Annual Report 2012-13

TROPICAL FOREST RESEARCH INSTITUTE
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EXECUTIVE SUMMARY

Executive Summary of the Report

- The International Council of UNESCO's Man and the Biosphere Programme (MAB) meeting in Paris from 9-13 July 2012 declared Achanakmar-Amarkantak Biosphere Reserve under the World Network of Biosphere Reserves (WNBR).
- Web based information centre was created for Achanakmar-Amarkantak biosphere reserve and linked to the website of TFRI, Jabalpur (http://tfri.icfre.gov.in /AABR/index.html) to exchange and share technology.
- Out of 558 insect samples collected from Achanakmar-Amarkantak biosphere reserve, 87 species of butterflies and moths were identified. 67 species of which were the new addition to the insect faunal composition of the biosphere reserve.
- The localities of selected target species of medicinal plants, such as *Thalictrum foliolosum, Embelia tsjeriam cottam, Rubia cordifolia* and *Celastrus paniculatus* in buffer and transition zone of Achanakmar-Amarkantak biosphere reserve were identified for the first time.
- The native populations, TFRIEPN-15 and TFRIEPN57 (*Steinernema* spp.) could sustain the temperature up to 36^0C, as compared to other native and known populations; *S. carpocapsae* and *H. indica* (NBAII populations). TFRIEPN-57, TFRIEPN-15 (*Steinernema* spp.) caused quick mortality within 5-9 days.
- White grubs were effectively managed by EPN population at and above 6000 IJs Larva^{-1} and the native populations of *Steinernema* sp., TFRIEPN-15, TFRIEPN-57 and *Heterorhabditis* sp., TFRIEPN-50 could be used either individually or in combination with the Chlorpyriphos or imidacloprid for enhanced effect.
- Probit Analysis on infectivity of native and exotic populations of EPNs against 2nd and 3rd instar grubs of *H. rustica* revealed that 2nd instar grubs were more susceptible to infection with LC_{50} values ranging from 855 – 1000 IJs G^{-1} than to exotic populations 1513 – 2365 IJs G^{-1}.
- Release of indigenous egg parasitoid, *Trichogramma raoi* @ 1.25 lakh ha^{-1} in teak forests of Choral Forest Range of Indore Forest Division proved effective in minimizing at least 50% damage impact caused by leaf skeletonizer.
- Eucalyptus gall wasp, *Leptocybe invasa*, found to be a major pest at nursery stage.
- Spraying of biopesticide and chemical pesticides on seedlings of eucalyptus for six months at 15 days interval effectively reduced the gall formation and increased height and collar diameter.
- Thirty seven species of *Apanteles* were recorded for the first time from Orissa as natural biological control agents of key defoliators of teak and sal forests.
- Sal borer infestations were identified in three Forest Ranges of Dindori Forest Division of M.P. and a total of 699 trees in 102 compartments were marked under different categories of borer attack.
- Multilocational trials in the form of national and zonal trials comprising 36 accessions in national trials and 14 accessions in zonal trial of *Jatropha curcas* were established at Institute's campus, Jabalpur. Data on growth performance, seed yield and seed characters were recorded at regular intervals and oil estimation of the samples was also done.Best performing accessions were: SFRI-1, TNMC-22, PDKV-2, TFRI – 1, TFRI-2, IGAU–1, PDKV -1 and Palampur–II.

These accessions performed better than others with regard to their growth characteristics, seed yield and oil content. 81 candidate plus trees (CPTs) of Karanja were identified from five agroclimatic regions of Madhya Pradesh. Best CPTs were: Bargi-4, Jabalpur; Chandna-2, Dindori; Chandna-1, Dindori; Kusmeli, Chhindwara; Sikharpur, Chhindwara; Bargi-4, Jabalpur; Lalpur, Satna; Nagound Road, Satna and Chandangoan, Chhindwara as determined by Duncan's multiple range test (DMRT).

- A multilocational trial comprising 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. On the basis of collar diameter, the best performing accessions were 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 was 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**.** Total flavonoid content in the root, stem and leaves of *Uraria picta* was found 0.117, 0.42 and 0.94% respectively. Quantification of total alkaloids (%) in different parts of *Solanum indicum* collected from two different agroclimatic regions 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) of Satpura Plateau (Chhindwara) and Chhattisgarh plains (Balaghat) respectively.
- Phyllanthin, the active ingredient of Bhui Aonla, and ursolic acid from Tulsi leaves were estimated using HPLC. The concentration of phyllanthin varied from 0.015% to 0.051% and ursolic acid from 0.016% to 0.092%. Essential oil was also extracted from tulsi leaves and yield was found to be 0.2%.
- Seed chemicals of *Sapindus mukrossi, Schleiochera oleosa and Pongamia pinnata* 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 surface tension of *P.pinnata*, *J.curcas* and *S.mukrossi* diethanolamides varied from 0.030-0.0504 dyns cm^{-1} at 1-10% concentration while viscosity of different dilutions varied from 1.19-47.7 M Pa. The pesticidal activities of products formulations were assessed against forest insect and fungus pest.
- Sustainable harvesting limits of Mahul (*Bauhinia vahlii*) leaves were determined from different levels of harvesting[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.
- 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.
- Three value added products of *Schleichera oleosa* were prepared: (A) Kusum concentrate, (B) Kusum leather and (C) Kusum katmith**.** Nutritional values of these products were determined as Kusum concentrate (total carbohydrates 67.5 %, ascorbic acid 0.71, CFC 7.3 % and protein 0.17 %), Kusum leather (total carbohydrates 86.0 %, ascorbic acid 0.73, CFC 7.9 % and protein 0.17) and Kusum katmith (total carbohydrates 77.5 %, ascorbic acid 0.76, Crude fiber content 7.5 % and protein 0.17 %).

- Starch was isolated from potato and *Amorphophallus companulatus* for the preparation of bioadhesives. The adhesive was prepared with alkali and acid as gelatinization modifier at different concentration and its effect on viscosity and drying time were evaluated. The effect of type and quantity of stabilizer i.e. borax and urea was assessed on the properties of adhesives, i.e. pH, solid content and viscosity. The pH and viscosity of adhesives varied from 9.0-13.4 and 794-2021cp, respectively. Waste biomass was carbonized and charcoal briquettes were prepared by adding binder in different ratios.
- Azadirachtin content obtained in seed samples, *in vitro* shoots and callus cultures of *A.indica* was maximum in Gwalior population. Positive correlation was obtained between azadirachtin (%) in seeds and *in vitro* shoots. Positive correlation between the neem oil (%) and azadirachtin (%) in seeds can be utilized to identify trees with high azadirachtin content in their seeds.
- Different localities in M.P. were visited and 20 individuals from each of 12 *B. serrata* populations, collected for leaf and wood core samples. Leaf samples were extracted for genomic DNA and wood core samples macerated for wood fiber length measurement. Extracted the genomic DNAs from nine populations and screened the ISSR and RAPD primers.
- For *in vitro* rooting in *R.serpentina*, the maximum rooting was obtained on ½ B5 medium in GO-MN genotype. Among different hardening substratum soilrite merged as the best medium for hardening with 100% survival. The ready hardened plantlets were transferred to the field.
- Germplasm of *Pterocarpus marsupium* was collected from diverse areas of Chhattisgarh. The seedlings of three localities were raised. Clear bole height emerged as main character, which was correlated with plant height.
- On the basis of maximum leaf number and largest leaf area (cm^2), two sites, Litipara and Lohattar were screened out as the best localities for collection of germplasm of *Diospyros melanoxylon* (tendu). Conversely, Kotadol was identified as the least performing locality out of the selected four localities.
- For collection of germplasm of *Bauhinia vahlii*, sites selected were Korba (Range: Kartala), Katghora (Range: Pali), Marvahi (Range: Keonchi and Achanakmar), Raigarh (Range: Manora and Kansabel) and Dhamtari (Range: Dugli and Nagri) in three agroclimatic zones. Locality and site and their interactions had significant effect on various leaf parameters. Locality Dugli significantly proved to be superior to all the other localities with respect to leaf number and total leaf area obtained in four localities of Kartala, Pali, Kasabel and Manora were statistically on par with each other.
- Non conventional two Lac host species, viz., *Flemingia macrophylla* and *Flemingia semialata* were tried in the tropical region of Central India for the development of Lac based Silvi-agri-lac system. Preliminary results indicated that *Flemingia macrophylla* performed better than *F.semialata* in terms of survival and growth of the plants.
- *Pterocarpus marsupium* species gain 1.57m height at the age of 18 months as intercropped under the Silvi-horti-agri system under demonstration plots at TFRI, Jabalpur (M.P.).
- The farmers of Jabalpur and Madhya Pradesh adopted *Gmelina arborea* Roxb. based agroforestry system after the implementation of new act issued by the M.P. Forest Department on May, 2012 declaring *Gmelina* wood as Transaction Pass (TP) free
- Production of vermi-compost commissioned for revenue generation in CFRHRD, Chhindwara.

- Survey on forest types of two states viz. Madhya Pradesh and Maharashtra was conducted. In Maharashtra, points at Nasik, Nanded, Dhule, Thane, Nandurbar and Sironcha were surveyed by the centre. In Madhya Pradesh, points at Chhindwara, Betul and Harda were surveyed.
- Extensive survey on Biodiversity status of Chhindwara District was conducted in three forest divisions of Chhindwara District (East, West and South). Total 18 ranges were surveyed.

✓ East Forest Division – 6
✓ West Forest Division – 7
✓ South Forest Division – 5

Summary of the Projects

Project type	**Completed projects**	**Ongoing projects**	**New projects initiated during the year**
Plan	6	11	7+1(4 subprojects) = 11
Externally Aided	10	10+1(3 subprojects) = 13	6

1. ***INTRODUCTION***

Tropical Forest Research Institute (TFRI) Jabalpur, situated on the bank of Gour River on Mandla Road, is a premere 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, Orrisa 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) Lead Institution for Achanakmar-Amarkantak Biosphere Reserve, Chhattisgarh

Surveyed and collected a total of 558 insect samples which included butterflies, moths, beetles, bugs, grasshoppers, dragon and damsel flies. Identified 82 species of butterflies and moths, out of which 67 species were new addition to insect faunal composition of Achanakmar-Amarkantak biosphere reserve. Carried out interaction with Professors/Scientists/Research students of GGU, Chhattisgarh and APS University and New Science College, Rewa, Madhya Pradesh and requested for development of suitable research projects. Maintained periodical interface with Bioshpere Researve manager and assessed the research needs, such as tree mortality in Biosphere Reserve and other activity like monitoring and evaluation of developmental activities of MAP, 2011-12. Created web based information centre for Achanakmar-Amarkantak biosphere reserve and linked to the website of TFRI, Jabalpur (http://tfri.icfre.gov.in /AABR/index.html) to exchange and share technology. Submitted project proposal for designation of Achanakmar-Amarkanatk biosphere reserve on World Network of BRs recognized by UNESCO. The International Council of UNESCO's Man and the Biosphere Programme (MAB) meeting in Paris from 9-13 July 2012 declared Achanakmar-Amarkantak Biosphere Reserve under the World Network of Biosphere Reserves (WNBR). Organized workshops/trainings on Achanamar-Amarkantak biosphere reserve and training materials provided to the frontline staff of biosphere reserve. Published Biosphere Reserve Information Series BRIS **2**(1-2): 158 pp. and **3**(1-2): 93 pp. and prepared Biosphere Reserve Information Series BRIS **4**(1-2): 50 pp., for publication.

(ii) Standardization of pruning practices and optimum doses of organic and inorganic fertilizers to increase leaf surface area of tendu

Experiments on foliar spray of chemical fertilizers were conducted in Morga to observe the effect of different doses of fertilizers, either individually or in combination, on increment in size of tendu leaves using RBD factorial design **(Fig 2.1).** Maximum increase (16.19%) in surface area of tendu leaves was observed when a combination of 2% nitrogen and 1% phosphorus was applied through foliar spray, which was followed by 1% phosphorus treatment when compared with control.

Experiments on chemical and biofertilizers *viz.* urea, single super phosphate, vermicompost and neem based biofertilizer on enhancement of quality and sustainable production of tendu leaves were conducted at Morga, Kotadol and Litipara using RBD factorial design. In Morga, maximum increase in Specific Leaf Area of tendu leaves was observed with a combination of 25 kg/ha N + 100 kg/ha P (25.07%), followed by 500g neem based fertilizer + 1000g VAM (16.78%).

Experiments on pruning practices of tendu with treatments including time interval of pruning, height of pruning and girth classes were conducted at Morga, Kotadol and Litipara

using RBD Factorial design. At Morga, surface area of tendu leaves reduced to 37.90% and 56.11%, when pruned at 15cm and 30cm respectively in comparison to ground pruning.

Fig 2.1 Conducting experiment on application of chemical fertlizer on tendu leaves: (A) foliar spray and (B) Collecting tendu leaves from experimental site at Morga

(iii) Studies on the effect of different level of seed collection on natural regeneration of Sal (*Shorea robusta*) in Chhattisgarh

Three sites, Bastar, Raipur, Bilaspur and two sites at Koria Forest Division and Marwahi Forest Division were selected and laid out sample plots to study the effect of different level of seed collection, fire and grazing in pure, mixed and degraded sal forests of Bastar, Raipur, Bilaspur and two sites at Koria Forest Division and Marwahi Forest Division. Experiments were laid out in pure mixed and degraded sal forest of three sites, Bastar, Raipur, Bilaspur and two sites at Koria Forest Division and Marwahi Forest Division.

Enumeration of vegetation and status of regeneration of sal recruits had been carried out. 30 Nos. of soil and 15 Nos. mycorrhiza samples were collected. After eight months of observations very low percentage of recruits were observed to survive. T1 (0% seed collection) in pure sal natural condition with cleaning undesirable bushes (Keochi, Marhwahi) and pure sal open grazing (Tarra-Koria), T2 (80% seed collection) in degraded / mixed sal forest (open grazing) and degraded sal forest (control grazing) (Tarra-Koria), T3 (70% seed collection) in mixed/degraded sal forest with cleaning undesirable bushes (Keochi, Marhwahi) and pure sal forest non-grazing condition (Tarra-Koria)), T4 (60% seed collection) in pure / mixed sal forest natural condition (Keochi, Marhwahi) and pure sal forest natural condition (Aklasarai-Koria) and T5 (50% seed collection) in pure sal forest natural condition (with cleaning undesirable bushes) (Aklasarai-Koria), mixed sal forest (control grazing) (Tarra -Koria) and Fire effected sal forest (Tarra-Koria) and degraded sal forest natural condition (Keochi, Marhwahi) were found the best recruit status.

