration of the vegetation in 3 preservation plots. 120 quadrats (5mx5m) laid out for the study of shrubs and saplings along with invasive species. 120 quadrat (1mx1m) were laid out for herbs and grasses occuring in the preservation plots

Maytenus rothiana

Lasiosiphon eriocephalus

Xantolis tomentosa

Callicarpa tomentosa

Fig. 3. Prominent flora found in compartment 200A of Bhimashankar

Vegetation change matrix determining temporal change in the structure and composition of the vegetation in preservation plots of Bhimashankar was prepared. 14 new species (with no historical record) were recorded from the preservation plot. Regeneration status of dominant trees was determined using size class distibution curves. Based on the study Succession trend and future trends in vegetation pattern of the preservationplot was determined. Project is completed and report writing is in progress.

(iv) Study on Indigenous Knowledge and documentation of extent of utilization of herbs in folk medicines prevalent in tribal pockets of Madhya Pradesh.

The study has been initiated in seven agro -climatic zones in MP viz., 1) **Kymore Plateau zone** : in districts of Satna and Panna , 2) **Satpura Hills zone** : in districts of Jabalpur & Seoni , 3) **Central Narbada Zone** : in districts of Sehore (Budni Tehsil) & Hoshanagabad. 4)in **Vindhya Plateau zone** : in districts of Sehore (except Budni) & Bhopal , 5) in **Bundelkhand zone** : in district of Chhattarpur , 6) in **Malwa Zone** : in district of Dewas , 7) in **Satpura Zone** in district of Chhindwara which are habited by ethnic communities such as Kol, Mawasi, Raj Gond, Gond, Bhilala, Pardhi .In districts 4-5 clusters are selected as sampling stage 1 having predominance of tribal and nontribal communities identified within each cluster for sampling 15-20 respondents in 6-8 villages in a cluster .These villages are identified with help of district forest officials based on purposive sampling which comprises of collecting information from Vaidyas and local community (both tribal and non tribal residing in village on 1) existing flora, species overexploited and at verge of extinction, ii) plant parts used in herbal medicines- name of indigenous flora local and scientific name, iii) formulations prepared , dosage in cure of ailment , iv) information from local community for utilisation of plants (in JFM /protected /PPA's and other areas) and collection methods of plant parts , v) method of collection /harvesting of local flora. The field survey is being conducted with following tools for documenting information :

Questionnaire method by preparation of schedule and recording of information from primary data; **Recording information from secondary data** : through past history, from working plan of forest dept and other sources .; **Interview with Structured / Semi structured questionnaire and Focused Group Discussion** method is being used for collecting information at group level per village. The presence of community leader's impedes participants in expressing their views and opinions. Moreover, assets and perceptions may be different amongst individuals. Therefore it was important to supplement this information collected from group discussions with surveys at household level. The group discussions will be organized with help of the local organisations as Village gram panchayat , JFM Society , although the whole village will be invited, for the participation .

Local and scientific names of plants, family along with plant parts as roots, rhizomes , leaves , bark, flowers , fruits , gum , panchang formulations prepared as powder, decoction , paste, juice etc, dosage etc comprising of 95 uses from 68 plants of local flora existing were recorded in cure of ailments which were orally communicated by 28 Vaid Raj used in cure of Fever, Malarial fever , skin infection (itching, white spot , scabies) , diabetes menstruation problems in females , joint pain , arthritis, ear pain , headache , tooth pain , sciatica leucorrhoea, heart problems , jaundice , piles, baldness, blood clotting, diarrhoea, dysentery, intestinal worms etc

There is high demand in trade of species 32 plants in Chhatarpur district are hence weekly collected out of which 12 species are collected at the rate of 100 gms/per week are Jatropha (Ratan jot leaves , and seeds), Bark of Neem , Arjun, Roots and leaves Gudmar ,Gatarn and Giloy , Seeds of Malkangni, fruits of Beal, Baibidang , gum of *Boswellia serrata*; less than 250 gms of Kali Musli ; more than 500 gms rhizome (kand) of Keokand, Bilarikand , Chitrak , Maida chal (bark) , Kahira , Shivlingi , seeds of Bavchi (*Psoralea cordifolia*)Aonla, Harra, Baheda, Nagar Motha, safed Musli, Palas bark and flower etc. from more than 10 kms away . Similarly in Satna district weekly collection form a distance of more than 10 kms radius and quantity less than 100 gms species collected are Amarbeal ,Gudmar ,Rasna ,Harsinghhar Kullu gum , whereas species collected between 250-500gms are Ghritkumar and Munj ; whereas species collected between 250 gms to 500 gms are Kemanch , Palas bark , Rohan , Arjun bark, species collected more than 500 gms Dhawa Palas , Khair and Beal.

Threat status in forest of species **Over exploited** : in Chhatatrpur district : Safed Musli , Kali musli , Kahira ,Satavar, Giloy ,Gattaran , Keokand, Bilarikand , Chitrak , Maida chal (bark) , Kahira , Shivlingi , seeds of Bavchi ; in Satna district Safed Musli , Kali musli and Palas , whereas species **At the verge of extinction** in Chhatatrpur district are Arjun , Vajradanti, Bechandi, Tikhur , and in Satna district are Malkangni Tikur, Satavar, Safed Musli, Harar, baheda, Kemach and Kali musli. The above study is still in progress as ongoing study ..

Safed Musli - Shakti vardhak

Kartoli kand - Scorpio sting

Diwakand - Joints pain

Mungus kand

Gulabi kand – removal of unwanted hairs

Takiya Kand : Anemia, Joint pains, Tuberculosis

Malkagni - Rheumatic pain

Hulda Kund Female Conceptoion ,TB

Kishan garh _ Chhattarpur

(v) 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

Study on seed maturation on *Boswellia serrata* shows that germination was best after full maturation at 68 DAA, when the color of the fruit is light brown and seed was brown with moisture content of about 2-3%.

Study on seed maturation on *Sterculia urens* shows that germination was best after full maturation at 75 DAA, when the color of the seed was grey with moisture content of about 16%.

Boswellia serrata seeds can tolerate up to 4-5% moisture content and *Sterculia urens* seeds can tolerate 2-3% moisture content; therefore they can be considered as orthodox seeds.

However, viability of seeds of *Saraca indica* was lost if dried to 20% moisture content. Seeds may be of recalcitrant category, further investigation is needed.

Seeds of *Sterculia urens* stored at all conditions were viable, thereby no deterioration occurs till six months of storage.

Effect of temperature, light quality and type and depth of soil on germination of *Sterculia urens* was evaluated. It was observed that white light was best for germination of seeds of this species. The seeds can germinate in 25-40°C temperature. The seeds can germinate better on the surface of the mixed type of soil.

4. Forest and Climate Change

(i) Soil, Vegetation – Atmosphere Carbon Fluxes Measurement and Modeling (SVF) Project

The Indian Institute of Remote Sensing (IIRS) has undertaken a National Carbon Project (NCP) under Geosphere Biosphere Programme (GBP) of the Indian Space Research Organization (ISRO) to estimate the carbon pools and fluxes in different terrestrial ecosystems of India. The project invisage temporal inventory of the forest and soil carbon stocks as well as measurement and modelling of carbon exchange along atmosphere-vegetation boundary. Six carbon-flux measurement towers using eddy covariance techniques are installed in five major forest types of the country. Betul (teak forest) in Madhya Pradesh, is one of them. Periodic data from the tower is being recorded. Soil samples were collected and analysed for soil moisture(%), soil carbon(%), EC, pH, N, P and K. Litter production and decomposition was detrmined. Biomass of herbs, shrubs was recorded. Phytosociological studies were undertaken in the study area. Leaf Area Index (LAI) of 10 major species was mesured using Ceptometer LP-80 and data of phenology of 10 major species were recorded.

Collection of herb shrub biomass, litter collection and litter decomposition bag

Measurement of LAI using ceptometer LP-80

(ii) Utilization of Automatic weather station/Agrometeorological station data for agriculture, forestry and hydrological applications in Madhya Pradesh.

This is a multi-institutional project coordinated by Space Application Centre (ISRO), Ahmedabad, with the objective to quantify energy and carbon exchange using field measurement and remote sensing data in different ecosystems of Madhya Pradesh.

In the 1st phase of the project, developed allometric regression equations for quantification of carbon in *Shorea robusta* trees by non destructive method. Selected sites near AWS and AMS installed in Kanha, Bandhavgarh and Madhav National Parks of M.P. and collected data on seasonal variation in grass biomass, soil moisture profile, Specific Leaf Area (SLA) and Leaf Area Index (LAI).

In the 2nd phase, laid out 11 quadrats of 0.1 ha size each in Pench, Panna and Satpuda Tiger Reserves of M.P. on the basis of floral diversity and canopy density. Regularly collected growth data of the trees found in the selected quadrats and observed seasonal variation in herbaceous and litter biomass and soil moisture profile. In Panna Tiger Reserve Teak, Kardhai, Khair, Salai-Teak mixed and miscellaneous forests were found. 388 trees of 24 species were recorded in the selected quadrats. Average GBH of the selected trees in the laid out quadrats was found to be 64.2 cm, whereas average height was calculated to be 14.1 m. Major tree species were found to be *Tectona grandis, Acacia catechu, Anogeissus pendula, Chloroxylon swietenia, Zizyphus xylopyrus* and *Boswellia serrata.* In Pench Tiger Reserve miscellaneous, Teak and Palas dominating miscellaneous and Gerari forests were found. A total 477 trees of 34 species were recorded in the laid out quadrats. Average GBH of the selected trees in the laid out quadrats was found to be 66.8 cm, whereas average height was calculated to be 17.3 m. *Tectona grandis, Pterocarpus marsupium, Buchanania lanzan, Syzygium cumini, Zizyphus xylopyrus* and *Chloroxylon swietenia* were the abundantly available tree species. In Satpuda Tiger Reserve Sal and Teak dominating miscellaneous and teak forests were found. A total 553 trees of 35 species were recorded in the laid out quadrats. Average GBH of the selected trees in the laid out quadrats was found to be 69.4 cm, whereas average height was calculated to be 13.9 m. *Shorea robusta, Soymida febrifuga, Diospyros melanoxylon, Emblica officinalis, Hardwickia binata, Saccopetalum tomentosum, Chloroxylon swietenia* and *Gardenia latifolia* were recorded as the major trees species of Satpuda Tiger Reserve.

Kardhai forest in Panna Tiger Reserve

Collecting litter in Satpuda Tiger Reserve

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

Surveyed and selected sites in and around Rourkela Steel Plant (RSP), Odisha for vegetation survey, collection and analysis of soil samples and quantification of carbon in vegetation, litter and soil. Laid out quadrats in the plantations raised by RSP for trees, shrubs, herbs, and regeneration status of trees. Also laid out quadrats for litter and deadwood. Conducted soil profile study at the site, where a 10 acre plantation has to be raised under the project. Monitored atmospheric CO_2 at 15 sampling locations in and around RSP in the first season of the first year.

Conducting vegetation survey at Rourkela Steel Plant

Conducting soil profile study at Rourkela Steel Plant

5*. Forest Genetic Resource Management and Tree Improvement*

(i) Studies on development of *in vitro* regeneration system for *Albizia procera* (Roxb.) Benth.

Up to the last year (2012-13) the first three objectives i.e. development of *in vitro* regeneration system, histological and biochemical investigation at various steps during *in vitro* regeneration and acclimatization and hardening procedure for regenerated plants was achieved. The brief asummary is as follows.

The *in vitro* shoot proliferation from nodal explants occurred on MS medium supplemented with 5µM BAP and 1µM IAA. The leaflet explants of *A. procera* regenerated callus on MS medium supplemented with 2.5µM 2, 4-D, and the *in vitro* adventitious shoots on MS medium supplemented with 0.25µM BAP and 0.25µM IBA. The *in vitro* raised shoots induced adventitious roots on B_5 medium supplemented with 3µM IBA. Changes in soluble sugars, phenols, nitrate reductase activity and peroxidase activity drive cellular differentiation and organization for *de novo* formation of adventitious shoots from leaflet explants. Soluble sugars acted as source of energy and carbon skeletons for synthesis of *de novo* biomolecules, phenols as lignin precursors for cell wall via peroxides' activity and nitrate reductase activity for input of reduced nitrogen during *de novo* formation of adventitious shoots from leaflet explants. Histological investigations established that *de novo* adventitious shoot formation on leaflet explants commenced only after 60d of inoculation and was a continuous cyclic process due to organization of apical meristem at different developmental stages on several locations of leaflet surface. Biochemical changes were complimentary to histological events during *de novo* formation of adventitious shoots from leaflet explants. The plantlets were hardened by sequentially maintaining on ½ strength of MS basal inorganic medium in (i) culture room for 35d on sand and (ii) shade house for 7d in potting mixture of sand soil and FYM in 1:1:1 ratio. For the year 2013-14, fund is released in the last week of January. Screening of commonly used DNA extraction methods is under progress for *A. procera* to select the best suited one.

(ii) Technology to regenerate/multiply mahulpatta for getting higher production

In the selected site of Keonchi air layering of climbers was carried out. Climbers were selected in best and degraded sites both. Five air layers were made in each quadrate. After three months the data on root formation was recorded. Out of 50 air layers, 23 green and healthy branches were cut below air layers and brought. Only 3 branches exhibited rooting. Stem cuttings were collected from Keonchi Range (Marvahi) and treated with auxins/non auxins viz., IBA, IAA, NAA, Thiamine and piperazine (0, 2, 4 and 6 mM). Out of 20 cuttings per treatment data of 10 cuttings were recorded randomly. Sprouting in cuttings was observed after 15 days of experiment. The sprouts died after 1 month and no rooting was obtained in the cuttings.

A two-way factorial experiment was conducted to standardize nutrient medium and GA_3 concentration for *in vitro* shoot multiplication and elongation. Four nutrient media, viz., MS, WPM, NN and B5 along with three concentrations of GA_3 (0, 1 and 2 µM) were tried. The effect of only GA_3 was found to be significant on shoot formation percentage whereas nutrient media did not show any effect on percent shoot formation. Two-way factorial experiment was conducted to standardize concentration of TDZ and auxins for callusing on seed cotyledons. IAA and 2,4-D produced maximum callus. Different cytokinins had a significant effect on number of shoots after 15 and 30 days of inoculation. TDZ was

screened out to be the most effective cytokinin. The effect of adenine sulphate, glutamine of four different concentrations and their interaction was found to be significant on number of shoots after 15 and 30 days of inoculation.150 mg l^{-1} adenine sulphate (1.16) and 200 mg l^{-1} glutamine (1.04) produced maximum number of shoots. Maximum shoots were obtained on interaction of 150 mg l^{1}each of adenine sulphate and glutamine. A two way factorial experiment was conducted to standardize auxins and their concentration for rooting. Four auxins viz., IBA, IAA, NAA and Coumarin in two concentrations (10 and 20 µm) were tried. Rooting was obtained on 10 µM NAA.

Fig 1. Rooting in Mahul cuttings collected from Keonchi and treated with 1000 ppm IBA and 800 ppm thiamine.

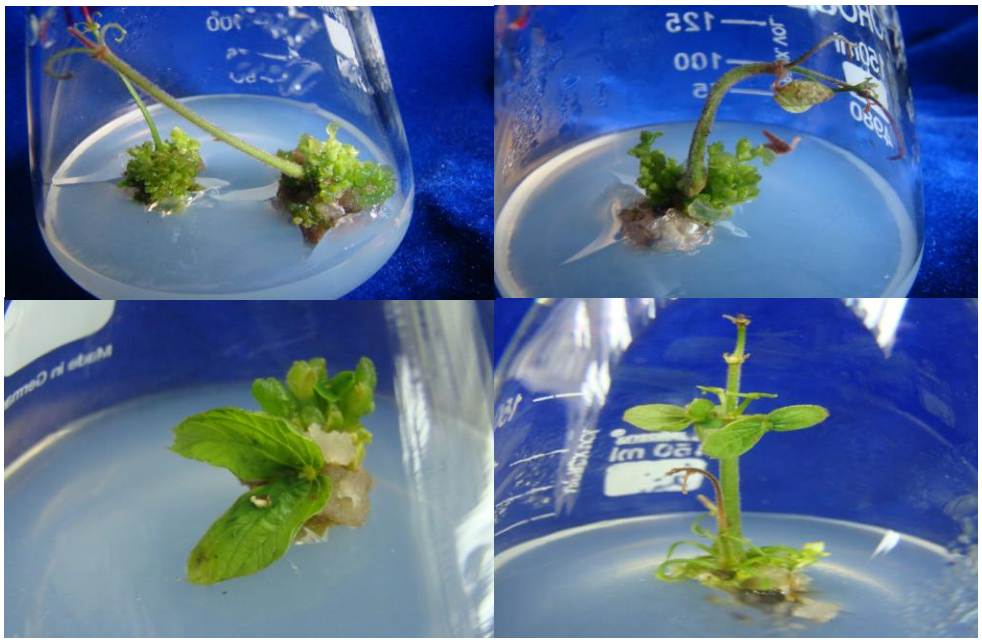


Fig 2 :Shoot multiplication and elongation of mahul on MS medium supplemented with1.0 µM TDZ.

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

The highest *in vitro* rooting of 81.67% and maximum number of roots (7) was obtained with GO-MN accession on ½ B5 medium. The hardened plantlets were transferred to the field

Fig. Field trial of five genotypes of *Rauvolfia serpentina*

for trial comprising *in vitro* and seedling raised plants of five genotypes. The samples are to be collected from the trial for estimation of reserpine.

(iv) Selection and cloning of superior germ plasm of *Diospyros melanoxylon* from Chhattisgarh. (a sub project of "Standardization of technique to enhance the quality and sustainable production of *Diospyros melaoxylon* leaves in Chhattisgarh")

The cuttings collected from Lohattar were tried for rooting. The single node cuttings were treated with following treatments. Control and 5mM each of IAA, IBA and NAA. The cuttings maintained in mist chamber and sprouting data were recorded after 2 months. Sprouting was recorded with maximum of 39.19% on control, which was on par with IAA and significantly different from other two treatments (Table). The nodal segments were tested for different doses of $HgCl_2$ and duration of treatment using MS medium with 10 µM BA. A non-significant data was obtained for aseptic culture establishment, however, the maximum response was obtained with 0.2% $HgCl_2$ and 10 min treatment duration (Table 2). No sprouting was noticed. Five media (MS, WPM, B5, NN and SH) and different doses of BA (0, 0.1, 1.0, 10 µM) were evaluated for aseptic culture establishment. No significant difference was obtained. No sprouting was noticed (Table 3).

LSD NS

Table 1. Sprouting % of stem cuttings

Treatment	Sprouting %
To- Control	39.19
T1- IAA(5mM)	33.86
T2- IBA(5mM)	30.97
T3- NAA(5mM)	24.84

LSD 7.16

Table 2. Aseptic culture (%) under different doses of $HgCl_2$ after 45 Days of inoculation.

HgCl2 Conc.	Duration			Mean
	5min.	10min.	15min.	
0.05%	63.44	81.11	81.11	75.22
0.1%	76.89	81.11	68.05	75.35
0.2%	81.11	89.95	89.95	87.00
Mean	73.81	84.05	79.70	

Variable	$C.D._{(0.05)}$
HgCl2(A)	NS
Duration(B)	NS
A*B	NS

Table 3. A**septic culture (%) in different basal media and BA treatments after 45 Days of inoculation.**

Conc. of BA(uM)	Medium					Mean
	MS	WPM	SH	NN	B5	
0	51.14	25.79	30.78	39.23	30.78	35.54
0.1	51.91	30.78	13.11	8.88	26.17	26.17
1	21.94	43.07	30.78	21.94	43.07	32.16
10	38.85	8.88	30.78	21.94	16.95	23.48
Mean	40.96	27.13	26.36	23.00	29.24	

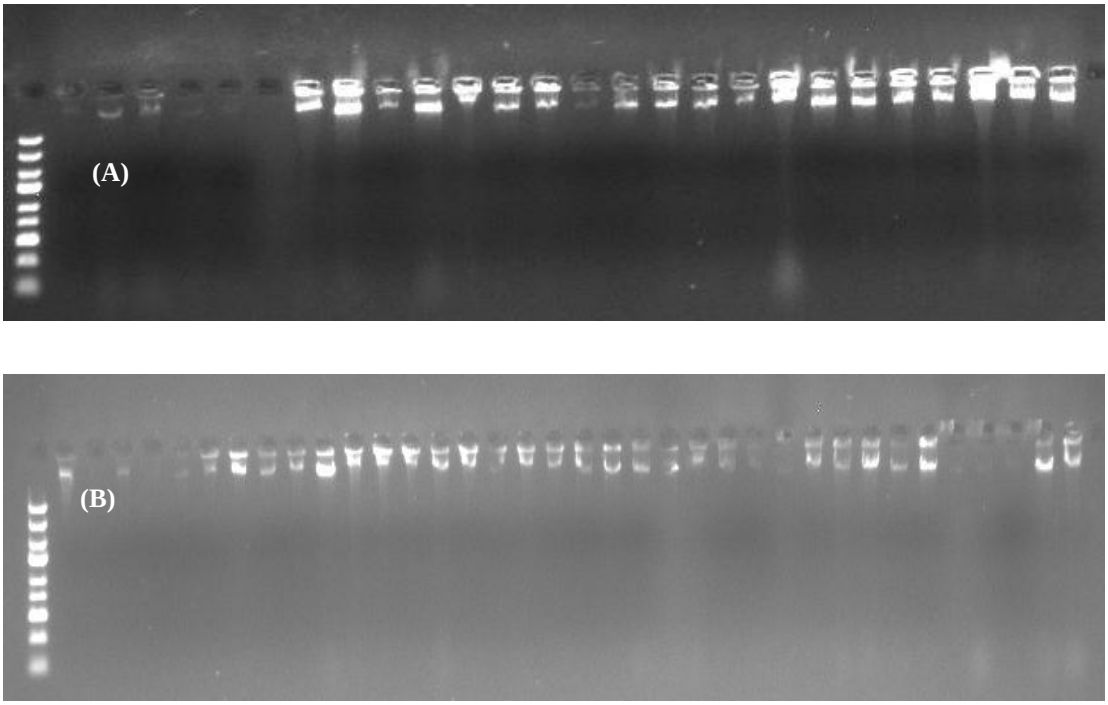
Variable	$C.D._{(0.05)}$
BA	NS
Medium	NS
BA*Medium	NS

(v) Studies on assessment of genetic diversity and structure of *Boswellia serrata* Roxb. populations through RAPD and ISSR molecular markers.

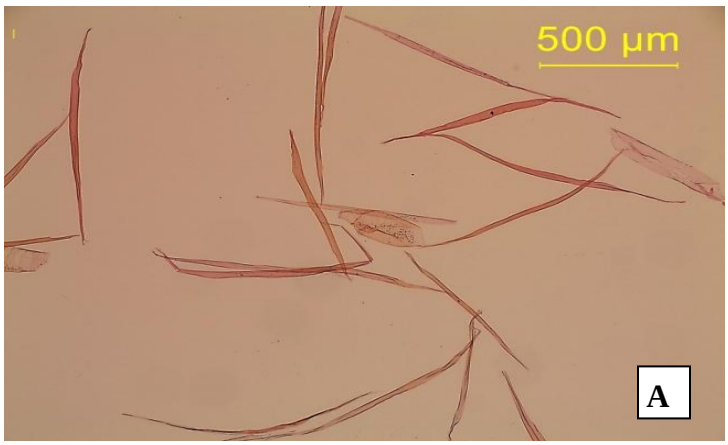
DNA samples from 12 populations of M.P. were analyzed for their purity index. Results reveal that the quantity of genomic DNA is higher than 2000 µg in 1 gm of leaf sample of all the populations. Genomic DNA was also checked qualitatively on 1% agarose through gel electrophoresis. No contamination of proteins and RNAs was found.Wood core samples collected from 20 trees of 12 populations of M.P. were macerated for fibre length analysis. 5 slides were prepared from each wood core sample and length of 5 fibres was measured from each slide. Total 25 fibres were measured from each tree and 500 fibres were measured from each population. A considerable variation in fibre length was noted which ranges from minimum 887 µm (Mandla and Sheopur) to maximum 1560 µm (Rewa).