(iv) Population dynamics of selected threatened medicinal plant species and conservation management through community participation in buffer and transition zone of Achanakmar-Amarkantak Biosphere Reserve, Madhya Pradesh

A pilot survey of the East Karanjiya range comprising 105 compartments and Amarkantak range with 47 compartments was undertaken to locate populations of the target species viz. *Celastrus paniculatus, Embelia tsjeriam- cottam, Peucedanum nagpurens, Rubia cordifolia* and *Thalictrum foliolosum*. The selected threatened medicinal plant species were then studied by laying quadrat and transects and their density determined. Not a single population of *P. nagpurense* was found so far in both ranges, although there were many sites which constituted the characters of its habitat. Seven beats each in Amarkantak and East Karanjiya range were sampled for the population density of four target species, the rest did not harbour the target species as large to be termed as population. The localities were mapped. Almost all beats in Amarkantak and nearly 12 beats in East Karanjiya range had some compartments infested with invasive *Lantana* cover. The populations of *C. paniculatus E. tsjeriam- cottam,* and *R. cordifolia* shared almost same habitat. In terms of density, *C. paniculatus* was the most populous species. Its young plants were sourced from old population which had been cleared off by harvesters or forestry operations by clearing climbers The present population with density as high as 2781 plants ha^{-1}. (Beat Lapti) needed protection from grazing cattle and degradation of canopy trees. Rampant grazing and browsing was observed for *E. tsjeriam- cottam* as well. Although it had sizeable population at least in closed forest canopy of 30-45%, browsing by cattle affected its flowering and fruiting, which resulted in low yield as well as poor/near negligible regeneration. Few populations of *T. foliolosum* were found in both ranges of Amarkantak and East Karanjiya and the area of occurrence was not very large. However, there were areas identified which could prove to be good habitat. The species introduced or protected from human intervention could help in species area expansion. *R. cordifolia* showed regeneration and occupied area in accordance with its habitat requirement of closed canopy and slopes. The populations of *R. cordifolia* were recorded from Bhundakona, Bijauri, Damgarh, and Umargohan beats in Amarkantak along with few unsampled localities in Shambhudhara, Kapildhara and Sonmuda. In East Karanjiya range, it was observed in Chauradadar, Dakshin Chauradadar, Kabir, Kharidih, Jagatpur and Hazaridadar (Narigwara) beats. Although both ranges showed signs of biotic pressure and human interference throughout, the area still had potential factors favourable for rehabilitation and enhancing population of target species.

The permanent plots for monitoring population dynamics were laid and marked with target plants. 41 plants of *T. foliolosum* in 6 plots and 145 plants of *R. cordifolia* in nine plots were tagged after recording of initial observations, in least disturbed areas of Shambhudhara, Damgarh and Kabir to study the dynamics of population of the two species. However, the subsequent observations could not be taken as the end of project period did not allow second observation and proposed extension of another year was not granted. Soil samples were collected and analyzed from each site to assess its role in providing substrate to established population. The determined soil characterstics revealed that it might provide compatible conditions in sampled beats for the establishment of all the four target species. Four interface programmes were conducted in selected villages with forest protection committees to encourage and promote the techniques of sustainable harvesting of medicinal plants and importance of conservation. The knowledge dissemination tools involved posters, demonstration

with live plant material and photographs of threatened species. Nine species of medicinal plants *viz*. pudina, kali tulsi, bach, lemon grass, gwarpatha, adusa, giloy, aonla, harra and bel of direct use to villagers were distributed to encourage herbal homestead garden and promote use of herbals among them. Socio-economic profile of participants was assessed through that questionnaire. It was observed that 90% of participants had not harvested medicinal herbs and other NTFP's other than sal leaves, aonla, harra and mahul whenever available in last 2-5 years commercially. It was mainly due to unavailability of the produce.

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

Different girth/age group populations of *Bauhinia vahlii* (Mahul) were selected to lay out experiments for standardization of sustainable harvesting practices. In each study site 25 quadrates of 10mx10m were laid out in randomized block design. Experiments were laid out in the forest areas of Keochi, Pendra Road (Marvahi); Saplawa Pahadi, Pali (Katghora) and Futka Pahad, Balco (Korba). Each quadrate was sampled initially for Mahul population. 5 plants per quadrates were selected and harvested as per treatments. To standardize sustainable harvesting limits, 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. On the basis of Duncan's multiple range test (DMRT) T_1 treatment was found to be the best followed by T_2, T_3 and T_4. November was found to have more number of leaves and Balco, Korba was found to be the best site with respect to emergence/ presence of new leaves. Overall results revealed that treatment T_1 (50% harvest) was found to be superior among other treatments. Different methods of drying (room temperature, oven and sun drying) were experimented. Sun drying was found to be the best method for drying of leaves followed by oven drying. The quality of leaves collected from study area was assessed by measuring their size (length and width), insect and fungal infestation. Data revealed that the 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.

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

Surveys were conducted to Amravati, Akola, Buldhana and Nasik districts of Maharashtra for the collection of *Argyreia speciosa* (Samudrashokh), *Asparagus officinalis* (Satavari), *Asparagus racemosus* (Satawar) and *Curculigo orchioides* (Kali Musli). *A. racemosus* was found available at all the above mentioned places. However, *A. officinalis* being cultivated species could only be collected from farmer's field at Nasik and Nagarjuna Medicinal Plants Nursery of PDKV, Akola. *C. orchioides* was collected from Botha forest area of Buldhana district and Nehru Garden, Nasik. *A. speciosa* was collected from Amravati, Akola and Nasik. Antioxidant activity of *A. officinalis* shoots and *A. speciosa* leaves was estimated by DPPH method. Chemical constituents viz. total phenols and flavonoids were determined in *A. officinalis* and *A. speciosa* samples. IC_{50} value of fresh shoots of *Asparagus officinalis* collected from Nasik was found to be 14.96 mg ml^{-1} and 24.91 mg ml^{-1} in methanol and ethanol extracts

respectively. Total flavanoids and phenol contents in shoots of *Asparagus officinalis* were found to be 0.24% and 0.39% respectively. IC_{50} value of fresh leaves of *Argyreia speciosa* from Nasik, Amravati and Akola was found to be 12.06 mg ml^{-1}, 8.64 mg/ml and 24.91 mg ml^{-1} respectively. Total flavonoid content in leaves of *A. speciosa* ranged from 0.84 – 1.36% and phenol content ranged from 1.28 – 1.56%.

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

Surveys were conducted in different agroclimatic zones of Madhya Pradesh for collection of plant samples of *Gymnema sylvestre* (Gudmar), *Ocimum* sp. (Tulsi), *Phyllanthus amrus* (Bhui aonla) and *Tinospora cordifolia* (Giloe). Samples were collected from Kymore plateau and Satpura Hills comprising Katni, Umaria, Panna, Satna, Rewa and Seoni districts; Gir Region comprising of Gwalior, Shivpuri, Morena and Satpura Plateau comprising Chhindwara and Balaghat. Giloe stems having different diameter were cut into pieces of different size i.e. 1, 2 and 4 cm and kept for drying at room temperature to study the effect of processing method on drying. The stems cut into small pieces dried faster irrespective of diameter. The concentration of phyllanthin varied from 0.015% to 0.051% and ursolic acid from 0.016% to 0.092%. Essential oil was also extracted from tulsi leaves and yield was found to be 0.2%.

Tulsi plants were planted in nursery for carrying out experiments of harvesting limits. Plants were trimmed before flowering and after flowering for investigating the effect of flowering on the emergence of new branches. It was observed that the plants trimmed before flowering produced more number of branches than those trimmed after flowering. In Bhui aonla, inspite of uprooting the whole plant, the upper part (shoot) was cut to observe the emergence of new branches. In each plant 2-3 new shoots emerged.

(viii) National Network on Integrated Development of Jatropha and Karanja

175 Candidate Plus Trees (CPTs) of *Jatropha curcas* were selected from Jabalpur, Chhindwara, Seoni, Balaghat, Dindori, Mandla, Betul, Katni, Shahdol, Satna, Rewa, Panna, Gwalior, Shivpuri, Sagar, Damoh and Sheopur-Kala districts of Madhya Pradesh. CPTs were selected on the basis of seed yield, oil yield and germination percentage. 36 accessions in national trials and 14 accessions in zonal trial of Jatropha were established at Institute's campus, Jabalpur. Data on growth performance, seed yield and seed characters were recorded at regular intervals and oil estimation of the samples was also done. Best performing accessions were- SFRI-1, TNMC-22, PDKV-2, TFRI – 1, TFRI-2, IGAU–1, PDKV -1 and Palmpur–II, which performed better than others with regard to their growth characteristics, seed yield and oil content. In national trial, seed yield per hectare ranged from 101.49 kg to 157.70 kg and maximum yield was found in SFRI-1 (157.7 kg) >PDKV-2 (151.7 kg) >TFRI-1 (149.6 kg)>TNMC-7 (149.57 kg). However, oil content varied from 31.20% to 35.81% with maximum oil content in PDKV-1 (35.81%)>TNMC-22 (35.8)>TFRI-2 (35.77%)>IGAU-2 (35.10 %). In national trial II, maximum seed yield was found in Palampur –II (165.01 kg ha^{-1}) and maximum oil content was also found in Palampur –II (33.30%). In zonal trial, seed yield per hectare ranged from 137.03 to 168.24 kg and maximum yield was found in IGAU-3 (168.24 kg), TFRI-1 (165.31kg) and MPKV-1 (163.63 kg). However, oil content varied from 31.50 to 36.67% with

maximum oil content in RRL-4 (36.67%)>TFRI-2 (36.13%)>RRL-3 (35.70%). In National trial III best performing accessions were RJ-92, TR-4, JCP-2, NRCJ-17 and TNJC – 19.

81 candidate plus trees (CPTs) of Karanja were identified from five agroclimatic regions of Madhya Pradesh. Selection of CPTs was done according to their morphological characteristics (Tree height, GBH, crown area, number of branches, fruiting intensity, fruits per branch, fruit size, fruit yield, seed yield and oil content etc.). Best CPTs were found to be Bargi-4, Jabalpur; Chandna-2, Dindori; Chandna-1, Dindori; Kusmeli, Chhindwara; Sikharpur, Chhindwara; Bargi-4, Jabalpur; Lalpur, Satna; Nagound Road, Satna and Chandangoan, Chhindwara as determined by Duncan's multiple range test (DMRT). The selected CPTs were at Balaghat in 2005 comprising 20 progenies. Kusmeli; Chhindwara, Sikharpur; Chhindwara, Lalpur; Satna and Nagound Road, Satna were found most promising progenies among all other progenies. National trial of Karanja comprising 5 accessions, zonal trial comprising 17 accessions were established at Institute's campus. In national trial TNMP-14 and RAK-5 accessions performed better and in zonal trial, IGAU-3, CCSHAU–1, IGAU–3, NRCAF–2, IGAU–2, JNKVV-29 and JNKVV-15 performed better. In progeny trial established at Balaghat, the fruit bearing progenies were Kusmeli; Chhindwara, Sikharpur; Chhindwara, Lalpur; Satna Chandangoan; Chhindwara. In zonal trial this year, we observed fruiting in IGAU-1 (Raipur), TFRI-2 (Jabalpur), NRCAF–2 (Jhansi) and TFRI-3 (Jabalpur).

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

A multilocational trial comprising 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 nine plants were planted per plot at a spacing of 3m x 3m. On the basis of collar diameter, the best performing accessions were 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. Fruiting was observed only in 16 accessions. Further oil analysis could not be carried out as number of fruits was less. No major incidences of pest and diseases were observed in the plantation.

(x) Chemo-profiling of some Dasmoola species (*Uraria picta, Solanum indicum* and *Solanum xanthocarpum*) in Madhya Pradesh

A study was 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. Forest area was surveyed and different plant parts of *Solanum xanthocarpum* and *Solanum indicum* were collected from Malwa Plateau (Indore) agroclimatic region. The collected plant materials were processed & shade dried. Quantification of total alkaloids (%) in different parts of *Solanum xanthocarpum,* collected from three agroclimatic regions was found 2.43, 2.19, 2.27 (roots), 2.40, 2.41, 2.29 (stem), 5.23, 5.06, 5.09 (fruits) and 3.62, 3.78, 2.43 (leaves) of Kymore Plateau & Satpura Hills (Jabalpur),

Chhattisgarh plains (Balaghat) and Central Narmada Valley (Narsinghpur) respectively. Quantification of total alkaloids (%) in different parts of *Solanum indicum* collected from two different agroclimatic regions was found 3.05, 2.93 (roots), 2.16, 2.17 (stem), 3.58, 3.48 (fruits) and 3.65, 3.58 (leaves) of Satpura Plateau (Chhindwara) and Chhattisgarh plains (Balaghat) respectively. Total flavonoid content in the root, stem and leaves of *Uraria picta* was found 0.117, 0.42 and 0.94% respectively.

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

Immature and mature fruits were collected, processed fruit and separated their pulp. Three value added products (A) Kusum concentrate (B) Kusum leather and (c) Kusum katmith were prepared from the pulp **(Fig: 2.2**. The nutritional values of Kusum concentrate (total carbohydrates 67.5 %, ascorbic acid 0.71, CFC 7.3 % and protein 0.17 %), Kusum leather (total carbohydrates 86.0 %, ascorbic acid 0.73, CFC 7.9 % and protein 0.17) and Kusum katmith (total carbohydrates 77.5 %, ascorbic acid 0.76, Crude fiber content 7.5 % and protein 0.17 %) were estimated.

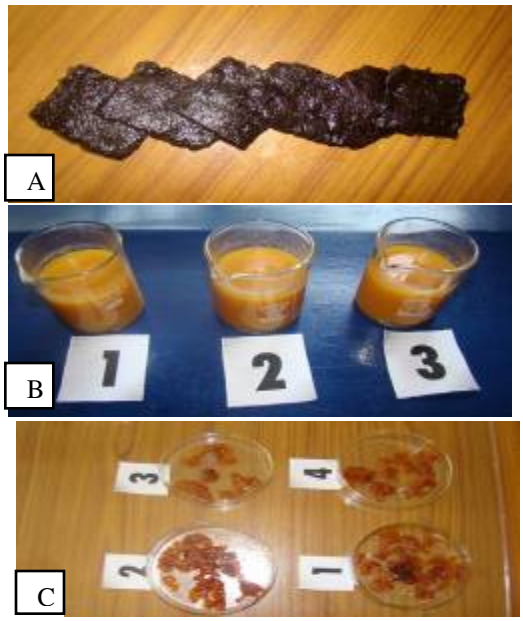

Fig 2.2: Value added products of Kusum: A- Kusum leather, B- Kusum concentrate and C- Kusum khatmith

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

Samples of *Shorea robusta (*seeds*), Madhuca indica* (seeds) and *Amorphophallus companulatus* (tubers)*, Pheonix acularis* tubers) were collected. Starch was isolated from potato, and *Amorphophallus companulatus* for the preparation of bioadhesives. Starch, total phenols, protein and tannins were estimated in defatted *S.robusta*, *M.indica* and *J.curcas* seeds.The adhesive was prepared with alkali and acid as gelatinization modifier at different concentration and its effect on viscosity.

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

Seeds of *Jatropha curcas, Sapindus mukrossi, Schleiochera oleosa and Pongamia pinnata* were collected and processed. Seeds biochemicalwere isolated. Physico-chemical properties of different oil seeds were determined. Standardized modification i.e. saponification and diethanolamide of oil and protein of seeds. Saponification process was characterized by FTIR spectra, the maximum saponification in samples saponified with 2M ethenolic KOH for 2 hour at 70ºC was observed.

The properties of modified products viz., solubility, surface tension, viscosity, foaming power, critical micelle concentration and alkalinity of were assessed. The surface tension of *P.pinnata*, *J.curcas* and *S.mukrossi* diethanolamides varied from 0.030-0.0504 dyns cm^{-1} at 1-10% concentration while viscosity of different dilutions varied from 1.19-47.7 MPa. The pesticidal activities of products formulations were assessed against forest insect pest of *Tectona grandis* and *Albizia spp*. i.e. *Eutectona machealaris* and *Spirama retorta* and fungicidal activities against *Fusarium oxysporum*, *Penicillium crysogenum*, *Alternaria alternate,Flavodon flavus , Ganoderma lucidum, Tramatis cingulated*, *Stachylidia spp*.. *S. mukrossi* and *P.pinnata* surfactant formulations showed feeding deterrency, mortality and fungicidal activities.

(xiv) Studies on the dynamics of litter decomposition in sal forest of central India and its impact on the nutrient status of soil

Lophodermium shoreae, a dominant sal litter colonizer was recorded from the experimental sites of MP, CG and Orissa. Combination of *Trichoderma harzianum*, *Cladosporium* sp. and *Aspergillus niger* accelereted decomposition of litter and also contributed nutritional substances to the soil. Fourteen documents of interesting fungi were prepared (**Fig 2.3**). Seasonal influence of micro fauna during litter decomposition of sal was also been evaluated.

Fig 2.3: Some mycorrhizal furctifications of sal forest

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

Inocula of AM fungi and bacterial biofertilizers were produced for quantification of infective propagules. Infective propagules in different inocula regularly determined exhibited decline in infective propagules with the time Decline in population of soilrite based inocula of *Rhizobium* (isolated from tinsa nodules) was recorded and noticed that there was sharp decline in population after 15 days (73%) and then constant for two months and after three months the population declined up to 80% at ambient room temperature. Pot experiment was conducted to assess response of AM fungi and *Azospirillum* on bael (*Aegle marmelos*). After nine months plant height, dry biomass, root colonization and shoot P contents were determined. Application of AM fungi in combination with *Azospirillum* produced maximum plant dry biomass and shoot phosphorus content. Maximum root colonization was also recorded in AM fungi and *Azospirillum* treatment. Application of *Azospirillum* along with AM fungi showed a synergistic effect on root colonization. On the basis of above, application of AM fungi along with *Azospirillum* was recommended to boost the growth of bael seedlings in nursery (**Fig. 2.4**). Pot experiments on mahua, tinsa and beeja sal are also in progress. Samples were collected from Barha, Jabalpur and three different localities of Mandla districts, MP for isolation of biofertilizers. From these samples microbial inoculants were isolated and AM spores population were estimated in laboratory.

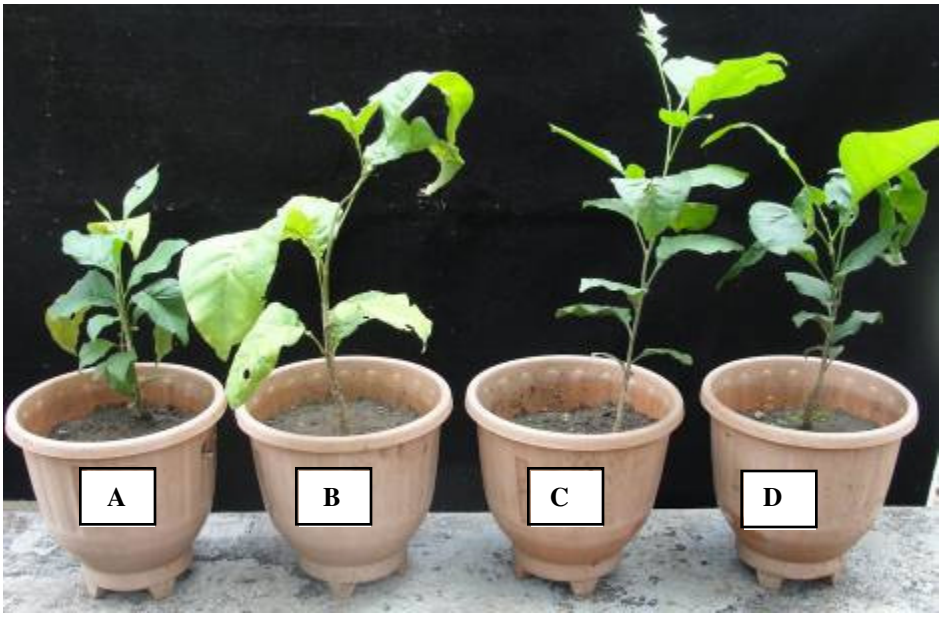

Fig 2.4: Effect of different growth promoting microbes on growth of bael seedlings in pot experiment (A) Control (B) AM fungi (C) *Azospirillum* (D) AM + *Azospirillum*

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

Survey was conducted in Kanhan region of Western Coal Fields Limited, Junnardeo and Pench area of Western Coal Fields Limited, Shivpuri for selection of coal mine overburden site for laying out experiment. Shivpuri open cast coalmine at Haranbhata was selected for taking up the experiment. Overburden samples were collected from the selected site and the samples

were analyzed for its physico-chemical properties *viz*, texture, bulk density, pH, EC, organic carbon, Available N,P, K, cation exchange capacity, exchangeable Ca, Mg, available micronutrients viz. iron, manganese, zinc and copper. Plantation was established with ten species. Leaf samples were analysed for nitrogen, phosphorus and potassium. Plant height and girth data were recorded at quarterly intervals. Good survival and growth of *Gmelina arborea, Mangifera indica, Moringa oleifera, Cassia siamea* and *Emblica officinalis* was recorded.

(xvii) Development of Entomopathogenic Nematode based strategy for the management of termites and white grub pests of major forest tree species

One of the EPN isolates, TFRIEPN-15 (*Steinernema* n. sp.) was identified (at molecular level) as new-to-science by CABI, Kew, UK. Investigated improved parameters for economical and successful mass-multiplication of the native populations/ isolates, including the most suitable temperature for the native EPN populations. The native populations, TFRIEPN-15 and TFRIEPN57 (*Steinernema* spp.) could sustain the temperature up to 36^0C, as compared to other native and known populations; *S. carpocapsae* and *H. indica* (NBAII populations). NBAII populations could not sustain temperature at and above 34^0C. Investigations on ssusceptibility of white grubs, *Holotrichia rustica* to the native populations/ isolates of EPNs revealed that TFRIEPN-57, TFRIEPN-15 (*Steinernema* spp.), followed by TFRIEPN-50 (*Heterorhabditis* spp.) were effective at 6000 IJs Larva^{-1} under controlled experimental conditions in two weeks. This was also confirmed by their ability to cause quicker mortality within 5-9 days as against other populations including the known populations of *S. carpocapsae* and *H. indica*. The investigations revealed that white grubs may be effectively managed by EPN population at and above 6000 IJs Larva^{-1} and the native populations of *Steinernema* sp., TFRIEPN-15, TFRIEPN-57 and *Heterorhabditis* sp., TFRIEPN-50 can be used either individually or in combination with the Chlorpyriphos or imidacloprid for enhanced effect.

For isolating more populations from central India, surveys were carried out and 100 samples were collected from two teak plantation areas of Kundam Project (M.P. Forest Development Corporation, Jabalpur (Slimnabad, Jirri, Dhimarkheda) and Dindori Territorial Forest Division, Dindori, (Karanjia, Jagatpur, Amarkantak) in Madhya Pradesh, Chhattisgarh and Maharashtra. One unidentified population of *Steinernema* sp. TFRIEPN-57 was isolated and culture maintained successfully.

(xviii) 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.

(xix) Damage assessment of gall making insect species of eucalypts and its management by pesticides

Developed insectary/nursery of eucalypts for experimental purpose to study the gall insect and its subsequent management in seedling stage. Conducted survey of forest nurseries/plantations to collect gall making insect species of eucalypts and its natural enemies. Recorded three insect defoliators for the first time feeding on eucalypts in nursery stage. Identified gall insect and its predator, *Illies indica* Timberlake (Coleoptera : Coccinellidae). Studied morphology of gall insect and galls. Assessed damage impact of gall insect of eucalypts in nurseries/ plantations and found to be a major pest in nursery stage. Laid out experiments with biopesticide (Spinosad 45% SC) and chemical pesticides (Monocrotophos 36% SL, Dimethoate 30% EC, Dichlorvos 76% EC, Hydrochloride 50% SP, Acephate 75% SP , Acetamiprid 20% SP, Imidacloprid 17.8% SL and Fipronil 5% SC) against gall insect in nursery stage. Collected periodical data (15 days interval) on development of galls in laid out experiments. Studied growth (height and collar diameter) and development of galls in relation to age of seedlings. Results revealed that spraying of biopesticide and chemical pesticides on seedlings of eucalyptus for six months at 15 days interval, effectively reduced the gall formation and increased the growth of seedlings both height and collar diameter.

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

Laboratory experiments were laid out against kalihari defoliator, *Polytela gloriosae* and muskdana defoliator, *Anomis 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 kalihari defoliator, *Polytela gloriosae* and muskdana defoliator, *Anomis flava.* After seven days of treatments*, Bacillus 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 kalihari defoliator, *P. gloriosae.* Predator *C. cornea* followed by parasite *T. chilonis* was found to be most effective for reduction of the larval population after 25 days.

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

Surveyed sal forest areas of Mandla and Dindori Forest Division of M.P. for monitoring of sal borer and collection of information on borer incidence, and abiotic and biotic factors. Investigated sal borer incidence in East Karanjia Forest range where 345 trees were marked as damaged by sal borer, South Samnapur Forest Range where187 sal borer affected trees were marked, and Bajag Forest range where 167 trees were marked for borer attack in Dindori Forest Division of M.P. Collected mature grubs and wood dust from attacked trees. Collected and identified predator of sal borer, *Alaus sordidus* (Coleoptera : Elatridae). Laid out sample plots in sal forest areas of Mandla, Dindori and Anuppur Forest Division of M.P. for borer incidence and subsequent management of sal borer. Prepared leaflet and brochure on sal heartwood borer for distribution to front line staff of M.P. Forest Department.

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

The Greater waxmoth, *G. mellonella* was continuously cultured in laboratory round the year for use as fictitious host for *in vivo* culture of entomopathogenic nematodes. 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 the target pests and compared efficacy with *H. indica and S. carpocapsae*. Determined optimum doses of native EPN populations against teak defoliator and skeletonizer. Experimented innovative method of field application of EPNs and related parameters affecting field applications. Pilot experiments carried out with individual and combination of EPNs with insecticides in field. Observations on other important related aspects which can contribute to successful application of EPNs against defoliators as a part of IPM programme. Further work is in progress.

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

Entomopathogenic fungus was isolated on dead larvae of bark eating caterpillar. Fungus was purified and identified as *Aspergillus* sp. for further field experiment. Six varieties and one local -wild of aonla (*Emblica officinalis)* were screened against the bark eating caterpillar. Field experiment was laid out in randomized block design to study the effect of microbials (fungal suspension $1x10^6$) and biopesticides (*Beavaria bassiana* 1% ; *Bacillus thuringiensis* 1% , neem based gronim 1% ; crude extract of *Cleistanthus collinis* 10% and combination of *C. collinis* + cow urine + vermiwash against bark eating caterpillar, *Indarbela quadrinotata. B. thuringiensis* ; Neem based Gronim; followed by crude extract of *Cleistanthus collinis* was found to be most effective against bark eating caterpillar, *I. quadrinotata.*

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

Surveyed nurseries / plantations and natural forests of teak, bamboo and aonla and collected eggs, nymphs and adults of *C. furcellata*. Carried out rearing of predator at different temperatures in laboratory. Observations recorded on predatory behaviour of *C. furcellata*.