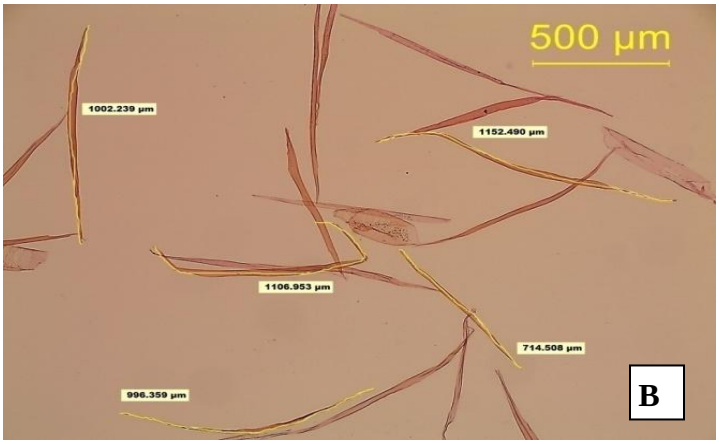
Table: Purity index of DNA and wood fibre length

Sl. No.	Population name	DNA Purity Index	Average length of fibres (in µm)
1.	Rewa	1.6	1560
2.	Mandla	1.6	887
3.	Shivpuri	1.6	1038
4.	Damoh	1.6	1000
5.	Dumna (Jabalpur)	1.7	954
6.	Khandwa	1.7	900
7.	Panna	1.7	1031
8.	Chhatarpur	1.7	1068
9.	Gwalior	1.6	967
10.	Sheopur	1.7	887
11.	Chhindwara	1.7	1072
12.	Balaghat	1.7	1004



Genomic DNAs of (A) Rewa and Mandla populations, (B) Shivpuri and Damoh populations





Measurement of wood fibre length in 5X magnification using Leica microsystem EC 3
(A) Wood fibres in unmeasured form (B) Measured wood fibres

(vi) Germplasm collection and *exsitu* conservation of *Pterocarpus marsupium* Roxb

The work of germplasm collection has been completed in Parvi (20 trees) (Range Bhanupratappur), Baisgaon (20 trees) (Range Antagarh), Tadoki (20 trees) (Range Antagarh), Balod (6 trees) (Durg Range), Hati (20 trees) (Dhramjaygarh Range, Raigarh), Baraudia (20 trees) (Range Bilaspur), Gurda (20 trees) (Range Kharsia). The seeds collected from above localities were sown and data are being collected fortnightly and to be analysed. Seedlings of each tree is being maintained in the nursery of the Genetics division. The bark samples were utilized to record dry weight biomass stored in oven at 70^0 C to record the dry biomass. Cotyledon explant responded 83% callus in the medium supplemented 5 µM BA and 2,4-D. The shoot regenerated only from the medium supplemented with 1.0, 2.0 and 5.0 µM BA. Callus cultures are further proliferated for organogenesis.

Marking, selection of trees of bija and collection seeds in Hati Dharamjaygarh range

(vii) Collection of germplasm of *Madhuca indica* J. F. Gmel for identification of best sources in Chhattisgarh through phytochemical evaluation.

Survey and selection of trees was carried out at Balod, Bilaspur, Jashpur, Kanker and Jagdalpur. Mahua trees were selected from five girth classes, viz., 61-90 cm, 91-120 cm, 121-150 cm, 151-180 cm and over 181cm. Five trees per girth class were selected at each location. GPS location of trees was noted. Height, GBH and crown length of the trees was measured. Around 1-2 kg flowers and seeds per tree were collected. Fresh weight, dry weight and moisture content (%) of the flowers were recorded. Seed length, seed width and seed weight of 25 seeds per tree were noted. 100 seeds per tree were sown in 4 replications for production of seedlings. Sugar content of the mahua flowers was estimated (Dubois *et al*., 1951). A two-way factorial experiment was conducted to estimate sugar content (%) in different girth classes and trees of different locations (Bilaspur, Balod and Jashpur). Five girth classes (61-90 cm, 91-120 cm, 121-150 cm, 151-180cm and over 181cm) with five trees per girth class were estimated. Girth class had statistically significant effect on sugar concentration but individual trees did not have significant effect. For all the three locations (Bilaspur, Balod and Jashpur), highest sugar content was obtained in the girth class 121-150 cm and 151-180 cm. Individual trees and the interaction between trees and girth class from two locations (Bilaspur and Balod) exhibited significant effect for phenol concentration.The highest phenol content was obtained in flowers of girth class above 180 cm and 121-150 cm in Bilaspur and 121-150 cm and 61-90 cm in Balod. Saponin content is being estimated in seeds.

Mahua trees selected in Bhanupratapur and Jagdalpur

Variation in size and shape in fruits and seeds of Mahua collected from Bilaspur

(viii) Collection and characterization of critically endangered *Litsea glutinosa* germplasm from Madhya Pradesh and Chhattisgarh

Visited and carried out survey of Chhindwara (West) Forest & Balaghat (South) Forest division. In Chhindwara (West) Forest Division, Total 31 trees has been located and detailed morpho-metric data was recorded along with GPS location in specified format. Out of 31 trees, propagating material from 10 trees has been collected and established in the nursery of the division. From Balaghat (South) Forest division, Total 26 trees has been located and detailed morpho-metric data was recorded along with GPS location in specified format. Out of 26 trees, propagating material from 7 trees has been collected and established in the nursery of the division. In adjoining villages of (Piperdaha and Tikaria), total 03 trees has been located and morpho-metric data is not recorded yet. Propagating material from all three trees has been collected and established in the nursery of the division

Field survey in *Litsea glutinosa* Balaghat Forest Division

(ix) Selection of plus trees, raising their progeny trials and establishing germplasm bank (a sub project of "All India Coordinated Programme for genetic improvement of Teak".)

Rukad and Kurai range of Seoni (South) forest division was surveyed and seven CPTs were marked and data was recorded on them along with the 35 comparison trees in the prescribed format.

Marking of CPTs of Teak in Seoni(South) Forest Division

(x) Production of transgenic teak tolerant to defoliating pests (a sub project of "All India Coordinated Programme for genetic improvement of Teak").

Seeds were extracted from mature drupes collected from different teak trees, surface sterilized and germinated *in vitro*. A two way factorial randomized experiment was conducted to study the effect of different concentrations of GA_3 for treatment, different strengths of MS medium and their interaction on germination%. Significant effect of GA_3 treatments was observed on seed germination after 10, 15 and 30 days of inoculation **(Fig. 1)**.

Shoot explants from the *in vitro* germinated seedlings were multiplied in shoot induction medium. An experiment was designed to study the effect of different strengths of TDZ, different auxins (IBA, IAA and NAA) and their interaction on callus formation in the different explants obtained from the

seedling *viz.,* internode, leaves, roots and hypocotyls **(Fig.2)**. The effect of auxins, TDZ and their interaction on callus formation was found to be statistically non-significant. The type of explant used had significant effect on callus formation. Callus derived from the different seedling explants were regularly subcultured and multiplied in fresh callus induction medium for designing further experiments.

Fig. 1 : Effect of different MS strengths and GA_3 doses on *in vitro* seed germination in teak after 30 days of inoculation: (a) ½ MS and 0.1% GA_3 (b) Full MS and 0.4% GA_3

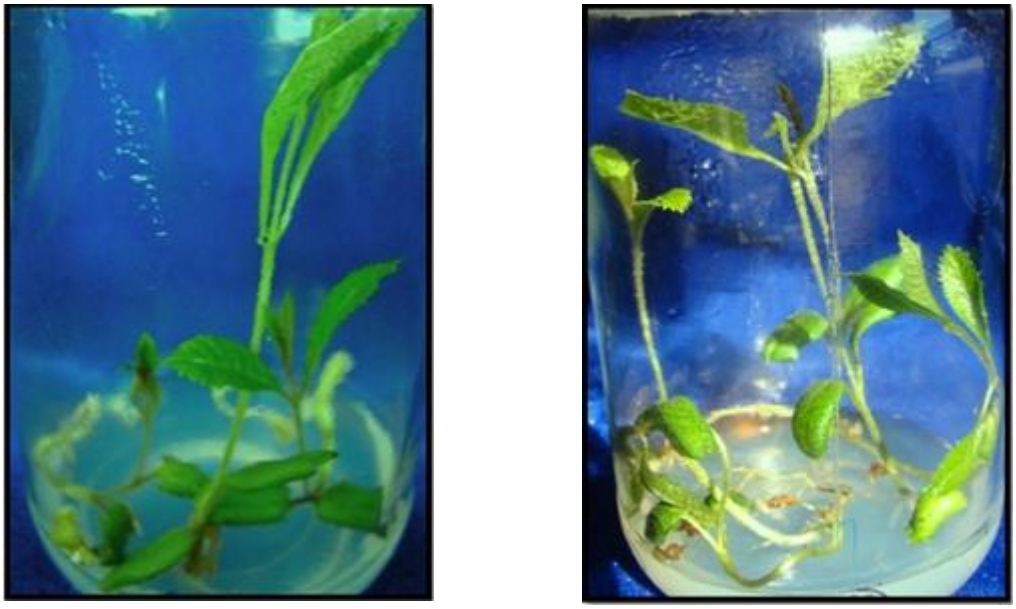
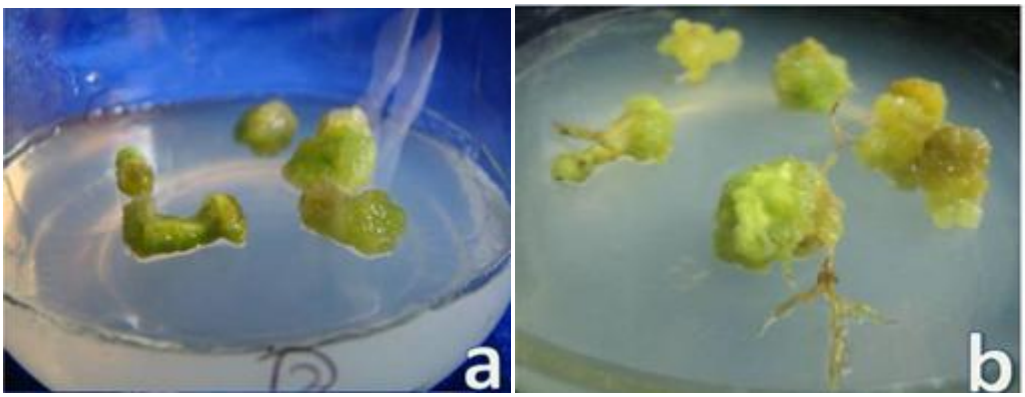
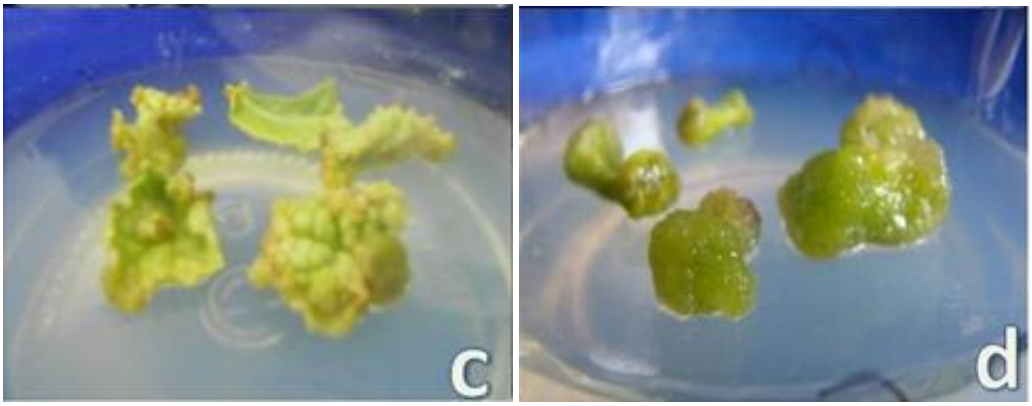


Fig. 2 : Callus formation in the different explants obtained from the seedlings *viz*., (a) **internode** in 0.1 TDZ and 0.1 IBA after 30 days, (b) **roots** in 1 TDZ and 0.1 IAA after 30 days, (c) **leaves** in 1 TDZ and 0.1 IBA after 15 days, and (d) **hypocotyls** in 1 TDZ and 0.1 NAA after 30 days of inoculation.





(xi) Studies on population structure, linkage disequilibrium and marker-trait association mapping of Indian teak (a sub project of "All India Coordinated Programme for genetic improvement of Teak").

Germplasm collection present at NTGB Chandrapur, Maharashtra was selected for pilot/baseline study. Cuttings and Leaf samples from 217 teak trees were collected for DNA isolation. Genomic DNA from 186 trees was isolated and 154 DNA samples were found suitable by quantity and quality for marker assay. Morph-metric data (Height and GBH) was recorded from 217 trees. Screening of Microsatellite primers is under progress.

A view of National Teak germplasm Bank Chandrapur (MS) and sprouting in collected cuttings from NTGB, Chandrapur for DNA extraction

(xii) Development of management practices of teak seed production areas, seedling seed orchards and clonal seed orchards. (TFRI & SFRI, Jabalpur) (a sub project of "All India Coordinated Programme for genetic improvement of Teak")

This project was started and is in initial phase

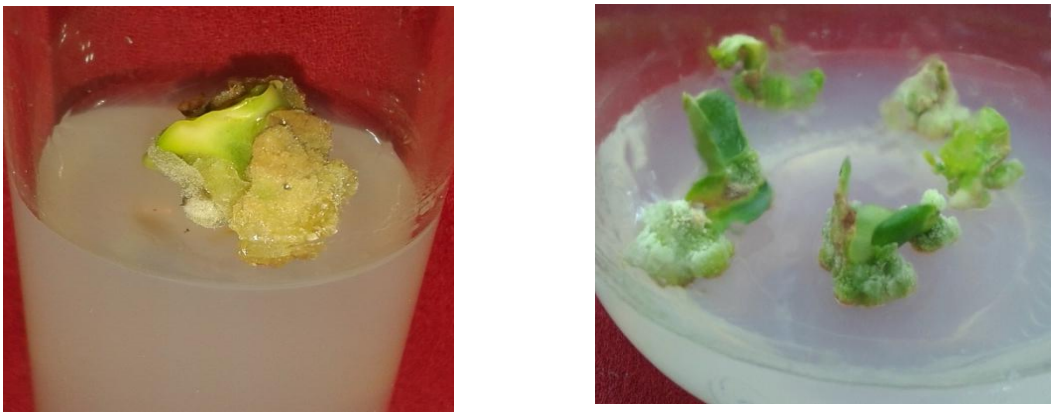
(xiii) Survey and selection of plus trees and establishment of progeny trials of *Dalbergia latifolia* (a subproject of "Genetic Improvement of *Dalbergia latifolia* Roxb. through selection and evaluation of germplasm in central India").

Field surveys were conducted in Kalpi, Udaypur and Seoni for selection of trees. Twelve trees were selected at different locations in Kalpi, three trees at Seoni and 7 trees at Udaypur. The morphological data on total height, clear bole height, GBH, crown diameter, number of primary branches, status of flowering and fruiting was noted. GPS data was also noted down. Half-sib seeds were collected from the trees.

Fig. Trees of *Dalbergia latifolia* selected in Kalpi (Mandla) and Seoni

(xiv) To refine existing micro-propagation protocols of *Dalbergia latifolia* for production of improved planting stock (a subproject of "Genetic Improvement of *Dalbergia latifolia* Roxb. through selection and evaluation of germplasm in central India").

Different cytokinins and 2, 4-D treatments were tested for *in vitro* callusing and organogenesis in immature seeds collected from Kalpi. Seeds collected from selected trees were germinated. Cotyledons of seeds collected from three different genotypes were tried for shoot formation. *In vitro* shoot cultures are being maintained.



Callus formation in immature seeds and cotyledons of *Dalbergia latifolia*

(xv) Comparative field performance of seedling and clonal planting stock of *Buchanania lanzan* Spreng.

Half sib progenies (fruits) of *Buchanania lanzan* were collected from thirteen selected plus trees. Before sowing, the seeds were soaked in cold water for 24 hours. 200 seeds of each family (plus tree) were sown in the polybags (size 10x8cm) filled with soil, sand and farm yard manure (FYM) in 1:1:2 ratio. Germination started after ninth day and completed in 21 days. Number of germinates were recorded everyday during the germination period. Maximum 75% germination was recorded for clone number 12 (Delakhari). Mechanical seed coat breaking pretreatment was also given to break the dormancy of one month old seeds. It was observed that maximum 80% and minimum 50% germination were recorded. Seeds of *B. lanzan* were kept in different environment condition i.e. poly house under shade, shade house and open condition. Germination on started seventh day and completed in twenty days in poly house under shade.

(xvi) Studies on the causes of *Gmelina* mortality in plantation of Madhya Pradesh, Chhattisgarh and its integrated management.

Literature regarding incidence of diseases in Gmelina plantation have been collected and list of important fungal pathogens responsible for cause of failure of plantation due to severity of diseases were recorded. It has been found that spp. of Hendersonula and *Phomopsis gmelinae* caused severe damage to the Plantation *of Gmelina arborea*

6. Forestry Education and Policy Research to Meet Emerging Challenges

6.1. Improving Formal Forestry Education-

6.1.1 FRI University (Applicable to FRI University only)

6.2 Accreditation of Universities: (Applicable to FRI University only)

6.3 Networking Forestry Education with Research and Extension

6.3.1 Participation in Seminar/Symposia/Workshop/Trainings

(a) Seminar/symposia

- Sanjay Singh and Dr. P.K. Khatri attended National seminar on Advancement and Recent Development in Tree Seed Technology to Enhance Forest Productivity held on 21-22nd February, 2014. Organized by Seed technology Division, State Forest Research Institute, Jabalpur
- Dr. Avinash Jain, Scientist E attended National Seminar on 'Recent advances in Applied Statistics & Its Applications in Forestry' and presented a research paper titled "Economic valuation of intangible benefits of tree plantations : A case study" at TFRI Jabalpur on 15-17 April 2013.
- Dr. Nitin Kulkarni attended VIIIth National Conference on "Biotechnology, Biodiversity and Environment", 19-20th April, 2013, New Science College, Rewa (M.P.) and delivered Invited Paper on "*Insect Pest Management options with special reference to biodiversity conservation: retrospect and prospect*" (Abstract Pp-26).
- Dr. N. Roychoudhury attended VIIIth National Conference on "Biotechnology, Biodiversity & Environment", 19-20 April, 2013, New Science College, Rewa (M.P.) and delivered lecture on "Achanakmar-Amarkantak biosphere reserve under world network of biosphere reserves".
- Dr.P.B.Meshram, Scientist-F participated in VIII National Conference on "Biotechnology, Biodiversity & Environment".Organized by Department of Botany & Biotechnology Govt. New science College, Rewa, M.P. on 19-20th April, 2013 and presented research paper entitled "Varietal resistance in aonla *Emblica officinalis* (Gaertn) to insect pests and diseases in Madhya Pradesh".
- Dr.P.B.Meshram, Scientist-F participated in National Seminar on "Contributions of Life Science in Human Welfare". Organized by Department of Botany, Biotechnology & Microbiology, Govt. P.G. College, Narsinghpur M.P. on 27-28th September, 2013 and presented research paper entitled "Biological control of insect pests of some important medicinal plants in Madhya Pradesh.
- Dr.P.B.Meshram, Scientist-F participated in National Seminar on "Advancement and Recent Development in Tree Seed Technology to Enhance Forest Productivity". Organized by S.F.R.I., Jabalpur on 21-22 February, 2014 and presented research paper entitled "Insect pests and diseases of fruits/seeds of *Buchnania lanzan* and their management".
- Dr. N. Kulkarni, Scientist-F delivered paper entitled "Use of probit analysis for toxicological experiments against forest insect pests". Paper written and presented in National Seminar on "Recent Advances in Applied Statistics and Application in Forestry (RAASAF)" April, 15-17, 2013 at TFRI, Jabalpur.

- Mrs. Tresa Hamalton attended national seminar on 'Tree Biotech 2013' held at IFGTB, Coimbatore from 23.9.13 to 24.9.13, and presented poster on 'Genetic variation studies in tree species using carbonic anhydrase isozyme analysis'.
- Smt. Neelu Singh, Scientist-E & Head, participated in National Seminar on "Research Advances in Applied Statistics and its Application in Forestry (RAASAF)" during April 15-17, 2013 as rapporteur
- RFRI National Seminar a) Rai (2014) " Promotion Of Bamboo based livelihood Oppourtunities through trade and Value addition" Abstract in National Seminar on Recent Advances on Bamboo Research and Development in India 6-7 Feb 2014 RFRI Jorhat . [6+1= 7]
- **SFRI National Seminar** a)Rai (2014)Phenological studies in *Azadirachta indica* A. Juss (Neem) an important tool for enhancing Seed Productivity through genetically superior seed orchard . Abstract in National Seminar on Advancement and Recent development in Tree seed Technology to enhance forest Productivity **21-22 Feb 2014 State Forest Research Institute ,Jabalpur**
- Dr. R.K. Verma delivered an invited talk on the topic "The 5th kingdom in the service of mankind" in the National Seminar on "Contribution of Life Sciences in Human Welfare" organized at Department of Botany, Biotechnlogy and Microbilogy, Govt. PG College, Narsinghpur, 27-28 Sep, 2013, p.7-8.
- Shri. Har Prasad, Dy. Conservator of Forests of the centre participated in the three days National seminar on "Recent Advances in Applied Statistics and its application in forestry (RAASAF)" sponsored by Ministry of statistics & program Implementation, GOI, Madhya Pradesh Council of Science and Technology, Bhopal and CSIR, New Delhi and organized by Tropical Forest Research Institute, Jabalpur from 15.4.13 to 17.4.13
- Dr. Nanita Berry, Scientist 'D' participated in the "World Congress on Agroforestry" and presented a paper titled **"** Performance of *Dendrocalamus strictus* and *Bambusa nutans* based Silvi-agri system in tropical region of Madhya Pradesh, India", held from 10 Febraury to 14th February,2014 at Van vigyan Bhawan, New Delhi

(b) Workshops

- Sanjay Singh attended National Workshop on "Exploring the Best Practices in Bamboo Management: Investing in Green gold" 24-25th February 2014, Organized by MP, State Bamboo Mission at Academy of Administration, Bhopal
- Sanjay Singh presented paper in the Workshop on Forest Seed Science: Recent Advances and Challenges in Seed Research, 26-27th February 2014 organised by Silviculture Division at Forest Research Institute Dehradun.
- Dr. N. Roychoudhury, Scientist-F and Dr. N. Kulkarni, Scientist-F attended workshop-cum-meeting on sal borer at Kanha Tiger Reserve, Kanha on 24.02. 2014 and delivered lecture on "Recent sal borer incidences in Madhya Pradesh and Chhattisgarh".
- Dr. N. Kulkarni, Scientist-F attended workshop-cum-meeting on Sal borer and presented status of Sal borer in Chhattisgarh on 05.03.2014 at PCCF Office, Raipur, C.G.
- Smt. Neelu Singh, Scientist-E & Head, participated in two days workshop on "Strengthing Network for Outreach of Research Findings" during 12-13 March,2014 at Angul (Orissa) as resource person

- Shri. N.D. Khobragade, Scientist –B of the centre participated in one day workshop on "International Biodiversity Day" organized by State Forest Department, Chhindwara at Samvad Sadan on 22.5.2013 and delivered a lecture on "Biodiversity status of Chhindwara District."

(c) Trainings

- Dr. Avinash Jain, Scientist E attended 2 days training programme on "REDD and REDD+ benefits in forestry sector under Green India Mission" during 26-27 June 2013 at Engineering Staff College of India, Hyderabad (A.P.).
- Dr. Avinash Jain, Scientist E attended one week training programme on "Human Resource Development" during 7-11 October 2013 at Uttarakhand Academy of Administration, Nainital.
- Raj Kumar, Scientist B attended training programme on "Land Restoration and Biodiversity Conservation for Sustainable Livelihood" during 19-21 February, 2014 at IFGTB Coimbatore
- Dr.P.B.Meshram, Scientist-F attended quarterly basic training programme for Assistant Development Extension Officers at Panchayat & Rural Development Institute, Raipur, CG. as a resource person and delivered two lectures on Preparation/production of vermicompost and Impact Assessment work in watershed management areas in Bundelkhand, monitoring & evaluation on 21st May, 2013.
- Dr.P.B.Meshram, Scientist-F attended training programme on "Cultivation of medicinal plants" at TFRI, Jabalpur as a resource person and delivered one lecture on "Pests of medicinal plants and their control measures" to the trainees of Panchayat members, elected representatives, NGOs Teachers & Bank Officers on 9th July, 2013.
- Dr. Nitin Kulkarni, Scientist – F delivered lecture entitled "*Biological control of forest insect pests and role of entomopathogenic nematodes*" in training programme organized for B.Sc. (Forestry) students of Guru Ghasidas University, Bilaspur (C.G.) on 24rd Sept., 2013 at TFRI, Jabalpur.
- Dr. N. Roychoudhury, Scientist-F delivered lecture in training programme on "Forest insect pest management in nurseries and plantations" to the B.Sc (Forestry) students of G.G University, Bilaspur, on 23 September, 2013 at TFRI, Jabalpur.
- Dr. N. Roychoudhury, Scientist-F attended one week HRD training programme on "Human Resource Development", from 7-12th October, 2013 at Uttarakhand Academy of Administration, Nainital.
- Dr. N. Roychoudhury, Scientist-F attended one week HRD training programme on "Forest Policy, Law, Act & Environmental Law", from 9-13 December, 2013 at Kerala Forest Research Institute, Peechi, Kerala.
- Dr.P.B.Meshram, Scientist-F organized training programme on "Insect pests of important medicinal plants and their biological control measures" under project ID NO. 154/TFRI/2010/Ento.4 (25) at Centre for Forestry Research & Human Resource Development, Chhindwara, M.P. on 19th December, 2013 and distributed training materials in hindi to the trainees of SFD officials/farmers on 19th December, 2013.
- Dr.P.B.Meshram, Scientist-F attended one week (27-31 January, 2014) training programme on "Team Building and Conflict Management" at IIFM, Bhopal, M.P.
- Dr. N. Roychoudhury, Scientist-F and Dr. N. Kulkarni, Scientist-F imparted theoretical and practical training on "Sal borer and its management" to the front line staff of Kawardha Forest Division, on 16 and 17 January, 2014 at Chilpi, Chhattisgarh.
- Dr. N. Roychoudhury, Scientist-F imparted theoretical training on "Sal borer and its management" to the front line staff of Gariaband Forest Division, on 4 February, 2014 at Gariaband, Chhattisgarh.