(xxv) Potential pathogens and insects responsible for the low seed production in teak seed orchards (TSO) and their management

Microflora of teak (*Tectona grandis*) during inflorescence period were recorded from the Mandla and Jabalpur Forest Division during August 2012.The fungal flora recorded were *Absidia fusca, Alternaria alternata, Alternaria raphani, Ampulliferina fagi, Aspergillus flavus, A.fumigatus, A.niger, Cladosporium cladosporoides, Colletotrichum capsici, Curvularia lunata, Fusarium moniliformae, F.pallidoroseum, F.solani, F.oxysporum, Gliocladium deliquescens, Helminthosporium australiensis, Humicola grisea, Phialophora lagerbergii, Phoma glomerata, Rhizopus stolonifer, Rhizoctonia solani, Scytalidium sp., Septonema philippinum, Sporotrichum pruinosum, Sterile mycelium, Trichoderma koninghii* and *T. pseudokoninghii*. Bioassay test were

conducted in the laboratory with spermoplane fungi isolated from teak. The antagonistic potential of *Bacillus amyloliquifaciens* and *B. mycoides* were tested against spermoplane mycoflora by dual culture method. Some teak seed borer insects like– *P.salvalis, D.punctiferalis, D.pendamalis and E.macheralis* were also collected from teak fruit. One field experiment, using biopestcides (*Bacillus thurengensis, B.amylolequifaciens*), insecticides (Monocotophos), 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.). The result of the experiment showed maximum number of fruits and weight of teak fruits in the treatment of Monocrotophos(0.05%) + Bavistin (0.02%), the insect and fungal damage was also less in the treatment, whereas other treatment did not show significant result. 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.

(xxvi) Development of Lac Based Agroforestry (Silvi- Agri-Lac) System

Kusumi strains were collected from flemingia bushes planted at Kanker Forest department on the new shoots of Flemingia species viz. *F.macrophylla* and *F.semialata* under the lac based Silvi-agri-lac system as an OSR trial during January, 2013. Agriculture crop *Cajanus cajan* were intercropped in the interspaces of *Flemingia* plants- a bushy lac host species. Nitrogen was maximum 313.6 kg ha^{-1} and minimum 156.8 kg ha^{-1}, Phosphorus was maximum 10.96 kg ha^{-1} and minimum 5.8 kg ha^{-1}, Potassium was maximum 103.06 kg ha^{-1} and minimum 78 kg ha^{-1} and pH value was found maximum 7.2 and minimum 6.8. Leaf folder attack on the seedlings of the *Flemingia* was recorded. The affected plants were controlled by spraying of spinosit.

(xxvii) Evaluation of *Madhuca indica based* Silvi-agri system

The field was selected and established with Mahua seedlings (grafted as well as seed originated) in the experimental area of agrofoestry division. Soil samples from the experimental area were collected and evaluated the status of soil nutrient available in the field. A 50% casualty of grafted Mahua plants were recorded whereas seed originated plants performed well. The field was poor in Nitrogen (125 kg ha^{-1}), Potassium (134.08 kg ha^{-1}) and phosphorus (6 kg ha^{-1}) in seed originated plot. Similarly, field condition of grafted mahua plot also contained poor nitrogen content i.e. 156 kg ha^{-1}, 181.8 kg ha^{-1} of potassium and very low level 0.8 kg ha^{-1} to 7.7 kg ha^{-1} of phosphorus which might be improved by establishing the Gram with mahua based Silvi-agri system.

(xxviii) Development of Silvi-Agri-Medicinal and Agri-medicinal systems in Vidharbh region of Maharashtra

The adjoining villages of Chandrapur district of Vidharbh region of Maharashtra state were surveyed to select the farmer's field for the establishment of the Silvi-agri-medicinal system to create awareness and adaptation of agroforestry system among the farmer of Maharashtra. Finally selected farmer's field and discussed with him about the agroforestry system. Collected soil samples indicated 188.6 kg ha^{-1} to 313.6 kg ha^{-1} N and pH value 6.0 to 7.24, OM 0.62 to 1.97% and Ca and Mg- 19-60 mg/100g and 9.6-46 mg/100g respectively. The site was timely prepared for establishment of the said system (**Fig 2.5**).

Fig 2.5: A Panorama of the Pawan Golchha's Farm, Katoli village of Chandrapur district (M.S.)

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

To revive the lac cultivation in the villages of Jabalpur through training and demonstration for additional income generation to the villagers/farmers and for the sustainable production of lac on conventional host (*S.oleosa, B.monosperma and Z.mauritiana*) as well as non-conventional host (*Flemingia* species) in the selected ten villages, interacted and explained the objective of the project with the villagers of Narai-Sohad, Bahmnoda and Ranipur village to sensitize them towards lac cultivation. Broodlac of Kusmi strains were procured from the Chhattisgarh forest department, Kanker and inoculated 15 trees of *Schleichera oleosa* (kusum) at tikariya village and 10 trees of *Zizyphus* mauritiana (ber) at TFRI campus (**Fig 2.6 & Fig 2.7**).

Fig 2.6: Preparing bundle of broodlac and Kusumi Broodlac ready for inoculation on new hostplant

Fig 2.7: Bundles of brooklac ready for inoculation and Inoculation of broodlac on new host kusum trees

3*. Biodiversity Conservation and Ecological Security*

(i) Investigation on floristic diversity in teak plantation of various age groups in Barnawapara Project Division, Raipur, Chhattisgarh

Plantations promote understory regeneration by shading out grasses and other light-demanding species, changing understory microclimates, improving soil properties and increasing vegetation structural complexity. With this view the project was started to determine the changing of plant diversity in different year old plantation, changing of soil properties in teak plantation and the similarities between plant species in each of teak plantations and plant species in natural forest of teak (**Fig 3.1**).

Fig 3.1: Team at work with forest officials and Teak plantation

Enumeration of vegetation was carried out in three ranges viz. Rawan Range, Raikera range and Sirpur range of Barnawapara project division, Raipur (CG). 48 trees, 12 shrubs and 36 herbs species were recorded in different years aged plantations from selected three ranges. The compartment wise dominant tree species were- Teak, Sinha, Karra, Saja, Char, Bija, Mahua, Tendu, Dhawara, Kasai, Bhilwa, Kusum, Moyan, Baheda, Kumbhi, Amaltas, Dhaman, Ghont and Chimti in 12 compartments of Rawan Range.

In Raikera range the vegetation data was recorded in 03 compartments. The compartment wise dominant tree species were- Teak, Sinha, Dhawda, Tendu, Karra, Mahua, Birra, Moyan, Koriya. In Sirpur range the vegetation data was recorded in 10 compartments. The compartment wise dominant tree species were- Teak, Bhirra, Sinha, Saja, Dhawda, Mahua, Karra, Kurru, Bhirra, Kasai. Soil samples were collected from the study sites and analysis of soil samples is in progress.

(ii) Vegetation Carbon Pool Assessment Project in India

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 envisages temporal inventory of the forest and soil carbon stocks as well as measurement and modeling 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 was one of them. Collected soil samples and analysed the parameters soil moisture % and soil carbon %, EC, pH, N, P and

K. Determined litter production, decomposition rate and herb/Shrub Biomass (**Fig 3.2**). Carried out inventory of teak forest and measurement of Leaf Area Index of 10 major species using Ceptometer LP-80 in experimental site (**Fig 3.3**). The data of phenophase of 10 species were recorded.

Fig 3.2: Collection of Herb/Shrub Biomass, litter collection net and litter decomposition bags

Fig 3.3 LAI measurement using Ceptometer LP - 80

(iii) Documentation and distribution of Forest Invasive Species (FIS) of Jabalpur, Katni, Mandla and Seoni districts of Madhya Pradesh

39 invasive species so far been documented and identified from forest area of four districts.

(iv) Population dynamics of Threatened medicinal plants species growing in buffer and transition zone of Tadoba National Park Maharashtra

Permission granted from Chief-Wildlife Warden to work in TATR for the study and maps/working plan of the study area were collected. Following species were suggested for the study after discussion with officials of forest department

- *Chlorophytum borivilianum* Santapau & R.R.Fern.
- *Dipcadi ursulae* **Blatt.**
- *Eulophia nuda* **Lindl.**
- *Uraria picta* (Jacq.) DC.

- *Eulophia ramentacea* **Wight**
- **Rauwolfia serpentina (L.) Benth. ex Kurz**
- *Desmodium gangeticum* (L) DC

(v) Ecological assessment of diversity of medicinal plants in conservation areas of Chhattisgarh and strategies for their protection

Seasonal data for floristic composition was collected from 7 Medicianal Plant Conservation Areas (MPCA) established in Chhattisgarh. Phytosociological studies showed that there was a marked seasonal variation in ground flora of these Conservation Areas. 251 plants were identified and documented from the conservation areas of Chhattisgarh. Herbarium for 132 species of medicinal importance was prepared and submitted to Funding Agency, Chhattisgarh State Medicinal Plant Board, Raipur, Chhattisgarh.

Trends in population growth and regeneration of important tree species were studied at conservation areas of Chhattisgarh. Succession pattern of the community was determined by studying community structure and size class distribution of important trees in the conservation areas. Species of conservation priority were enlisted and linked to *Ex -situ* and *In-situ* conservation by establishment of Community Field Gene Bank Community Gene Bank and Community Seed Bank with participation of local communities was suggested to promote conservation (**Fig 3.4**).

Fig 3.4: Important medicinal plants growing in MPCA, Chhatisgarh

(vi) Germination ecophysiology of two important tropical forest tree species: *Schleichera oleosa* and *Pterocarpus marsupium*

Mature seeds of *Pterocarpus marsupium* and *Schleichera oleosa* were collected from Jabalpur (MP), Chindwara (MP) and Korba (Chattisgarh). Effect of soil type and depth, light and temperature on germination of these two species was evaluated. Sampling for germination showed that both species are orthodox in nature and dormancy of *Schleichera oleosa* was overcome after one year of storage. Deterioration of seeds of *Schleichera oleosa* was observed at different temperatures, if stored at high moisture content. Viability of seeds of *Pterocarpus marsupium* was maintained for more than one year at all temperatures and moisture content (as high as 10.5%). Effect of maturation on dormancy and germination of seeds of *Schleichera oleosa* and *Pterocarpus marsupium* seeds was evaluated. Seeds of *Pterocarpus marsupium* acquired germination capacity and desiccation tolerance well before shedding.

(vii) 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

Fruits of *Sterculia urens* and *Bridelia retusa* were collected during March –May. Seeds were pretreated to increase the germination of *Sterculia urens* and *Bridelia retusa.* Removal of germination inhibitor in seed coat resulted in the increase in germination of *Sterculia urens.* No treatment was successful to induce germination of *Bridelia retusa.* After ripening procedure was continued for these species. Maturation studies are continued in *Sterculia urens* and *Bridelia retusa.*

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

Project initiated from January, 2013. Jungle / site clearance and staking work were completed. Seedling preparation / procurement and pit digging work is in progress.

(ix) Studies on larval parasitoids, *Apanteles* spp. (Hymenoptera: Braconidae) of major defoliators of teak and sal forests of Orissa

Surveyed teak and sal forests of 106 localities belonging to 13 districts of Orissa (Angul, Bargarh, Balangir, Boudh, Ganjam, Jharsuguda, Kalahandi, Koraput, Phulbani, Nawapara, Sambalpur, Sonepur, Sundargarh) for the collection of larvae and pupae of major defoliating insects. Collected 336 samples of larvae and pupae of teak and sal defoliators from field during their population outbreak. Identified 37 species of *Apanteles*, viz. *Apanteles agilis, A. antipoda, A. antraliensis, A. aristolochiae, A. ashmeadi, A. belippae*, *A. bambusae*, *A. caniae*, *A. creatonoti*, *A. colemani*, *A. cylycinae, A. detrectans*, *A. detrectans*, *A. deliodis*, *A. efferenus*, *A. expulsus*, *A. endymion*, *A. erionotae*, *A. fuseinervis*, .*A. hasorae, A. hemitheae, A. hyblaeae*, *A. hyposidra*, *A. javenensis, A. lakhaensis*, *A. lamprosemae*, *A. leptothecus*, *A. machaeralis*, *A. neocajani*, *A. neotaeniticornis*, *A. obliquae, A. philoeampus*, *A. prodeniae, A. prosper*, *A. recusans, A. rudius, A. tachardiae* and *A. taprobanion* on defoliators of teak, namely *Hyblaea puera* Cramer (Lepidoptera : Hyblaeidae) and *Eutectona machaeralis* (Walker) (Lepidoptera : Pyralidae) and sal, namely *Lymantria mathura* Moore (Lepidoptera : Lymantriidae) and *Paectes subapicalis* Walker (Lepidoptera : Noctuidae). All these *Apanteles* spp. are indigenous and these are being recorded for the first time from Orissa. Worked out natural field parasitisation of different species of *Apanteles*, parasitising the defoliators of teak and sal. Studied biology of *Apanteles machaeralis* on teak skletonizer, *E. machaeralis*. Conducted laboratory tests of *Apanteles* species against target insect pests.

(x) Taxonomy and documentation of wood decay fungi of Chhattisgarh and Orissa

Survey was conducted in the rainy season of the year 2010, 2011and 2012, 59 forest areas under districts were visited in Chhattisgarh (41) and Orissa (18) from there 727 specimens of wood decaying were collected on thirty five timber tree species. The following species of wood decaying fungi were identified- *Auricularia polytricha, Daldinia concentrica, Daedalea flavida, Ganoderma lucidum, Favolus sp., Flavodon flavodon, Hymenochaete*

rubiginosa, Polyporus sp., Hypoxylon sp., Mircroporus xanthopus, Hexagonia teneuis, Ramaria sp., Pycnoporus sanguineus, Stereum sp., Coriolopsis sp., Necteria sp., Lenzites elegans, Schizophyllum commune, Phellinus sp., Boletus sp., Pyrofomes tricolor,Trametes cingulata, Trichaptum bisogenum, Xylaria polymorpha, Earliella scabrosa, Navisporus floccosa, Leucocoprinus birnbaumii, Mycena rosella, Helvella sp., Phlyctaeniella sp., Hapalopilus nidulans, One new species *Phlyctaeniella indica (**Fig 3.5**)* and two species were recorded as new record to India namely *Leucocoprinus birnbaumii* and *Mycena rosella*. The occurrence and distribution of wood decaying fungi on different host in forest and wood depots of Chhattisgarh and Orissa was also reported. The maximum number of wood decaying fungi recorded from Chhattisgarh and minimum with Kopriya Orissa. Three species were common to all place are *Flavodon flavus* (Kolt) Ryv. *Trametes cingulata* Berk and *Schizophyllum commune* Fr. With 100% occurrence and frequency. Twenty five (25) cultures of wood decaying fungi were isolated. Cellulolysis Adequacy Index (CAI) for dominant wood decay fungi found in the study area was measured. On the basis of CAI activity correlation cannot be framed regarding comparison of species with same genera, because the activity was varied from species to species and genera to genera.