- Dr. N. Roychoudhury, Scientist-F imparted practical training on “Sal borer and its management” to the front line staff of Bhanupratappur Forest Division, on 6 February, 2014 at Amabera, Chhattisgarh.
- Dr. Nitin Kulkarni, Scientist – F delivered training lecture entitled "वन रोपणीयों में श्वेत इल्ली का समंन्वित प्रबंधन" as Resource Person in connection with forest insect management in Workshop-cum-Training Programme organized by TFRI, Jabalpur at Forest Rangers College, Angul (Orissa), 12-13th March, 2014.
- Dr. Nitin Kulkarni, Scientist – F delivered training lecture entitled "साल वनों में साल बोरर (होप्लोसिरेम्बिक्स स्पाइनीकार्निस) का प्रकोप एवं इसका प्रबंधन" as Resource Person in connection with forest insect management in Workshop-cum-Training Programme organized by TFRI, Jabalpur at Forest Rangers College, Angul (Orissa), 12-13th March, 2014.
- Dr. Nitin Kulkarni, Scientist – F delivered training lecture entitled "सागौन के वृक्षारोपण में कीटों का जैविक नियंत्रण" as Resource Person in connection with forest insect management in Workshop-cum-Training Programme organized by TFRI, Jabalpur at Forest Rangers College, Angul (Orissa), 12-13th March, 2014.
- Shri Sanjay Singh, Dr. Deepa M., Mrs. Tresa Hamalton and Dr. Naseer Mohammad attended 18 weeks ‘Induction Training Programme for Scientists and Research Officers of ICFRE’ conducted by FRI University, Dehradun from 28.2.2013 to 3.7.2013.
- Dr. Yogeshwar Mishra attended one week training on "Forest Certification" at IIFM, Bhopal from 26-30 August 2013.
- Dr. Yogeshwar Mishra attended one week training on Team "Building and conflict management" at IIFM, Bhopal from 27-31 January 2014.
- Smt. Neelu Singh, Scientist-E & Head, participated as resource person in training programme on “Bamboo handicraft for the Farmers, field functionaries and Artisan” BTSG-ICFRE, Dehra Dun (National Bamboo Mission) during 24-06-2013- 28-06-2013and 03-2-2014 to 07-02-2014 held at TFRI,Jabalpur .
- Smt. Neelu Singh, Scientist-E & Head, participated as resource person in short course on "DRUG RESIDUES AND ENVIRONMENTAL POLLUTANTS" (ICAR-10 days) conducted during 11 to 20 Sept., 2013 at the Department of Veterinary Pharmacology & Toxicology, College of Veterinary Science and A.H., NDVSU, Jabalpur
- Smt. Neelu Singh, Scientist-E & Head, participated as resource person in two training programme for B.Sc.forestry students of Guru Ghasidas Vishva vidhyalaya, Bilaspur held from 23-9-13 to 5-10-13and 03-03-14 to 7-3-14 at TFRI, Jabalpur
- Smt. Neelu Singh, Scientist-E & Head, participated as resource person in training programme on "Cultivation of Medicinal Plants" held at TFRI, Jabalpur from 8-10 July 2013.
- Smt. Neelu Singh, Scientist-E & Head, participated in a training programme on “HPTLC” conducted by ANCHROM,Mumbai in NWFP Division of TFRI,Jabalpur during 16/12/14-20/12/14.
- Shri H.O. Saxena, Scientist – B participated as resource person in two training programme for B.Sc.forestry students of Guru Ghasidas Vishva vidhyalaya, Bilaspur held from 23-9-13 to 5-10-13and 03-03-14 to 7-3-14 at TFRI, Jabalpur
- Shri H.O. Saxena, Scientist – B participated as resource person in training programme on "Cultivation of Medicinal Plants" held at TFRI, Jabalpur from 8-10 July 2013.
- Shri H.O. Saxena, Scientist – B participated in a training programme on “HPTLC” conducted by ANCHROM,Mumbai in NWFP Division of TFRI,Jabalpur during 16/12/14-20/12/14.

- Dr. R.K. Verma attended one week training programme on "Team Building and Conflict Management" at Indian Institute of Forest Management, Bhopal during 26.1.2014 to 1.2.2014
- Dr. R.K. Verma attended one week HRD training programme at Uttarakhand Administrative, Academy, Nainital, Uttarakhand during 6.10.2013 to 13.10.2013
- Dr. Vishakha Kumbhare, Scientist–C of the centre participated in the three days training programme entitled "Cultivation, processing and marketing of economically viable medicinal and aromatic plants" sponsored by SIDBI and organized by CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow at National Chemical Laboratory, Pune (Maharashtra) from 10.12.13.to 12.12.13.
- Dr. Vishakha Kumbhare, Scientist–C of the centre delivered a lecture on "Prospects of NWFPs processing and value addition" in the three days training programme entitled "Agroforestry and Entrepreneurship Development" organized by AICRP on Agroforestry, College of Agriculture, Nagpur (under Punjabrao Krishi Vidyapeeth, Akola) conducted at Agroforestry Research Farm (Futala), Amravati Road, Nagpur (Maharashtra) from 9.1.2014 to 11.1.2014
- Dr. Vishakha Kumbhare Scientist C and A J K Asaiya, Research Officer of the centre attended three days training on "Land restoration and Biodiversity conservation for sustainable livelihood India" organised by Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore from 19/02/2014 to 21/02/2014.

(d) Key Lecture delivered

- Sanjay Singh delivered lead presentation " Impact of Harvesting Practices on Bamboo Regeneration" at the National Workshop" at National Workshop on "Exploring the Best Practices in Bamboo Management: Investing in Green gold" 24-25th February 2014, Organized by MP, State Bamboo Mission at Academy of Administration, Bhopal
- Dr. P.B. Meshram, Scientist-F delivered on lecture on "Biodiversity" to the students of M.Sc. I & III Semester at Govt. M.H. College of Home Science and Science for Women, Jabalpur on 17.08.2013.
- Dr. N. Kulkarni, Scientist – F delivered on Invited Lecture entitled "Tests of Significance" in statistical training for pre-Ph.D. course, Rani Durgawati Vishwavidyalaya, Jabalpur , 09.09.2013.
- Dr. P.B. Meshram, Scientist-F delivered in invited lecture on ANNOVA to pre-Ph.D./M.Phil course work (2013-14) students at the Dept. of Bioscience, R.D. University, Jabalpur on 25.09.2013.
- Dr. N. Kulkarni, Scientist – F delivered on Invited Lecture entitled "Insect Immunology : Role in Insect Pest Management. Presented at Mahila Mahavidyalaya on 11.02.2014.
- Dr. R.K. Verma delivered one lecture on "Production and Application of Biofertilizers", in a training programmes organized at TFRI on cultivation of medicinal plants for other stakeholders sponsored by MoEF during 8-10 July 2013.

e) Others

- Radio Talk was broadcasted by All India Radio (AIR) Bhopal under the theme "Bharat Mein Hai Vishwas" programme on 2.9.13 highlighting the achievements of CFRHRD, Chhindwara.
- Shri. Har Prasad, Deputy Conservator of Forests attended the Research Advisory Group Meeting (RAG) as RAG member. Dr. Vishakha Kumbhare, Scientist – C, Shri. N.D. Khobragade, Scientist – C and Smt. Mamta Meshram, Research Officer attended the Research Advisory group Meeting

(RAG) and presented the concept notes of new project proposals during the meeting held on 21st – 22nd October 2013 at Tropical Forest Research Institute, Jabalpur.

- Shri. Har Prasad, Deputy Conservator of Forests and Shri. Aviral Asaiya, Research Officer of the centre conducted FDA evaluation work at West, North and South Divisions, Betul District (MP) during January 2014.

6.3.2 Visits Abroad: NIL

6.4 Capacity Buildings Scientific and Management Cadre (Trainings organized)- NIL

7. Forestry Extension for Taking Research to People

7.1 Collection Compilation and Publication of Forestry Reports/Journals

7.1.1 Research Publications

a) Book/Book Chapters

- Roychoudhury, N. (2012, received July, 2013). Comparative effect of ivermectin and spinosad on larval mortality in greater bamboo leaf roller, *Crypsiptya* coclesalis (Walker) (Lepidoptera : Pyralidae). In : *Recent Advances in Bamboo Propagation, Management and Utilization* (Eds. P. Aggarwal, V.P. Tewari, P.R. Triveni and S.C. Joshi), pp. 116-123, Institute of Wood Science and Technology, Bangalore.
- Roychoudhury, N. and Sharma, R. (2013). Invasive alien species with special emphasis on forest invasive species in India. In : *Forest Health Management* (Eds. A. Balu, R.S.C. Jayaraj, A. Regupathy, V. Mohan, R.R. Warrier, T.P. Raghunath and N. Krishnakumar), pp. 343-353, Institute of Forest Genetics and Tree Breeding, Coimbatore, Tamil Nadu.
- Roychoudhury, N. (2013). Resistance in genotypes of teak to key insect pests. In : Assessment and Conservation of Forest Genetic Resources (Eds. S. Singh and R. Das), pp. 136-143, Institute of Forest Productivity, Ranchi, Jharkhand.
- Tiwari CK, Parihar J, Verma RK and Prakasham U (2013). Atlas of wood decay fungi of central India. Published by Tropical Forest Research Institute, Jabalpur, MP, 166p.
- Khobragade, N.D., Har Prasad, Suryaprabha, A.C. and Mandal, A.K. 2013. Parameters for selection of candidate plus trees of *Terminalia chebula* and *Terminalia bellerica. Indian Forester,* 139:9, 833-835

b) International journals

- Pyasi A, Soni KK, and Verma RK (2013). Effect of ectomycorrhizae on growth and establishment of sal (*Shorea robusta*) seedlings in central India. *Nusantara Bioscience* 5(1): 44-49.

c) National journals

- Sanjay Singh, P.K. Khatri and Chandrashekhar Dixit (2014) Food from the forests, Van Sangyan, 1(1): 10-16
- Sanjay Singh, P.K. Khatri and Chandrashekhar Dixit (2014) Food from the forest: Edible fruits, Van Sangyan, 1(2) : 29-31
- Avinash Jain, Pratiksha Tiwari and A.K. Bhowmik. Eco-restoration of degraded forests of central India with participation of local people. In : Sustainable biodiversity conservation in the landscape. (Ed.) O.P. Chaubey and Ram Prakash. Aavishkar Publishers, Jaipur (Rajasthan) : 94-107 (2013).
- Avinash Jain and R.B. Manjhi. Selection of superior provenances of Neem (*Azadirachta indica* A. Juss.) through morphological and chemical characteristics in central India. In : Plant biodiversity utilization and biotechnology. (Ed.) Arvind Bijalwan and Chandra Prakash Kala. Aavishkar Publishers, Jaipur (Rajasthan) : 29-39 (2013).

- Kulkarni, N., Rizvi, A., Kumar, Vikas Paunikar, S. and Mishra V.K. (2012, published in 2013). Morphological and molecular characterization of *Steinernema dharanaii* sp. N. (Nematoda: Steinernematidae): New Entomopathogenic Nematode from India. *Indian Journal of Tropical Biodiversity* 20 (2):107-116.
- Kulkarni Nitin, Paunikar Sanjay, Mishra Vinod and Daksh, Smita (2013).Tolerance of entomopathogenic nematodes, *Steinernema carpocapsae* to some modern insecticides and biopesticides. *Ann. Entomol*., 31(1):129-134.
- Dadwal, V.S, Singh, N., **Meshram, P.B**. and U. Prakasham (2013). Potential pathogens and insects responsible for low seed production in teak orchards and their management. *Indian Forester*, 139(7):585-589.
- Roychoudhury, N., Chandra, S. and Deepa, M. (2012, received June, 2013). Occurrence of *Canthecona furcellata* Wolff – a predatory bug on *Hyblaea puera* and *Eutectona machaeralis* (Walker) in teak forests of Madhya Pradesh. *Ann. For.* 20(2): 265-272.
- Roychoudhury, N., Chandra, S. and Deepa, M. (2013). *Botyodes asialis* Guen. (Lepidoptera : Pyralidae) – a new addition to the moth fauna of Achanakmar-Amarkantak biosphere reserve. *Indian J. Forestry* 36(4) : 455-458.
- Naseer Mohammad, Yogeshwar Mishra, S. A. Ansari (2013). Assessment of Inter-character Correlations in Pterocarpus marsupium, An Endangered Medicinal Plant of Tropical forest. The Indian Forester, 139(7):633-635
- Rajiv Rai ,(2013) Ethno- medicinal studies in cure of ailments of Baiga Tribes of Madhya Pradesh , Journal of Tropical Forestry 29(2)33-41.
- Md Azzul Islam, SM Quoli, Rajiv Rai and PA Sofi (2013) Livelihood contribution of Forest Resources to the tribal communities of Jharkhand .Indian Journal of Fundamental and Applied Life Science ISSN 2231-6345, 3(2):131-144
- Rajiv Rai ,(2013 Rehabilitation of degraded lands and amelioration with suitable plants of medicinal and HerbalValues (2013). In O P Chaubey and Ram Prakash (Edited) Sustainable Biodiversity Conservationin the land scape ,: 194- 208 p ,Avishkar Publications ,Jaipur
- Rajiv Rai ,(2013 Indigenous Herbal Medicines in cure of tuberculosis in Central India .In Sampat Nehra (eds)Herbal Folk Medicines (2014):1-8 p
- Rajiv Rai ,(2013) Lesser Known herbal Folk medicines in cure of skin infection amongst tribals of Chhattisgarh. In Sampat Nehra (eds) Herbal Folk Medicines (2014):39-52 p
- Verma RK (2013). Outbreak of a nursery disease of teak in central India. *The Indian Forester,* 139(8): 750-752.
- Verma RK, Hanwat Rinki, Rajput PS and Tiwari CK (2013). Status of khair mortality in central India. *The Indian Forester,* 139 (9): 790-796.
- Dadwal V.S., Singh. N., Meshram P.B. and U. Prakasham (2013). Potential pathogens and insects responsible for low seed production in teak seed orchard and their management. *Indian Forester* **139** (7) 585-589.
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- Roychoudhury, N. (2012). Vanya silk : a potential NWFP for forest dwellers. In : Non-Timber Forest Products and Madicinal Plants (S. Singh and R. Das, Eds.), pp. 215-224. Institute of Forest Productivity, Ranchi.
- Tiwari, C.K., Parihar, Jagriti, Verma, R.K. and Prakasham, U. (2013). Atlas of Wood Decaying Fungi of Central India, Tropical Forest Research Institute, Jabalpur India, 166p.

- Mohammad N., Mishra Y., Ansari S.A., (2013) Development of selection criteria in bel (*Aegle marmelos*) and kuchla (*Strychnox nux-vomica*) through correlationand path coefficient study, Bioinfolet, 10: 8-11.
- Pyasi Abhishek, Soni K.K. and VermaR.K. (2013). Effect pf ectomycorrhizae on growth and establishment of Sal (*Shorea robusta*) seedlings in central India. *Bioscience*, 5(1): 44-49 pp.
- Dadwal V.S., i Bhartiya Savitr and. Verma R.K. (2010). Management of root-knot caused by *Meloidogyne incognita* on *Withania somnifera* L. by soil amendments*. Indian* J, Trop. Biod. 18(2): 231-234 pp.
- Soni K.K.,. Hosagoudar V.B., Pyasi Abhishek and Verma R.K. (2010). *Asterostomella shoreae* so. NOV, from Achanakmar Bioshere Reserve in Chhattisgarh, India*. Indian J, Trop. Biod*. 18(2): 255-257 pp.
- Soni. K.K. . Pyasi Abhishek, Tiwari Pooja and Verma. R.K. (2011). Black Mildew of neem seedlings : A new disease record from India. *Indian. J. Trop. Biodiv.* 19 (1&2) : 133-136
- Roychoudhury, N., Chandra, S. and Deepa, M. (2012). Occurrence of *Canthecona furcellata* Wolf – A predatory bug on *Hyblaea puera* Cramer and *Eutectona machaerails* (Walker) in teak forests of Madhya Pradesh. Ann. For., 20(2) :265-272.
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- Meshram, P.B. (2012). Pest Management of Bamboo in Central India. In : Recent Advances in Bamboo Propagation, Management and Utilization (. Aggarwal P.,. Tewari V.P.,. Trivenu P.R. and Joshi S.C., etc.), pp 105-115. Institute of Wood Science and Technology, Bangalore.
- Kulkarni, N. (2013). Status of Potential Biocontrol Components for Integrated Management of Forest Insect Pets in India. In : r Koul Opende., Dhaliwal G.S., Khokhar S. and Singh Ram (eds.) Biopesticides in Sustainable Agriculture: Progress and Potential. Science Publishers (India), pp.389-419.
- Roychoudhury, N. and Sharma, R. (2013). Components of biosphere reserves. CURE Env. Bull. 19:18-23.
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- Soni, K.K., Pyasi A, Tiwari Pooja, Fatima Shirin and Verma R.K. (2013). Inscidence of vascular wilt disease in different population of neem (*Azaderachita indica*) in central India and their control. Indian Forester 139 (12)

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- Kulkarni, N., Paunikar, S., Mishra, V.K. and Daksha, S. (2013). Tolerance of entomopathogenic nematode, *Steinernema carpocapsee* to some moderm insecticide and biopesticide. *Annuals of Entomology*, 31 (1): 129-134.
- Kulkarni, N., Rizvi, A.N., Kumar, V., Paunikar, S. and Mishra, V.K. (2012). Morphological and molecular characterization of *Steinernema dharanaii* sp. N., : a new entomopathogenic nematode from India. *Indian Journal of Tropical Biodiversity*, 20(2) : 107-116 (Late publication of Journal).
- Roychoudhury, N. (2013). Resistance in genotypes of teak to key insect pests. In : Assessment and Conservation of Forest Genetic Resources (Eds. S. Singh and R. Das), pp. 136-143. Institute of Forest Productivity, Ranchi, Jharkhand.
- Roychoudhury, N., Chandra, S. and Deepa, M. (2013). *Botyodes asialis* Guen. (Lepidoptera: Pyralidae) – a new addition to the moth fauna of Achanakmar-Amarkantak Biosphere Reserve. Indian Journal of Forestry, 36(4) : 455-458.

d) Abstracts/Proceedings

- Kulkarni, N., Roychoudhury, N. and Chandra, G. (2013). Use of probit analysis for toxicological experiments against forest insect pests. Paper written and presented in National Seminar on "*Recent Advances in Applied Statistics and its Application in Forestry (RAASAF),* April, 15-17, 2013 at Tropical Forest Research Institute, Jabalpur.
- Roychoudhury, N., Sharma, R. and Das, A.K. (2013). Achanakmar-Amarkantak biosphere reserve under world's network of biosphere reserves by UNESCO's man and biosphere programme. National Conference on "Insect Diversity and Systematics : Special Emphasis on Molecular Approaches", 28-30/10/13, AMU, Aligarh, p. 36 (abstract).
- Roychoudhury, N., Kulkarni, N. and Das, Anand K. (2013). Sal heartwood borer and its epidemics in India with special reference to Madhya Pradesh & Chhattisgarh. Paper presented in *VIIIth National Conference on Biotechnology, Biodiversity and Environment* April, 19-20, 2013, Govt. New Science College, Rewa (M.P.), India (Abstract Page No. 12).
- Kulkarni, N., Paunikar, S., Mishra, V., Daksha, S. and Roychoudhury, N. (2013). Insect pest management options with special reference to biodiversity conservation: retrospect and prospects. Paper presented in *VIIIth National Conference on Biotechnology, Biodiversity and Environment* April, 19-20, 2013, Govt. New Science College, Rewa (M.P.), India (Abstract Page No. 26).
- Meshram, P.B. and Soni, K.K. (2013).Varietal resistance in aonla *Emblica officinalis* (Gaertn) to insect pests and diseases in Madhya Pradesh. VIIIth National Conference on "Biotechnology, Biodiversity & Environment". Organized by Department of Botany & Biotechnology Govt. New Science College, Rewa, M.P. on 19-20th April, 2013. Published Abstract No. 22: 27.
- Meshram, P.B.(2013). Biological control of insect pests of some important medicinal plants in Madhya Pradesh. National Seminar on "Contributions of Life Science in Human Welfare". Organized by Department of Botany, Biotechnology & Microbilogy, Govt. P.G. College, Narsinghpur M.P. on 27-28th September, 2013.Published Abstract No.91:82.
- Meshram, P.B.(2014).Integrated pest management of bamboo in central India. National seminar on Bamboo, Research & Development in India, RFRI, Jorhat on 6-7 February, 2014. Abstract No. C-2:47-48.