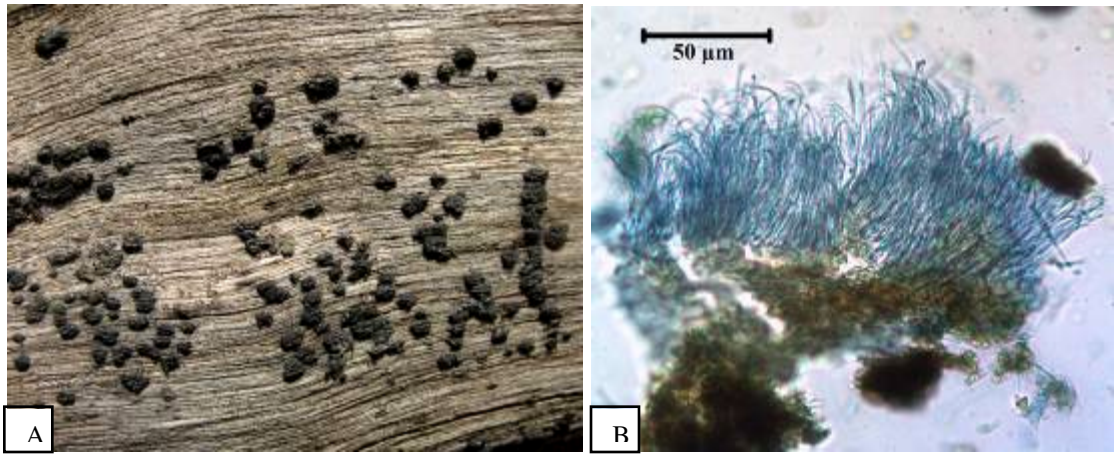

Fig 3.5: New species: (A)- *Phlyctaeniella indica:* Symptoms on wood and (B)- Pycnidia with conidiophores and attached conidia

4. Forests and Climate Change

(i) Monitoring the impact of climate variables on plant diversity in Bhimashankar permanent preservation plot of Sub tropical hill forest of Maharashtra

Preliminary survey was carried out in compartment No. 200 A for general information pertaining to site, terrain, physical features and vegetation. Enumeration of vegetation was carried out in three permanent preservation plots. 30 quadrats of 20m x20m were laid out for the enumeration of the vegetation in 3 preservation plots, 120 quadrats (5mx5 m.) laid out for the study of shrubs and saplings along with invasive species. 120 quadrats (1mx1 m.) were laid out for herbs and grasses in preservation plots. Number of tree species along with height, girth and shrubs, herbs and grass occurring in the respective quadrats were recorded. 25 trees, 1 shrub, 4 climber, and 6 herb species were documented and identified from preservation plots. Floristic identification for Inventorization and phenological observations on important species was carried out (**Fig 4.1**). Vegetation analysis is in progress.

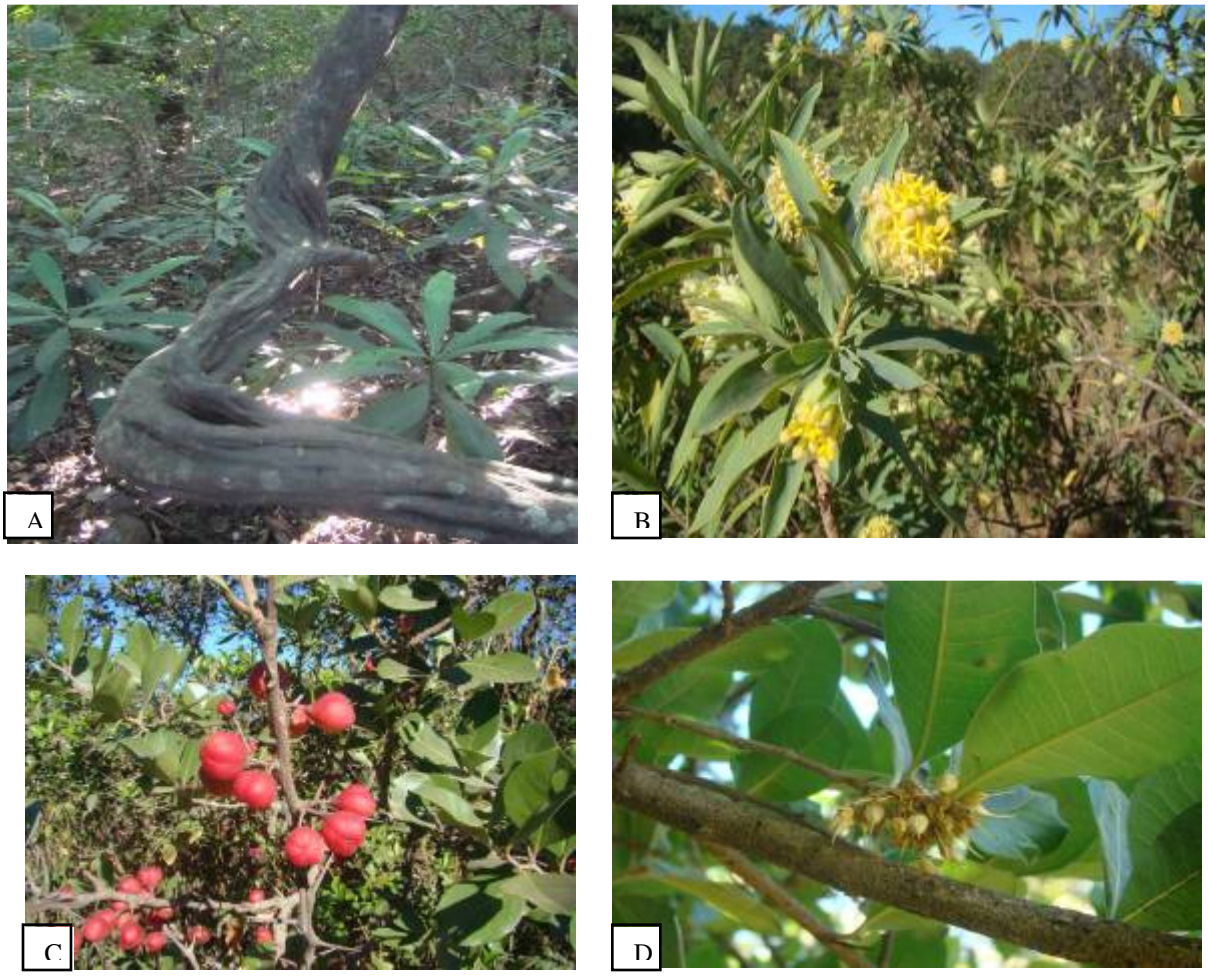

Fig 4.1: Some of the prominent flora found in compartment No. 200A: (A)- ***Entada phaseoloides*** (B)- ***Lasiosiphon eriocephalus, (C)- Maytenus rothiana and (D)- Xantolis tomentosa***

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

Selected 10 sites of 0.1 ha size each in three Tiger Reserves of Madhya Pradesh namely, Satpuda, Panna and Pench on the basis of floral diversity and canopy density. Laid out quadrats for trees, litter biomass and herbaceous biomass, collected growth data *viz.* height and GBH of trees falling in the selected quadrats **(Fig 4.2)**. Litter biomass and herbaceous biomass were quantified in the laid out quadrats in all three Tiger Reserves. Collected soil samples from the selected quadrats and estimated moisture content and analysed samples in laboratories for their physico-chemical parameters.

Major tree species in Panna Tiger Reserve were found to be *Tectona grandis, Acacia catechu, Anogeissus pendula, Chloroxylon swietenia, Zizyphus xylopyrus* and *Boswellia serrata.* In Pench Tiger Reserve *Tectona grandis, Pterocarpus marsupium, Buchanania lanzan, Syzygium cumini, Zizyphus xylopyrus* and *Chloroxylon swietenia* trees species were abundantly found. *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.

Fig 4.2: Laying out quadrate for data collection on herbaceous biomass and recording growth data of trees

5*. Forest Genetic Resource Management and Tree Improvement*

The institute is engaged with genetic improvement of forestry species, encompassing conservation of genetic resources of *Azadirachta indica* and *Rauvolfia serpentina*, improvement of *Diospyros melanoxylon*, *Bauhinia vahlii* and *Pterocarpus marsupium* through collection and selection of germplasm and biotechnological interventions, including molecular marker assisted evaluation of germplasm for future performance of *Boswellia serrata*. Project wise achievements are given below:

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

RAPD and ISSR primers were screened and selected for the amplification of genomic DNAs. The leaves and wood core samples of 20 individuals from the 12 different populations were collected along with the observation of Leaf morphology, height and girth, crown shape. Genomic DNAs was extracted from the nine populations and their purity index was of desirable quality.

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

The experiment was conducted to screes suitable basal media and their strength for in vitro rooting. Among different basal media and hormones, the maximum of 81.67% rooting was obtained on ½ B5 medium in GO-MN genotype (**Fig 5.1**). In the interaction studies the maximum number of root (7.06) was obtained on MS medium in KL-AJ genotype, which was at par with GO-SG (7) and significantly different than other genotypes and basal media. Among different hardening substratum soilrite merged as the best medium for hardening with 100% survival. The experiment was conducted for organogenesis. Varied response of organ formation was noticed in different genotypes depending upon different concentration of growth hormones. In the interaction study, the maximum shoot formation was obtained in 5 mg/l BA and 4.5 mg/l NAA in GO-MN genotype which was statistically significant to other genotype and hormonal doses. In the interaction study, the maximum rooting (66%) was obtained in 2.5mg/l BA and 8.5mg/l NAA in GO-MN genotype. The ready hardened plantlets were transferred to the field **(Fig 5.1A)**.

Fig 5.1: Maximum rooting (81.67%) of *R.serpentina* obtained on ½ B5 medium in GO-MN genotype

Fig 5.1A Plantlets raised through micropropagation and seedlings are in the field condition

(iii) Studies on variations with respect to *in vitro* azadirachtin production in selected high yielding populations of *Azadirachta indica* A. Juss

Variation with respect to azadirachtin content in the samples was observed within and between populations. Maximum azadirachtin was present in the seeds of Gwalior which was on par with Chhatarpur, Katni, Sihore, Shahdol and Chhindwara. Maximum azadirachtin in *in vitro* shoots was present in the cultures of Gwalior which was statistically on par with Sihore. Positive correlation was obtained between azadirachtin (%) obtained in seeds and *in vitro* shoots.Positive correlation was observed in the neem oil (%) and azadirachtin (%) in seeds. Positive correlation was observed between neem oil (%) and azadirachtin (%) in *in vitro* shoots. Positive correlation between the neem oil (%) and azadirachtin (%) in seeds can be utilized to identify trees with high azadirachtin content in their seeds. Intra-population variation was more than inter-population variation for azadirachtin content (%) of seeds and *in vitro* shoots.

Highly significant differences were observed among five populations of neem viz., Raigad, Shahdol, Bilaspur, Chhindwara and Gwalior for number of shoots after 30 days of inoculation. Maximum number of shoots per nodal segment were obtained in cultures of Raigad (r=0.60) which was statistically on par with the number of shoots obtained with cultures of Shahdol (r=0.43) and Gwalior (r=0.51). A factorial randomized experiment was conducted to study the effect of plant growth regulators and their interactions on *in vitro* shoot multiplication using nodal segment as explants. Best shoot multiplication and maximum shoot length was obtained on Full MS, 3/4 MS, 2/3 MS and ½ MS strengths. This indicated that for *in vitro* shoot multiplication of neem, MS medium can be reduced to 3/4 MS, 2/3 MS or ½ MS without hampering the shoot formation and shoot multiplication.

Callus cultures were established using nodal segments for 10 populations, viz., Chhatarpur, Katni, Sehore, Khandwa, Bargi, Shahdol, Chhindwara and Gwalior in MP and two populations in Chhattisgarh, viz., Raigarh and Bilaspur on MS medium supplemented with 5 mg l^{-1} BA, 10 mg l^{-1} NAA and 10 mg l^{-1} IBA. Callus was harvested and azadirachtin was isolated from it using HPLC solvent extraction method and azadirachtin content was quantified in callus cultures. Significant differences were observed among populations whereas non-significant differences were observed within populations for azadirachtin content in callus cultures of nodal segments in neem. Azadirachtin obtained from callus cultures was maximum in Gwalior population.

(iv) Technology to regenerate/multiply mahul patta (*Bauhinia vahlii*) for getting higher production

Selected sites viz. Korba (Range: Kartala), Katghora (Range: Pali), Marvahi (Range: Keonchi and Achanakmar), Raigarh (Range: Manora and Kansabel) and Dhamtari (Range: Dugli and Nagri) in three agroclimatic zones. From the perusal of data, locality and site and their interactions had significant effect on various leaf parameters. 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, Dugli was the best locality. As for comparison of the best and degraded sites, the best site significantly excelled in all leaf parameters. The cuttings collected were tried for rooting. Sprouting of shoots was achieved. However, there was no rooting

response. *In vitro* cultures were established using Seeds and Nodal segments of shoots sprouted from cuttings.

In the month of March, at the selected site of Keonchi air layering of climbers was carried out. Climbers were selected in best and degraded sites both. Branches of 5-7 cm diameter thickness were selected and bark of the branch was removed in a circle (approx. 5 cm) and cotton soaked in 100 ppm IAA solution was applied to it. Sphagnum moss which was soaked overnight in100 ppm IAA solution, was placed on a piece of black polythene sheet and then placed on the cut made on the branch and tied on either sides with the help of string tightly (**Fig 5.2**). Five air layers were made in each quadrate. After three months the site will be visited again and data on root formation will be recorded.

Fig 5.2: Air layering of climbers of *Bauhinia vahlii*: (A) Making cut on branches of mahul in Keonchi forest, (B) Removing bark, (C) Tightening Sphagnum moss which was soaked overnight in 100 ppm IAA solution and (D) String tight air layer

(v) Selection and cloning of superior germplasm of *Diospyros melanoxylon* from Chhattisgarh

Germplasm were collected from best and worst sire screened out namely, Lohattar (Bhanupratappur) and Kotadol (Korea) before hedging of the plants. The germplasm collected from the above sites were pretreated with 1000 ppm IAA and maintained at Genetics and Plant Propagation nursery of the institute **(Fig 5.3)**. The cuttings and seeds collected from Lohattar and Kotadol were under the investigation of *in vitro* and *ex vitro* responses. The soil collected from Lohattar, Kotadol and Madanpur were tested for N, P, K, organic carbon, pH and EC. Statistical analysis was carried out for these parameters of soil.


Fig 5.3: Cuttings in mini mist chamber and shade house for rooting from Lohattar locality

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

The work of germplasm collection was completed in three localities of Basart region, namely, Bhanupratappur, Antagarh, and Narayanpur and one locality of Hati, Dhramjaygarh range. In each locality 20 trees were marked as superior trees on the basis of phenotypic characters **(Fig 5.4)**. The pods and bark from a total of 60 trees were collected. The pods collected from individual trees were utilized for raising plants in the nursery of the Genetics Division **(Fig 5.5)**. Collected bark samples were dried in oven at 70^0C to record the dry biomass. Clear bole height emerged as main character, which was significantly higher in all genotypic characters and correlated with plant height. No rooting response was obtained in any season in cuttings. A maximum of 43% germination was obtained in Baisgaon (Antagarh range). The highest seed germination (76%) was achieved in large seed (16-17 mm). Growth parameters for seedling growth was recorded. Tissue culture work (nodal and seedling explant) was initiated.


Fig 5.4: Selection of phenotypically superior trees, collection of bark and recording of field data of Pterocarpus marsupium

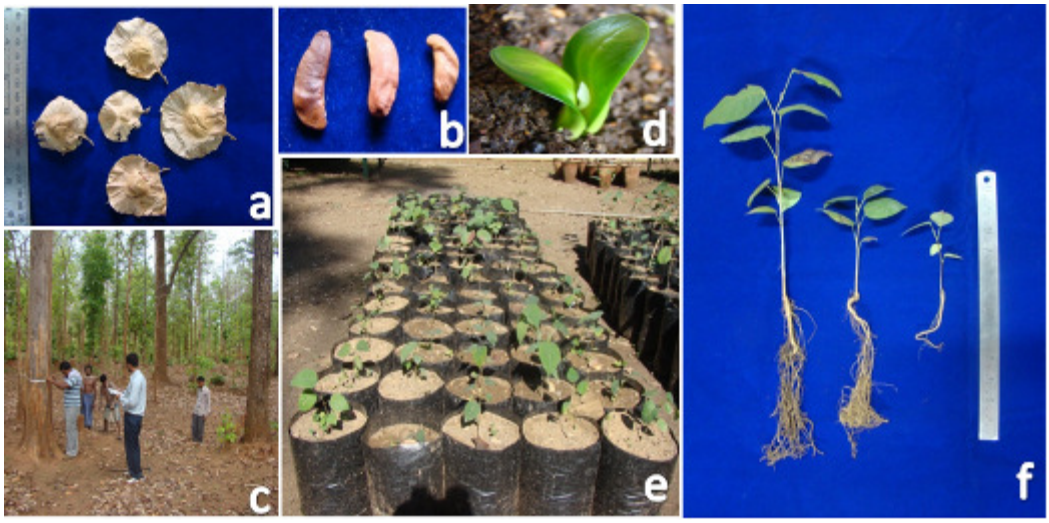

Fig 5.5: Germination in *Pterocarpus marsu*pium: (a & b) variation in pod and seed size (c) selection of phenotypically superior trees from Antagarh range in Bastar Forest Division, Chhattisgarh (d) emergence of cotyledons and (e & f) variation in germination of seeds of different size classes

(vii) Standardization of management practices for tendu gall forming insect and diseases

Experiment was laid out on the effect of different chemicals against gall forming insect *Trioza obsoleta* / foliar diseases in randomized block design. Seven treatments (Nimolin 0.5%,Trichoderma 2%, Nimolin +Trichoderma, Cypermethrin 0.03%, Decis 0.002%, Fytalon 2%) including control with three replication were taken. Decis followed by cypermethrin was found to be most effective against *T. obsoleta.*

Experiment was laid out on the cultural practices i.e. effect of different pruning period after 15 days interval including control fire on the incidence of gall forming insect,*Trioza obsoleta* / foliar diseases in randomized block design. Observations were recorded on the incidence of *T. obsoleta* / foliar disease of first pruning and control fire in set design of experiment.

(viii) Development Methodology and parameters for selection of superior genetic plants of five NTFP species

Data were recorded on *P. pinnata, A. marmelos*; *P. marsupium*, *Nux-vomica and S. suaveolens* **(Fig 5.6)** for number of traits i.e. Plant height, girth, number of primary branches, 100-seed weight, Crown diameter, clear bole height, crown height, crown volume, 100-pod weight etc. Recorded data was analysed statistically to find the correlation between the traits as well as to find out the traits having direct effect on economic produce.

Based on the results of correlation and path coefficient analysis, in *Pterocarpus marsupium*, the highest score has been awarded to the clear bole height in the rating scale followed by girth and plant height. Correlation and path analysis also revealed the importance of the clear bole height, plant height and GBH in selection of superior plants. Similarly, for

Stereospermum suaveolens clear bole height, plant height, GBH and crown volume found to be important for increasing timber and heartwood being used for medicinal purpose.

In *Strychnox nux-vomica*, *Aegle marmelos* and *Pongamia pinnata* fruits and/or seeds are the economically important produce. From correlation and path analysis, it became clear that crown diameter, number of branches and GBH had positive correlation with the crown volume, imparting higher direct and indirect effect on the parameter. Therefore, these traits along with crown volume deserved more weightage during selection of superior plants where fruits/seeds are important.

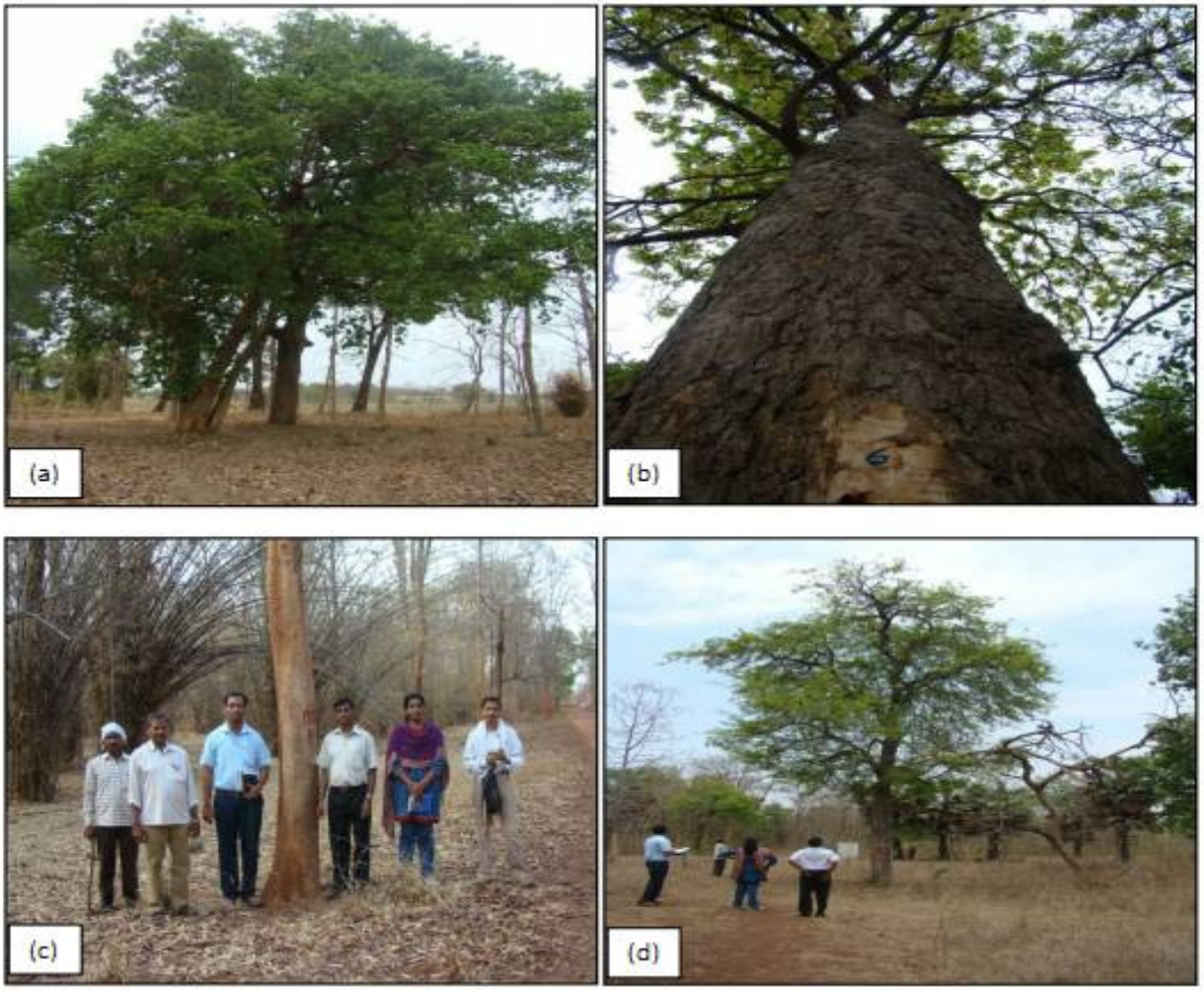

Figure 5.6: (a) superior plant of *Nux vomica* (Kuchla), (b) *Stereospermum suaveolens* (Padal), (c) & (d) Visit to Chandrapur forest division for recording observations.

(ix) All India Coordinated programme for genetic improvement of Teak" as four sub projects.

Sub project: - (i) Selection of plus trees, raising their progeny trials and establishing germplasm bank. (TFRI, Jabalpur)

Sub project: - (ii) Development of management practices of teak seed production areas, seedling seed orchards and clonal seed orchards. (TFRI & SFRI, Jabalpur)

Sub project: - (iii) Production of transgenic teak tolerant to defoliating pests. (TFRI, Jabalpur)

Sub project: - (iv) Studies on population structure, linkage disequilibrium and marker-trait association mapping of teak. (FRI & TFRI, Jabalpur)

These projects were started and are in initial phase.

(x) Collection of germplasm of madhuca indica J. F. Gmel for identification of best sources in Chhattisgarh through phytochemical Evaluation.

This project was started and is in initial phase.

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

- Dr. R.K. Verma, Scientist-F attended the National Seminar on "Biodiversity: Ecological security and sustainable utilization of natural resources" during 8-10th March 2013 at Bipin Bihari College, Jhansi, Uttar Pradesh and delivered a lead lecture on 'Biodiversity and conservation of forest fungi of central India'.
- Dr. R.K. Verma, Scientist-F acted as Chairman of Session-I, Theme Lectures on 08.03.2013 in the National Seminar on "Biodiversity: Ecological security and sustainable utilization of natural resources" during 8-10th March 2013 at Bipin Bihari College, Jhansi, Uttar Pradesh.
- Dr. Vishakha Kumbhare, Scientist –C, participated in the National Seminar on "Bio-Diversity, Conservation, Environment and Resource Management" organized by Dept. of Geography, D.P. Chaturvedi Science, Commerce, Arts & Education College, Seoni (MP) and sponsored by Indian Council of Social Science Research, New Delhi and M.P. Council of Science & Technology, Bhopal on 19-20 Janaury 2013 and oral presentation of the research paper entitled "Optimum harvesting time of *Gymnema sylvestre* leaves for antioxidant and mineral constituents" was done.
- Shri. N. D. Khobragade, Scientist –B, participated in the National Seminar on "Bio-Diversity, Conservation, Environment and Resource Management" organized by Dept. of Geography, D.P. Chaturvedi Science, Commerce, Arts & Education College, Seoni (MP) and sponsored by Indian Council of Social Science Research, New Delhi and M.P. Council of Science & Technology, Bhopal on 19-20 Janaury 2013 and oral presentation of the research paper entitled "Biodiversity status of South Chhindwara forest division of Madhya Pradesh" was done.
- Dr. Vishakha Kumbhare, Scientist –C, participated in the National Conference on "Integration of Medicinal and Aromatic Plants for Rural Development and Prosperity" organized by Medicinal and Aromatic Plants Association of India (MAPAI) at Anand, Gujarat, India in association with Directorate of Medicinal and Aromatic Plants Research (DMAPR), Anand Agricultural University (AAU), ICAR, New Delhi and NMPB and poster presentation of research paper entitled "Optimum harvesting time of *Moringa oleifera* leaves for antioxidant and mineral constituents" was done.