- Meshram, P.B.(2014). Ecofriendly management of insect pests of some important medicinal plants. AZRA Silver jubilee International Conference on "Probing Biosciences for Food Security and Environmental Safety. 16-18 February, 2014, CRRI, Cuttack(Odisha) Abstract No. 123:165.
- Meshram,P.B. and Soni, K.K.(2014). Insect pests and diseases of fruits/seeds of *Buchnania lanzan* and their management.National Seminar on "Advancement and Recent Development in Tree Seed Technology to Enhance Forest Productivity". Organized by S.F.R.I., Jabalpur on 21-22 February, 2014. Published Abstract No. P-17:22.
- Hemant Ahirwar, Sudeepta Mishra and Tresa Hamalton (2013) Genetic variation studies in tree species using carbonic anhydrase isozyme analysis. In Modhumita D, Rekha RW and Yasodha R (eds.) Proceedings of the national seminar on tree biotechnology 2013: Emerging opportunities in forestry and tree science, held at IFGTB, Coimbatore, pp. 145-7.
- Yogesh Pardhi, Vivek Vaishnav, Naseer Mohammad and Yogeshwar Mishra (2014) Assessment of Seed Parameters in the *Pterocarpus marsupium* Collected from Chhattisgarh' published in 'National Workshop on Forest Seed Science: Recent Advances & Challenges in Seed Research' organized by F.R.I., Dehra Dun (UK) from 26-27 February, 2014.
- Yogesh Pardhi, Vivek Vaishnav, Shashank Mahesh, Naseer Mohammad (2013) Comparative assessment of genomic DNA of five forest species isolated using liquid N2and without liquid N published in the National seminar on Tree Biotechnology 2013: Emerging opportunities in forestry & tree science' organized by I.F.G.T.B., Coimbatore (T.N.).
- Y. Mishra, Maravi S, Sonkar, MK and Rana, PK (2014) Clonal Propagation of *Bambusa vulgaris* green through adventitious rhizogenesis in microcuttings, published in Abstract of Recent advance on bamboo research and development held in RFRI, Jorhat from 6-7 February, pp 23.
- Y. Mishra and Rimi Rawat (2013) In vitro propagation of *Pterocarpus marsupium* Rox. through cotyledonary explants, Proceedings of the national seminar on tree biotechnology 2013: Emerging opportunities in forestry and tree science, held at IFGTB, Coimbatore, pp. 90.
- Vivek Vaishnav, Naseer Mohammad, Shashank Mahesh, SA Ansari (2014) 'Screening of EST-SSR primers in teak *(Tectona grandis* L. f.) designed from *carbonic anhydrase* gene sequences of model plant species' published in 'International conference on frontier discoveries and Emerging opportunities In life sciences' held from 13-15 Feb, 2014 at Dr. Harisingh Gaur University (A Central University) Sagar, (M.P.)
- Vivek Vaishnav, Shashank Mahesh, Naseer Mohammad and Shamim Akhtar Ansari (2013) Abstract entitled 'Genetico-statistics Continuum: a Review' published in ' National seminar on Recent Advances in Applied Statistics & Its Application in Forestry' held from 15-17 April, 2013 at T.F.R.I., Jabalpur (M.P.)
- Rajiv Rai [1] and DrRicha Rathore [2] presented by Dr Rathore (2013) Role of Aqautic and Floating plants in Management of Ground Water and Surface Water pollution in Rivers , Ponds and Lakes presented by Dr Rathore in All India on Conservation and Protection of Underground water , 5-6 July 2013
- Dr Richa Rathore [1] , Dr Rajiv Rai [2] and Er Rakesh Rathore 3 (2013) Rain water harvesting Scenario : an approach for Conservation and protection of underground water presented by Dr Rathore in All India on Conservation and Protection of Underground water , 5-6 July 2013
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- Rai (2013)Management and Conservation of Bamboo Species Diversity in Recent Advances in Biodiversity Conservation, Biotechnology and Environmental Management Research" which was organized on 19th -20th April 2013.at Govt. New Science College Rewa
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- Rai (2014)Phenological studies in *Azadirachta indica* A. Juss (Neem) an important tool for enhancing Seed Productivity through genetically superior seed orchard . Abstract in National Seminar on Advancement and Recent development in Tree seed Technology to enhance forest Productivity 21-22 Feb 2014 State Forest Research Institute ,Jabalpur.
- Verma R K, Chourasiya Sonam and Thakur AK (2013). Arbuscular mycorrhizal colonization on less researched tree species in central India, p. 91. Abstract published in National Seminar on "Frontiers in Modern Biology from Discovery to Applications" organized at St. Aloysius College, Jabalpur, 6-7 Sep, 2013
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- An abstract entitled 'Identification of the best seed collection time with respect to seed maturation stage' by Dr. M. Kundu was published in the Proceeding of National seminar on "Advancement and Recent Development in Tree Seed Technology to enhance Forest Productivity' held in 21st -22nd February 2014 at State Forest Research Institute, Jabalpur.
- An abstract entitled 'Development of germination and desiccation tolerance in developing seeds of *Pterocarpus marsupium'* by Dr. M. Kundu was published in the Proceeding of National workshop on "Forest Seed Science: Recent advances & challenges in seed research" held in 26 -27 February 2014 at Forest Research Institute, DehraDun
- An abstract entitled 'Performance of *Dendrocalamus strictus* and *Bambusa nutans* based Silvi-agri system in tropical region of Madhya Pradesh, India " by Dr. N.Berry was published in the Proceeding of **3rd World Congress on Agroforestry** on "Trees for better life " held from 10th February – 14th February,2014 at Vigyan Bhawan, New Delhi organized by the ICRAF, Kenya
- An abstract entitled '*Gmelina* based Agroforestry System in Madhya Pradesh: Potential and Prospects in Tree Business" By Dr. N.Berry was published in the Proceeding of **3rd World Congress on Agroforestry** on "Trees for better life " held from 10th February – 14th February,2014 at Vigyan Bhawan, New Delhi organized by the ICRAF, Kenya.

e) Reports

- Dr. P.K. Khatri submitted "Final Evaluation report of Bundelkhand Special Package (ACA head) of Nauradehi Forest Division Madhya Pradesh".

- Sanjay Singh as a team member compiled report on Conservation plan of Saraipali-OCP submitted to SECL, Korba, Chhattisgarh
- Sanjay Singh as an associate in the project compiled report on “Assessment of green cover, its tangible and intangible benefits and tree cover management plant for STPP-Korba project”.
- Shri. NPS Nain, Kandhi Singh and Sunil Jharia prepared and submitted "Final Evaluation report of Bundelkhand Special Package (ACA head) of Chhattarpur and Datia Forest Division Madhya Pradesh".
- Shri. NPS Nain, Kandhi Singh and Sunil Jharia prepared and submitted, "Draft report of FDA of Harda, Narshighpur, and Hosangabad Forest Division of Madhya Pradesh".

f) Others

- Asaiya, A. 2014. Jivamrut (Jaiv-urvarak). *Van Sangyan* ejournal, March issue, 21-23.
- ननिता बेरी 2014 . "कृषि वानिकी एक झलक – वेदों से वर्तमान तक " **, वन सन्ज्ञान के प्रथम भाग मे प्रकाशित,** उष्ण कटिबंधीय वन अनुसंधान संस्थान जबलपुर
- ननिता बेरी 2014. " कृषिवानिकी पर विश्व संगोष्ठी **" , वन सन्ज्ञान के प्रथम भाग मे प्रकाशित,** उष्ण कटिबंधीय वन अनुसंधान संस्थान जबलपुर

7.2 Dissemination of developed technologies

7.2.1 Van Vigyan Kendras (VVKs) and Demo Village (DVs)

To disseminate information about various technologies developed, institute provide regular funds to organize training programmes by them and also provide literature published in Hindi, English and regional language. Four VVKs one each in the state of Madhya Pradesh, Chhattisgarh, Maharshtra and Odisha and one Demo village at Moiya Nala, in Bijadandi West Mandla Forest division is working under the institute.

- Dr. Nanita Berry, Scientist 'D' participated as a invited speaker in three days training workshop on " Krishivaniki ke dwara Madhya Pradesh ko hara bhara kaise banaye "for District/Block Co-ordinators of M.P. Jan Abhiyan Parishad " held from 24th - 26th April,2013 at Devi Ahilya Bai Vishwvidhyalaya, Indore.
- Dr. Nanita Berry, Scientist 'D' participated as a invited speaker, delivered lecture on 'Krishivaniki" during one day workshop on " Involvement of Joint Forest Management Committee Member in plantation" held on 5/5/2013 at State Forest Research Institute, Jabalpur (M.P.)
- Dr. Nanita Berry, Scientist 'D' participated as a invited speaker and delivered lecture during one day training workshop on "*Gmelina* and Bamboo based agroforestry system" under VanVigyan Kendra training programme held on 31/7/2013 at Research and Development circle, Jabalpur(M.P.)
- Dr. Nanita Berry, Scientist 'D' participated as a resource person and delivered lecture during three days training workshop on "Cultivation of medicinal plants" under Mo EF sponsored training programme, New Delhi, organized by TFRI Jabalpur held from 8/07/2014 to 10/07/2014 .
- Dr. Nanita Berry, Scientist 'D' participated as a resource person and delivered lecture during five days training workshop on "Bamboo based agroforestry system" under SLEM project held from 8/07/2014 to 10/07/2014 TFRI, Jabalpur (M.P.)

7.2.2 Direct to consumer Scheme:–Nil

7.2.3 Technologies transferred: -

A seminar cum workshop programme had been organized by the institute for "Outreach of Research Findings". This programme was organized to disseminate research findings of the identified technologies suitable for the state of Madhya Pradesh. Similar such programme has also been under consideration for the state of Chhattisgarh, Orissa and Maharshtra. Following technologies were identified during these programs.

- Transferred technologies developed in Forest Ecology & Rehabilitation Division to farmers and forest officials through workshop-cum-training programme on "Strengthening the network for outreach of research findings developed by ICFRE" conducted during 12-13 March 2014 at Odisha Forest Ranger's College, Angul.
- Eight technologies listed below transferred to stackholders at Angul (Orissa) during 12-13 March, 2014.

a) Processing technique of Bael fruits.
b) Drum-dryer techniques for NTFPs.
c) Development of handmade paper/Paper making from Lantana.
d) Non destructive harvesting techniques of Arjuna bark.
e) Agro-techniques of *Asparagus racemosus.*
f) Agro-techniques of *Andrographis paniculata*.
g) Agro-techniques of *Rauvolfia serpentina*.
h) Agro-techniques of *Withania somnifera* Linn.

A two day workshop-cum-training programme was organized by TFRI, during 12-13 March 2014 at Forest Rangers College, Angul Odisha for Strengthening Network for Outreach of research Findings of ICFRE and its institute under OTSG to ICFRE. For this workshop cum training programme 20 technologies developed by TFRI and other ICFRE institutes, which are suitable for Odisha were presented and extended to the participants for extension in Odisha state. 48 participants which includes 33 women participants (28 SHG, 8 VSS Animator, 6 Forest guards, 4 Farmers and 2 NGO) and other officials from TFRI and Odisha state Forest department had attended the workshop.

Information was disseminated through various training programmes being conducted by the centre by giving demonstration on mahua flowers collection method, Azolla cultivation and preparation of Jivamrut (biofertilizer).

- Dr. Nanita Berry participated by presenting the developed technologies on teak-turmeric silvi-medicinal system, **Bamboo based silvi-agri system** and Bach-paddy agri-medicinal system in the two days workshop on "Transfer of Technologies" held from 12-13th of February,2014 at Angul (Odisha) to the women self help groups and forest officials technologies developed by the TFRI(ICFRE), Jabalpur.

Demonstration of agroforestry models:

- Demonstrated field of developed technology on various agroforestry system such as Silvi-medicinal system, Bamboo based silvi-agri system and horti-silvi-agri system to the number of groups of Forest guard/ Farmers/ Scientist/ Students of various organization at TFRI demonstration field.

1. A Group of Farmers of Chhattisgarh and Madhya Pradesh were visited during BTSG sponsored training for Bamboo held from 24/6/13 to 28/6/2013.
2. A Group of forest officials of Balaghat on 5/7/2013.
3. A Group of forest guards of Lakhnadon, Seoni on 13/06/13 to 14/6/13.
4. A Group of Forest guards of Pachmarhi on 23/06/13.
5. A Group of Farmers and forest officials of Odisha were visited one day training programme on agroforestry held on 14th October, 2013.
6. A Group of Farmers and forest officials of Amravati district (Maharashtra) were visited during one day training programme on bamboo based agroforestry system held on November, 2013.
7. A Group of students of B.Sc.(Forestry) final year students of Gujrat, during October,2013.
8. A group of B.Sc. (Forestry) students of Guru Ghasidas University, Jabalpur District during 23rd September-5th October,2013

7.3 Evolving and coordinating comprehensive extension strategies in forestry research

7.3.1 SLEM

Land degradation is a major concern for India with the country's National Action Plan to Combat Desertification (UNCCS-NAP), 2001 identifying 6 major causes for the issue that include unsustainable water management, poor agricultural practices, human and livestock pressure on land, deforestation, climate change and industrialization. These concerns would multiply many folds if these were juxtaposed with the fact that 72% of India's population is rural ad depend mainly on land and water resources and that at present 80% of all Indian farmers are under the poverty line. In this background Sustainable Land and Ecosystem Management (SLEM) Approach was evolved. SLEM is a joint initiative under the Country Partnership Project (CPP) of Government of India (GOI) and Global Environmental Facility (GEF). The goal of SLEM-CPP is to apply multi-sectoral approach to land management related to Biodiversity Conservation and Climate Change issues in several Indian states through a multi-stakeholders project to support adaptation and Implementation of sustainable land management.

One week specialized training programme on "Bamboo based Handicraft for farmers and Artisans for Livelihood Enhancement" was organized during 03-07 Feb., 2014 by Forest Extension division under SLEM-CPP project at TFRI Jabalpur.

7.3.2. Seminar/Symposia/Workshops/Training Organized

TFRI, Jabalpur organized the following training programs during the year:-

- A three days National Seminar "Recent Advances in Applied Statistics and its Application in Forestry" was organized at this institute from 15-17 April, 2013.
- One week specialized training programme on Bamboo Handicrafts for Farmers & Artisans of Madhya Pradesh and Chhattisgarh was organized during 24-28 June 2013 by Forest Extension division under BTSG-ICFRE (NBM) programme .
- Tropical Forest Research Institute, Jabalpur organized a "Three days Training Programme on Cultivation of Medicinal Plant for other stakeholders", July, 8-10, 2013, sponsored by the

Ministry of Environment & Forests (GoI), New Delhi. The training programme was participated by 36 trainees.

- Training programme organized by Genetics and Plant Propagation division for B.Sc. VII Semester (Forestry) Students of Guru Ghasidas Unversity, Bilaspur from 23.09.2013 to 05.10.2013.
- One week specialized training programme on Bamboo Handicrafts for Farmers & Artisans of Madhya Pradesh and Chhattisgarh was organized during 23-27 Sept., 2013 by Forest Extension division under BTSG-ICFRE (NBM) programme
- Four Training Programs (during 13/01/2014 to 17/01/2014, 20/01/2014 to 24/01/2014, 27/01/2014 to 31/01/2014 and 10/02/2014 to 14/02/2014) were organized for B.Sc (Biotechnology) 1st Semester students of Government Model Science Collage, Jabalpur
- One week specialized training programme on "Bamboo based Handicraft for farmers and Artisans for Livelihood Enhancement" was organized during 03-07 Feb., 2014 by Forest Extension division under SLEM-CPP project.
- One training program was organized by Genetics and Plant Propagation division for B.Sc. VI Semester Students of Government MLB Girls College, Bhopal during 3.3.2014 to 7.3.2014.

CFRHRD, Chhindwara organized the following Training programmes during 2013-14

S.No	Date	Topics	Target groups
1.	20.04.2013 22.04.13	NWFP value addition, processing and marketing	Womens
2.	26.6.13	Cultivation, sustainable harvesting and marketing of medicinal plants	Farmers
3.	31.7.13	Azolla cultivation	Farmers
4.	6.8.13	Cultivation of Medicinal plants /Azolla cultivation	Farmers (Sponsored by Social Forestry Department, Amravati
5.	12.9.13	Bio-fertilizers and bio-pesticides	Farmers
6.	26.9.13	Cultivation of oil yielding species	Farmers
7	18.10.13 5.12.13	Environmental Awareness	Students (Sankalp Higher Sec. School, Sausar) Kendriya Vidyalaya, Chhindwara
8	24.10.13	Research activities of CFRHRD, Chhindwara/Azolla cultivation/Medicinal plants	B.Sc (Final year) students of Agriculture from JNKVV, Jabalpur
9	4.12.13	Agro-forestry with special reference to medicinal plants	Farmers
10	19.12.13	Insect pests of important medicinal plants and their biological control measures	SFDs/Farmers
11	23.1.2014	Diseases and their control measures in forest nurseries and plantations	SFDs

12	29.1.14	Identification of medicinal plants and their documentation	Herbal healers
13	12.2.14	Cultivation of mushrooms	Farmers

7.3.3 Special Activities:

During 2013-14 TFRI and CFRHRD celebrated/organized following day/week/pakhwara. Various cultural and competitive activities were organized in this period to create awareness about the events among children, employees and general public.

(a) TFRI, Jabalpur

- International day for Biological Diversity 22/5/2013
- World Environment Day 5 June 2013
- Sadbhawana Pakhwara was inaugurated at TFRI on 20/8/2013 with oath taking ceremony
- Celebrated Teacher's day on 5.9.2013
- Vigilance Awareness week celebrated during 28 October -2 Nov. 2013 in the institute.
- Celebrated National Science day on 28.2.2014 (The monthly e-magazine of the institute, *Van Sangyan* was released).
- Seminar series (Weekly/Friday and Thursday seminars)

(b) CFRHRD, Chhindwara

- "International Biodiversity Day 2013" was celebrated by the centre on 22 /05 /2013 amongst the villagers of Munaga, Chhindwara District.
- World Environment Day was celebrated on 5th June 2013 by planting seedlings of forestry species in the campus of CFRHRD, Chhindwara.
- Van Mahotsav was celebrated during first week of July 2013 by planting seedlings of forestry species in the campus of CFRHRD, Chhindwara. Seedlings were also distributed in residential campus for plantation.
- Independence Day was celebrated by the centre on 15.8.13
- Wildlife Conservation Week was celebrated by the centre from 2.10.2013 to 4.10.2013
- Centre for Forestry Research and Human Resource Development, Chhindwara celebrated Republic Day on 26.1.2014

7.4 Consultancies Services

- Assessment of green cover and its tangible and intangible benefits and tree cover management plan for STPP-Korba Project', funded by NTPC Korba.
- Preparation of conservation plan and comprehensive study of the impact on the wildlife for Rajgamar underground project, SECL Korba (C.G.).

- Preparation of conservation plan for endangered species in and around Saraipali open cast project, SECL Korba (C.G.).
- Analysis of organic carbon content in soil and forest floor samples received from Forest Survey of India, Nagpur was done

7.5 Activities of Rajbhasa

संस्थान द्वारा राजभाषा के प्रचार प्रसार के लिए की जा रही गतिविधियॉ एवं वार्षिक कार्यक्रमः–

हिन्दी पखवाड़े का आयोजन : राजभाषा विभाग, भारत सरकार द्वारा जारी दिशा निर्देशों की अनुपालन में उष्णकटिबंधीय वन अनुसंधान संस्थान, जबलपुर में दिनांक 02 सितम्बर 2013 से 16 सितम्बर 2013 के दौरान ''हिन्दी पखवाड़ा'' मनाया गया जिसमें हिन्दी को बढ़ावा देने के उद्देश्य से विभिन्न प्रतियोगिताओं का आयोजन किया गया – हिन्दी प्रश्न मंच प्रतियोगिता, प्रशासनिक हिन्दी भाषा ज्ञान प्रतियोगिता, वैज्ञानिक तथा तकनीकी शव्दावली का हिन्दी ज्ञान प्रतियोगिता, हिन्दी टंकण प्रतियोगिता, हिन्दी भाषण प्रतियोगिता, हिन्दी निबन्ध प्रतियोगिता, हिन्दी व्यवहार प्रतियोगिता, हिन्दी में तकनीकी लेखन प्रतियोगिता तथा हिन्दी कविता पाठ प्रतियोगिता ।

हिन्दी पखवाड़े का समापन दिनांक 16 सितम्बर 2013 को संस्थान के निदेशक डॉ यू0 प्रकाशम की अध्यक्षता में काव्य पाठ प्रतियोगिता एवं पुरस्कार वितरण का आयोजन किया गया जिसमें संस्थान के अधिकारियों, कर्मचारियों एवं अनुसंधान अध्येयताओं ने बढ़ चढ़ कर भाग लिया।

राजभाषा विभाग की हिन्दी में कार्य करने हतु प्रोत्साहन योजना – संस्थान में राज भाषा विभाग द्वारा जारी की हिन्दी में कार्य करने वाले कर्मचारियों के प्रोत्सहन हेतु लिए नकद पुरूस्कार योजना भी लागू की गयी है। इस योजना के अन्तर्गत प्रतिवर्ष हिन्दी में किए गए कार्यों के लिए 10 कर्मचारियों को प्रथम, द्वितीय एवं तृतीय पुरूस्कार एवं 5 सांत्वना पुरूस्कार दिए जाते हैं। वर्ष 2012–13 के दौरन संस्थान के कर्मचारियो द्वारा हिन्दी में किये गये कार्यों के मूल्यांकन के आधार पर उन कर्मचारियों को नकद राशि के रूप में राज भाषा प्रोत्साहन पुरूस्कार प्रदान किये गये ।

All official correspondence is being dealt in hindi as far as possible. All computers in the centre have been provided with hindi font. All seals and name plates are in bilingual as the Govt. of India's direction.

7.6 Awards and Honours: Nil

8 *ADMINISTRATION AND INFORMATION TECHNOLOGY*

8.1 Information Technology

The institute have successfully implemented the National Knowledge Network (NKN) scheme of NIC project. Under this project 100MBPS bandwith line has been installed, the Cissco router from NIC and L3 Cissco switch from ICFRE, Dehradun have been received and installed and configured over the existing LAN with the help of NIC personnel and IT division, ICFRE, Dehradun. The configuration has been done in the manner so as to use the earlier 2MBPS leased line of BSNL and 100 MBPS NKN link simultaneously as and when needed. The NKN comprises of an ultra-high speed CORE (multiples of 10 Gbps), complimented with a distribution layer at appropriate speeds. The network is designed to support Overlay Networks, Dedicated Networks, and Virtual Networks.The institute The 100 MBPS fast Ethernet fiber optic backbone LAN is functional at TFRI and is working smoothly. The system is being successfully used for Internet access and other online activity. Video Conferencing facility also been used through out the year. Under IFRIS project various modules including Personal Information System, Research Information System, Payroll Management System, Electronic Document Management System and Financial Accounting System have been successfully operational. Institutes website is time to time updated to extend various activities of the institute. The institute procured 10 online UPS (1kva) for providing backup to the network switches available in different locations of the institute, 4 network racks and patch panels, 2 high speed scanner and colour laser printer and 10 laser printers.

The Chhindwara centre has successfully implemented the National Knowledge Network (NKN) scheme of NIC project. Under this project 100MBPS bandwidth line has been installed. The router have been installed and configured over the existing LAN. The configuration has been done in the manner so as to use the earlier 2MBPS leased line of BSNL and 100 MBPS NKN link simultaneously as and when needed. The NPN comprises of an ultra-high speed CORE (multiples of 10 Gbps), complimented with a distribution layer at appropriate speeds. The 100 MBPS fast Ethernet fiber optic backbone LAN is presently non functional

8.2 Sevottam

Activities related to the Citizens/Clients Charter are mentioned as under-

8.2.1 Action taken to formulate the Charter for the Institute and its subordinate formation

Citizen's Charter is being drafted by the Institute. 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.
- Grievances received in the institute and their follow-up will be reviewed. Steps will be undertaken to take remedial measures for quick disposal of complaints, specifically on those, which are of repetitive nature.

8.2.2 Action taken to implement the Charter

Action will be taken for implementing the Charter.

8.2.3 Details of Training Programmes, Workshops, etc. held for proper implementation of Charter

These programs will be organized after approval of the citizen charter.

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

Publicity and awareness campaigns on charter for the citizen/clients were made by holding slogans on notice boards and other areas to motivate citizens. General lectures on the awareness were also organized at the institute.

8.2.5 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 is to be initiated.

8.3 Welfare measures for the SC/ST/Backward/minority communities - Nil

9. Balance Sheet

To be prepared at ICFRE level

10. 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 Rajaram Singh, Under Secretary, TFRI, Jabalpur	As per provision and guidlines provided under RTI Act, 2005.
Centre for Forestry Research & Human Resource Development, Chhindwara	Director, CFRHRD, Chhindwara	Dr. P. Subramanyam, IFS, Director, CFRHRD, Chhindwara	As per provision and guidlines provided under RTI Act, 2005

2. Email and Postal addresses

a. 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. 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 – 254473(O)
FAX : 07162 – 254463
e-mail – head_cfrhrd@icfre.org

3. Intellectual Property

3.1 Patents Granted – Nil

3.2 Others-Nil

List of Abbreviations

AAU - Anand Agricultural University
BR- Biosphere Reserve
CFRHRD-Centre for forestry Research & Human Resource Development, Chhindwara
CG-Chattisgarh
DMAPR - Directorate of Medicinal and Aromatic Plants Research
DMRT- Duncun's Multiple Range Test
DST- Dept. of Science and Technology, New Delhi
ICAR – Indian Council of Agriculture Research
IFRIS- Indian Forestry Research Information System
ISSR- Inter Simple Sequence Repeat
MAPAI -Medicinal and Aromatic Plants Association of India
MH- Maharashtra
MP- Madhya Pradesh
NGOs – Non Governmental organization
NMPB- National Medicinal Plants Board
NWFP –Non-Wood Forest Produce
OR- Orrisa
PCCF – Principal Chief Conservator of Forest
RAPD- Random Amplification of Polymorphic DNA
RBD- Randomized Block Design
SHGs - Self Help groups
SLEM- Sustainable Landuse Ecosystem Management
TSO- Teak Seed Orchard
UGC-University Grants Commission
VVK- Van Vigyan Kendra
WII - Wild Life Institute of India
WNBR- World Network of Bioshpere Researve
NGOs – Non Governmental organization
SHGs - Self Help groups
ICFRE- Indian Council of Forestry Research & Education
MPSBB – Madhya Pradesh State Biodiversity Board
FDA – Forest Development Agency
CSIR – Council of Scientific and Industrial Research
SIDBI – Small Industries Development Bank of India
CIMAP – Central Institute of Medicinal and Aromatic Plants
IFGTB – Institute of Forest Genetics and Tree Breeding
AIR – All India Radio
RAG – Research Advisory Group
AICRP – All India Co-Ordinated Research Project
JNKVV – Jawaharlal Nehru Krishi Vishwavidyalaya
NIC – National Informatics Centre
BSNL – Bharat Sanchar Nigam Limited