- Shri. N. D. Khobragade, Scientist –B, participated in the Department of Science and Technology, Govt. of India Lockheed Mortin India Innovation Growth programme 2013 at Sun and Sand Hotel, Nagpur (Maharashtra) on 29.1.13 organised by Federation of Indian Chambers of Commerce and Industry (FICCI) Federation House, Tansen Marg, New Delhi.
- Shri. N. D. Khobragade, Scientist –B and Shri. A.J. K. Asaiya, Research Officer, participated in the National Seminar on "Impact of coal mines and thermal power stations on local area" organized by Dept. Of Chemistry, Govt. Pench Valley P.G. College, Parasia and sponsored by UGC Central Regional Office, Bhopal on 8th – 9th March 2013 and oral presentation of the research paper entitled "Impact of coalmining on plant biodiversity" was done by Sh. N. D. Khobragade.
- Shri. A.J. K. Asaiya, Research Officer and Shri. N. D. Khobragade, Scientist –B, participated in the National Seminar on "Impact of coal mines and thermal power stations on local area" organized by Dept. Of Chemistry, Govt. Pench Valley P.G. College, Parasia and sponsored by UGC Central Regional Office, Bhopal on 8th – 9th March 2013 and oral presentation of the research paper entitled "Physico-chemical characterization of overburden dump material from coal mining areas of Western Coalfield Ltd. Parasia (Pench Area) Chhindwara" was done by Sh. A.J. K. Asaiya.
- Nimisha Chaturvedi participated in National conference on "Forest, Environment and Climate change: Issues and Challenges' held in January 30-31, 2012 at Bilaspur, Chattisgarh and delivered lecture on 'Development of germinability, desiccation tolerance and hardseededness in developing seeds of *Abelmoscus moscatus* (L) Medic'.
- Dr. M. Kundu participated in National seminar on "Strategy for restoration of Forest Biodiversity of Natural Forests and Plantations" to be held in September, 2012 at SFRI, Jabalpur and presented a lecture on 'Effects of soil type, sowing depth and moisture on germination of seeds of *Schleichera oleosa* (Lou.) Oken'.
- Dr. Deepa, M, Scientist-B attended the seminar on "Rastriaya Ganith Divas" held from 22nd to 28 th December 2012 at JNKVV, Jabalpur.
- Kulkarni, N., Paunikar, S., Mishra, V.K., Daksh, S. and Hussaini S.S. (2013). Efficacy of entomopathogenic nematodes, *Heterorhabditis indica* against the bamboo leaf roller *Crypsiptya coclesalis* Walker (Lepidoptera:Pyralidae). *International Conference on Insect Science*, Univ. Agri. Sci., Bangalore, Dept. of Entomol. (P. No. 21) (February 14 - 17th 2013) Bangalore, India.
- Dr. P.B. Meshram, Scientist-F participated and presented research paper entitled "Impact of Open Cast Coal Mines on Biodiversity and Social Aspect" in National Seminar on "Impact of Coal Mines & Thermal power Station on Local Area". Organized by Department of Chemistry, Govt. Pench Valley P.G. College, Parasia, Dist. Chhindwara, M.P. on 08-09 March, 2013.

(b) Workshops

- Dr. Girish Chandra, Scientist-C attended first annual workshop on National Knowledge Network at IIT Mumbai during October 31-Nov 03, 2013.
- Dr. N.Berry, Scientist-D participated and delivered lecture as resource person on "*Gmelina* based agroforestry system" in one day Workshop-cum-training on

Lokvaniki evam Van Vistar of forest officers of MPFD, on 24 November, 2012 at International Herbal Trade Fare, Lal Pared Ground, Bhopal (M.P.).

- Dr. N.Berry, Scientist 'D', attended National workshop on Integrating Forest Based Enterprises with Rural Development for Livelihood Support and Economic Growth" held on 21st March,2013 at ICFRE,Dehradun(UK).

(c) Trainings

- Dr. Vishakha Kumbhare, Scientist- C and Mrs. Shalini Bhowate, Research Officer attended one week training organised by Dept. of Science and Technology, New Delhi for woman Scientist/Technologist on "Role of scientists in community resource management" under DISHA at Indian Institute of Forest Management, Bhopal from 12.2.13 to 16.2.13.
- Dr. Vishakha Kumbhare, Scientist- C attended one week training organised by Dept. of Science and Technology, New Delhi (DST) for woman Scientist/Technologist on "Biodiversity Conservation" at Wild Life Institute of India (WII), Dehradun from18/2/2013 to 22/2/2013.
- Dr. Vishakha Kumbhare, Scientist- C attended one week specialised training on "Nanotechnology production, estimation and characterization" at Institute of Wood Science and Technology, Bangalore from 25/2/2013 to 01/03/2013.
- Dr. P.B. Meshram, Scientist-F Participated one week DST training on " Role of Scientists in Natural Resources & Environment Management at IIFM, Bhopal w.e.f. 28.01.13 to 01.02.2013 and Presented about the organization and its research on 30.01.2013.
- Dr. R.K. Verma, Scientist-E attended 2 weeks programme on "Science Administration and Research Management" during 6-17th Aug. 2012 at Administrative Staff College of India, Hyderabad (AP).
- Shri Pramod Singh Rajput, RA-II attended the training programme on 'Application of GIS in effective Forest planning and management' during 18-20th March 2013 at State Forest Research Institute, Polipather, Jabalpur organized by IIFM, Bhopal.
- Dr. K.K. Soni, Scientist-E attended the training on 'Agroforestry' at Van Vigyan Kendra, Raipur on 22nd March 2013 and delivered a lecture on 'Diseases of Agroforestry tree species'.
- Dr. Vishakha Kumbhare, Scientist- C, participated in the one day "Interactive meeting on Research methods on Forest Biodiversity" held at Institute of Forest Biodiversity, Hyderabad (AP) to deliberate on "Livelihood linkages on Forest Biodiversity" on 18.3.13.
- Dr. Girish Chandra, Scientist-C attended three days "User Interaction Meet (IUIM-2013)" held during March 11-12, 2013 at IIRS, Dehradun.
- Dr. N.Berry, Scientist-D participated and delivered lecture to the trainees of frontline staff of SFD in training programme on "Soil and Water Conservation through Agroforestry system" under SLEM project on the topic "Watersheds in Bundelkhand special package" at TFRI, Jabalpur on 27 September, 2012.

- Dr. N.Berry, Scientist-D, participated and delivered four lectures on"Lac cultivation, processing and its marketing to the officials of Rajiv Gandhi Watershed Management in training programme on "Collection, Value addition and Marketing of Non wood forest produce" 18th and 24th September, 28, 05 September & 2nd and 9th October, 2012 at TFRI, Jabalpur (M.P.).
- Dr. N.Berry, Scientist-D, participated and delivered on " Agroforestry and scope of its system" to the Rangers of Forest College, Burnihat (Assam) on 16.11.2012 at TFRI, Jabalpur.
- Dr. N.Berry, Scientist-D, participated and delivered on " Agroforestry and scope of its system" to the Rangers of Forest College, Govindgarh on 07.02.2013 at TFRI, Jabalpur.
- Dr. N.Berry, Scientist-D, participated and delivered on " Agroforestry and its system" to the Rangers of Forest College, Balaghat on 02.03.2013 at TFRI, Jabalpur.
- Dr. N.Berry, Scientist-D, participated and delivered on " Agroforestry systems and its scope and Lac culture " to the group of 80 tribal women of Mandla and Dindori districts for during training cum demonstration programme on Sustainable livelihoods held on28/12/2012 at TFRI, Jabalpur.
- Dr. N.Berry, Scientist-D, participated and delivered lecture on “Scope of Agroforestry and its systems" to the Rangers trainee probationer, Andhra Pradesh Forest Academy, Hyderabad, on13th December, 2012 at TFRI, Jabalpur.
- Dr. N.Berry, Scientist-D, participated and delivered lecture on “Agroforestry-Scope and necessity and its system under different agroclimatic zones of India” to the B.Sc and M.Sc. students of Guru Ghasidas University, Bilaspur, on 13.03.2013 at TFRI, Jabalpur.
- Dr. N.Berry, Scientist 'D', participated and delivered on"Agroforestry systems for sustainable livelihood", in Training Programme on "Recent Advances in Forestry Research and Sustainable NTFP Harvesting" for the Senior Forest Officers of Maharashtra State Forest Department, 05 – 07th March, 2013.

(d) Key Lecture delivered

- Dr. Avinash Jain, Scientist E delivered a lecture on ‘Forests and climate change’ to forest officials of Madhya Pradesh on 14 June 2012 at TFRI Jabalpur.
- Dr. Avinash Jain delivered a lecture on ‘Mitigating effect of climate change through afforestation on degraded land" to forest officials of Madhya Pradesh under the training programme on 'Sustainable Land Management and Water Conservation' on 26.09.2012 at TFRI Jabalpur.
- Dr. M. Kundu delivered lecture on Laboratory management under ICFRE HRD plan for the training programme at TFRI Jabalpur from 25th to 29th June, 2012 on Laboratory facilities, common instruments and their handling, care and maintenanceof log books.
- Dr. M. Kundu delivered lecture on ‘Recent trends in research on forest seeds’from 5th March to 7th March, 2013 in the training –cum- workshop for the Maharashtra Forest Department officials on

- Dr. M. Kundu delivered lecture in one day training program for extension of technologies developed by ICFRE (topic- Apparatus for preservative treatment of bamboos).
- Dr. N. Roychoudhury, Scientist-F participated and delivered lecture on "Management of insect pests in plantations and natural forests with special reference to biological options" inWorkshop-cum-training of forest officers of MSFD, on 7 March, 2012 at TFRI, Jabalpur.
- Dr. N. Roychoudhury, Scientist-F participated and delivered lecture on "Daily routines of laboratory" in training programme on Laboratory Management under ICFRE HRD plan, on 25 June 2012 at TFRI, Jabalpur.
- Dr. P.B. Meshram, Scientist-F participated and delivered lecture on laboratory management and purchase rule and procedure to the Support Scientific Staff (Technical) of ICFRE on Laboratory Management under HRD Plan of ICFRE on 28 June, 2012 at TFRI, Jabalpur.
- Dr. N. Kulkarni, Scientist – F participated and delivered lecture on "*White grub menace in forest nurseries and their Integrated Pest Management*". In "*Workshop on REDD++, CDM, Research Methodology and Dissemination of Research Results*" 22-23rd August, 2012, organized by Maharashtra State Forest Department, Nagpur (M.S.), India.
- Dr. P.B. Meshram, Scientist-F participated and delivered lecture to the trainees of frontline staff of SFD in training programme on "Soil and Water Conservation" under SLEM project on the topic "Watersheds in Bundelkhand special package" at TFRI, Jabalpur on 27 September, 2012.
- Dr. P.B. Meshram, Scientist-F, delivered lectures to the trainees of R.G. Watershed Management in training programme on "collection, value addition and marketing of forest produce" on the topic "production and application of vermicompost" at TFRI, Jabalpur on 21, 28, 05 September & 12 October, 2012.
- Dr. N. Roychoudhury, Scientist-F participated and delivered lecture on "Achanakmar-Amarkanatk biosphere reserve: scope and challenges" in seminar on "Achanakmar-Amarkantak Biosphere Reserve on World Network: Prospects and challenges" held at Bilapur on 21st November 2012.
- Dr. N. Roychoudhury, Scientist-F participated and delievered lecture on "Forest insects and biological control" to the Rangers of Forest College, Burnihat (Assam) on 16.11.2012 at TFRI, Jabalpur.
- Dr. N. Kulkarni, Scientist-F participated and delievered lecture on "Entopathagenic nematodes and their role in forest insects control" to the Rangers of Forest College, Burnihat (Assam) on 16.11.2012 at TFRI, Jabalpur.
- Dr. N. Roychoudhury, Scientist-F participated and delivered lecture on "Forest insects and biological control" to the SHG and NGOs, on 30.11.2012 at TFRI, Jabalpur.
- Dr. N. Kulkarni, Scientist-F participated and delivered lecture on "Integrated Pest Management of white grubs in forest nurseries" on 30-11-2012 to the Self Help Groups and NGOs at TFRI, Jabalpur.

- Dr. N. Kulkarni, Scientist-F participated and delivered lecture on “Vilvekam – *Aegle* marmelos seed oil based biopesticide for the management of teak defoliator” on 30-11-2012 to the Self Help Groups and NGOs at TFRI, Jabalpur.
- Dr. N. Kulkarni, Scientist-F participated and delivered lecture on “Peststat, a Metarhizium based mycoinsecticide for management of defoliator pests in forest nurseries and plantations” on 30-11-2012 to the Self Help Groups and NGOs at TFRI, Jabalpur.
- Dr. N. Roychoudhury, Scientist-F participated and delivered lecture on “Forest entomology, its research mandates and achievements” to the Rangers trainee probationer, Andhra Pradesh Forest Academy, Hyderabad, on13 December, 2012 at TFRI, Jabalpur.
- Dr. N. Kulkarni, Scientist – F participated and delivered an Invited Lecture entitled "*Insects as friends and foes: their role as environmental indicators*" at Dept. of Zoology, Banaras Hindu Vishwavidyalaya (BHU), Varanasi on 9th Jan., 2013.
- Dr. N. Roychoudhury, Scientist F, participated and delivered lecture on “vpkudekj&vejdaVd ck;ksfLQ;jfjtoZ&fo'o tyra= dk euksuhr lnL; % vfHkizkk;” ,oa “ dkslk dhV ikyu % thfodksiktZu dk O;ogk;Z fodYi” in workshop “Achanakmar-Amarkantak Biosphere Reserve” held on 23/03/2013 at Koni, Bilaspur.
- Dr. Kulkarni, Scientist F, participated and delivered lecture on “o`{kksa ds lw[kus ds dkjd” in workshop “Achanakmar-Amarkantak Biosphere Reserve” held on 23/03/2013 at Koni, Bilaspur.
- Dr. N. Roychoudhury, Scientist F, participated and delivered lecture on “Management of insect pests in plantations and natural forests with special reference to biological options” inWorkshop-cum-training of forest officers of MSFD, on 7 March, 2012 at TFRI, Jabalpur.
- Dr. N. Kulkarni, Scientist – F, participated and delivered an Extension Lecture entitled "*Integrated Pest Management of Insect Pests in Forest Nurseries*", in Training Programme for the Senior Forest Officers of Maharashtra State Forest Department, 05 – 07th March, 2013.
- Dr. P.B. Meshram, Scientist-F participated and delivered lectures on "Insect pests of Agroforestry and Vermicompost" to the trainees of SFD at VVK, Raipur, CG. on 22 March, 2013.
- Dr. N. Roychoudhury, Scientist-F participated and delivered lecture on “Achanakmar-Amarkantak biosphere reserve under world network of biosphere reserve” and Tasar silkworm rearing – An income generation alternative” in workshop for the front line staff of Acahanakmar-Amarkantak biosphere reserve, Chhattisgarh Forest Department, on 23 March, 2013 at Bilaspur, C.G.

6.3.2 Visits Abroad:

Dr. A.K. Pandey visited Columbus, Ohio (USA) to attend the 4th International Eco-summit on Ecological sustainability during 30 Sept. to 5 Oct., 2012

6.4 Capacity Buildings Scientific and Management Cadre (Trainings organized)

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

SN	Date	Details
1.	June, 25-29, 2012	Training for Support Scientific Staff of ICFRE on Laboratory Management had been organized by the Forest Extension Division Sh. Bharat Singh Yadev, Adhyaksh, Zila Panchayat Jabalpur attended valedictory ceremony of training of support scientific staff of ICFRE on 29 June 2012.
2.	September 17-21, 2012	One training programme on collection value addition and marketing of Non-timber forest products in being organized at the institute by NWFP Division for the members of Rajiv Gandhi Mission for watershed management
3.	September 24-28 2012	One training programme on collection value addition and marketing of Non-timber forest products in being organized at the institute by NWFP Division for the members of Rajiv Gandhi Mission for watershed management at Tropical Forest Research Institute, Jabalpur.
4.	September 25-27, 2012	A Training Programme on Sustainable Land Management and Water Conservation under SLEM Programme, ICFRE, organized by Forest Extension Division, TFRI, Jabalpur
5.	October 1-5, 2012	One training programme, from 1-5 Oct.2012 on Collection, Value addition and Marketing of Forest Produce.
6.	October 8-12, 2012	Cultivation methods and marketing of Non Wood Forest produce which can be grown in short period for the members of Rajiv Gandhi Mission for watershed management organized at the institute by NWFP Division on 8-12 Oct, 2012
7.	December 20-27, 2012	Organized five days training programme for 1st batch of B.Sc. Biotechnology students of Government Model Science College, Jabalpur from 20-27 December, 2012
8.	January 7-11, 2013	Genetics and Plant Propagation division imparted five days training program for 3rd batch of B.Sc. Biotechnology students of Government Model Science College, Jabalpur from 7th January 2013 to 11th January 2013
9.	February 4-8, 2013	Genitics and plant propagation division imparted five days training programme for 5th batch of B.Sc. Biotechnology students from 4th to 8th February 2013.
10.	March 23, 2013	Organized workshop-cum-training on Achanakmar-Amarkantak biosphere reserve and developed training materials for the front line staff of Acahanakmar-Amarkantak biosphere reserve, Chhattisgarh Forest Department at Bilaspur, C.G.

- CFRHRD Chhindwara organized the following training programmes:

SN	Date	Topics
1.	30.5.2012	Cultivation of medicinal and aromatic plants
2.	27.06.2012	Soil conservation and watershed management
3	24.07.2012	Agro-forestry with special reference to medicinal plants
4	22.08.2012	Forest pests and their management
5	27.9.12	Cultivation of Jatropha / karanj / Oil yielding plants
6.	30.10.12	NWFP value addition, processing and marketing
7	29.11.12	Environmental Awareness
8	19.12.12	Bio-fertilizers and bio-pesticides
9	29.1.13	Diseases and their control measures in forest nurseries and plantations
10	28.2.13	Training on Medicinal plants, Birds, preparation of vermi-compost
11	5.3.13	Reclamation and revegatation of mined overburden dumps
12	6.3.13	Cultivation and Marketing of important medicinal plants
13	21.3.13	Sustainable harvesting of Medicinal plants

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

Avinash Jain and S.A. Ansari. Quantification of carbon sequestered by *Tectona grandis* in different agroforestry systems using allometric equations. *Journal of Forestry Research* - Accepted.

Avinash Jain, C. Lepande and A.K. Bhowmik (2010). Ecorestoration of degraded forests of Pali, Katghora division, Chhattisgarh (India). *Indian Journal of Tropical Biodiversity*. **18**(2) : 203 - 210.

Kundu, M. & Sett, R. (2012). Effects of fruit maturity, storage and pretreatments on germination of Mimusops elengi seeds for effective collection and ex-situ conservation. In: Non-timber forest products and medicinal plants conservation, improvement and sustainable utilization. Eds. Sanjay Singh and Rameswar Singh Pp- 193-204. Institute of Forest Productivity. Ranchi, India.

S. Sambath, Avinash Jain, N. Roychoudhury, N. Kulkarni and K.C. Joshi (2012). Effect of host plants on the growth and development of *Spirama retorta* Clerck (Lepidoptera : Noctuidae). *Indian Journal of Forestry* **35**(2) : 213 - 217.

b) International journals

Roychoudhury, N. (2012). Toxicity of ivermectin in inducing larval mortality in bamboo leaf roller, *Crypsiptya coclesalis* Walker. *Bangladesh J. For. Sci.* 32(1) : 1-9.

c) National journals

Dadwal V.S. and Nisha Singh (2011). Role of some antagonistic bacteria on the spermoplane mycoflora of Teak (Tectona grandis). Journal of Basic and Applied Mycology, Vol 10 (I&II) in press.

Dadwal, V.S. and Savitri Bhartiya (2012). New Report of a Leaf Spot Disease of *Chlorophytum borivilliaum* caused by *Macrophomina phaseolia* from India. *J. Mycol Plant Pathol.*, **42** (3): 397-398.

Dadwal, V.S., Savitri Bhartiya and Pratigya Patel (2012). Seed mycoflora of some forest tree species and their control with bioagents.. *Journal of Tropical Forestry* **28 (I & II))** : 73-78.

Dadwal, V.S., Savitri Bhartiya and R.K. Verma (2010). Management of root-knot caused by *Meloidogyne incognita* on *Withania somnifera* L. by soil amendments. *Indian J. Trop.Biodiv.* **18(2)** : 231-234 pp.

Dadwal, V.S., Savitri Bhartiya and R.K. Verma (2012). A new species of *Passalora* from India. J. *Mycol. Pl. Pathol.* **42(1)** : 176-177.

के. के. सोनी, अभिषेक प्यासी एवं आर के वर्मा ;2012द्ध ण एलोवेरा की रोपणी में गेरूवा रोग ;रस्टद्ध का प्रकोप एवं उसका निदान, *वानिकी संदेश*] **(2):** 56-58 pp.

Kulkarni, N., Kushwaha, D.K., Mishra, V.K. and Paunikar, S**. (2012**). Effect of Economical Modification in Artificial diet of greater wax moth *Galleria mellonella (*Lepidoptera: Pyralidae). *Indian Journal of Entomology,***74(**4):369-374.

Kulkarni, N., Paunikar, S. and Singh, R.B. **(2012)**. Efficacy and field persistence of some insecticides against the white grub, *Holotrichia rustica* (Burm.)(Scarabaeidae: Melolonthinae). *Indian Journal of Entomology*, **74**(2): 105-107.

Kushwaha, D.K., Barve, S.K. and Roychoudhury, N. (2012). *Ypthima avanta* Moore (Lepidoptera : Satyridae) – a new addition to the butterfly fauna of Achanakmar-Amarkantak biosphere reserve. *Indian J. Forestry* 35(2) : 231-234.

Parihar Jagrati, C.K. Tiwari and R.K. Verma (2012) Two new records of macro-fungi from India. *J. Mycol. Plant Pathol.* 42(3) :321-325.

Pyasi Abhishek, Soni, K.K. and Verma, R.K. (2012). A new record of *Boletus fallax* from India (short communication). *J. Mycol. Pl. Pathol.* **42** : 172-173.

Roychoudhury, N. (2012). Deployment of resistance in teak to key insect pests. *Indian Forester* 138(2) : 123-130.

Roychoudhury, N. and Chandra, S. (2011, received on May 2012). *Degonetus serratus* (Distant) : a new record of pentatomid bug feeding on teak. *J. Tropical Forestry* 27(4) : 31-34.

Roychoudhury, N. and Chandra, S. (2012). *Chrysoperla carnea* (Stephens) : a new record of insect predator on teak pests, *Hyblaea puera* Cramer and *Eutectona machaeralis* (Walker). *Indian Forester* 138(1) : 98-99.

Sambath, S., Jain, A., Roychoudhury, N., Kulkarni, N. and Joshi, K.C. (2012). Effect of host plants on the growth and development of *Spiroma retorta* Clerck (Lepidoptera : Noctuidae). *Indian J. Forestry* 35(2) : 213-217.

Soni, K.K., Pyasi, A, Tiwari, P and Verma, R.K. (2012). A new record of occurrence of *Aloe vera* rust (*Uromyces aloes*) from Madhya Pradesh. *J. Mycol. Plant Pathol.* **41**(4): 644-646.

Soni, K.K., V.B. Hosagoudar, Abhishek Pyasi and R.K. Verma (2010). *Asterostomella shoreae* sp. from Achanakmar Biosphere Reserve in Chhattisgarh, India. *Indian J. Trop.Biodiv.* **18(2)** : 255-257 pp.

Tiwari, C.K., Jagrati Parihar and Verma, R.K. (2012). Potential of *Aspergillus niger* and *Trichoderma viride* as biocontrol agents of wood decay fungi. *Journal of the Indian Academy of Wood Science,* 8(2) : 169-172.

Tiwari, C.K., Parihar Jagrati and Verma, R.K. (2012). A new and rare species of *Phlyctaeniella* from central India. *Mycosphere* **3(4)**, 450-453.

Verma, R.K., Thakur, A.K. and Rajput, P.S. (2012). Effect of organic amendments and plant growth promoting microbes on *Santalum album* in central India. Indian Forester, **138** (8): 742-746.

d) Abstracts/Proceedings

Asaiya, A.J. K. and N. D. Khobragade. 2013. Physico-chemical characterization of overburden dump material from coal mining areas of Western Coalfield Ltd. Parasia (Pench Area) Chhindwara. Research paper abstract was published in the National Seminar on "Impact of coal mines and thermal power stations on local area" organized by Dept. Of Chemistry, Govt. Pench Valley P.G. College, Parasia and sponsored by UGC Central Regional Office, Bhopal on ^{8th} – ^{9th} March 2013.

Khobragade, N. D. and A.J. K. Asaiya. 2013. Impact of coalmining on plant biodiversity. Research paper abstract was published in the National Seminar on "Impact of coal mines and thermal power stations on local area" organized by Dept. Of Chemistry, Govt. Pench Valley P.G. College, Parasia and sponsored by UGC Central Regional Office, Bhopal on 8^{th} – 9^{th} March 2013.

Maitreyee Kundu and Nimisha Chaturvedi (2012). Effects of soil type, sowing depth and moisture on germination of seeds of *Schleichera oleosa* (Lou.) Oken. Abstract published in Proceedings of National seminar on "Strategy for restoration of Forest Biodiversity of Natural Forests and Plantations" held in September, 2012 at SFRI, Jabalpur.

Nimisha Chaturvedi, Rupnarayan Sett and Maitreyee Kundu (2012). Development of germinability, desiccation tolerance and hardseededness in developing seeds of *Abelmoscus moscatus* (L) Medic. Abstract published in Proceedings of National conference on "Forest, Environment and Climate change: Issues and Challenges' to be held in January 30-31, 2012 at Bilaspur, Chattisgarh.

Vishakha Kumbhare 2013. Fortification of Rural Health through *Madhuca indica* flowers nutraceuticals. Research paper abstract was published in the souvenir of the National Seminar on "Value Added Functional Foods: Prospects and Future Challenges" sponsored by Govt. of UP and organized by Dept. of Animal Husbandry and Dairying on 23-24 February 2013 at Janata College, Etawah, U.P.

Vishakha Kumbhare 2013. Optimal utilization of *Moringa oleifera* to ameliorate the economy of tribals. Research paper abstract was published in the souvenir of the National Seminar on "Value Added Functional Foods: Prospects and Future Challenges" sponsored by Govt. of UP and organized by Dept. of Animal Husbandry and Dairying on 23-24 February 2013 at Janata College, Etawah, U.P.

Vishakha Kumbhare 2013. Value addition of *Cissus quadrangularis* Linn. stem (Hadjor) for domestic use by ethnic communities of India. Research paper abstract was published in the souvenir of the National Seminar on "Value Added Functional Foods: Prospects and Future Challenges" sponsored by Govt. of UP and organized by Dept. of Animal Husbandry and Dairying on 23-24 February 2013 at Janata College, Etawah, U.P.

Vishakha Kumbhare, Ganesh Pawar and Y.K. Soni. 2013. Optimum harvesting time of *Moringa oleifera* leaves for antioxidant and mineral constituents. Research paper abstract published in souvenir of the National Conference on "Integration of Medicinal and Aromatic Plants for Rural Development and Prosperity" held on 22-23 Jan. 2013 organized by Medicinal and Aromatic Plants Association of India (MAPAI) at Anand, Gujarat, India in association with Directorate of Medicinal and Aromatic Plants Research (DMAPR), Anand Agricultural University (AAU), ICAR, New Delhi and NMPB.

Vishakha Kumbhare, Scientist- C and A J K Asaiya. 2013. Sustainable utilization of medicinal and aromatic plants by value addition : A futuristic approach. Research paper abstract was published in the souvenir of the National Seminar on "Value Added Functional Foods: Prospects and Future Challenges" sponsored by Govt. of UP and organized by Dept. of Animal Husbandry and Dairying on 23-24 February 2013 at Janata College, Etawah, U.P.

e) Others

- Kundu, M., Schmidt, L. (Editor), 2012. *Bischofia javanica Blume.* Seed Leaflet, No. 157. P-1-2. Forest & Landscape, University of Copenhagen, Denmark.
- Kundu, M., Schmidt, L. (Editor), 2012. *Emblica officinalis* Gaertn. Seed Leaflet, No. 154. P-1-2. Forest & Landscape, University of Copenhagen, Denmark.
- Kundu, M., Schmidt, L. (Editor), 2012. *Holoptelea integrifolia* Planch. Seed Leaflet, No. 155. P-1-2.Forest & Landscape, University of Copenhagen, Denmark.
- Kundu, M., Schmidt, L. (Editor), 2012. *Madhuca longifolia* (Koenig) J. F. Macb. Seed Leaflet, No. 156. P-1-2.Forest & Landscape, University of Copenhagen, Denmark.
- Kundu, M., Schmidt, L. (Editor), 2012. *Michelia champaca Linn..* Seed Leaflet, No. 158. P-1-2. Forest & Landscape, University of Copenhagen, Denmark.
- Kundu, M., Schmidt, L. (Editor), 2012. *Phoebe goalparensis Hutchinson*. Seed Leaflet, No. 160. P-1-2.Forest & Landscape, University of Copenhagen, Denmark.
- Kundu, M., Schmidt, L. (Editor), 2012. *Terminalia myriocarpa van Heurck & Müll. Arg...* Seed Leaflet, No. 161. P-1-2.Forest & Landscape, University of Copenhagen, Denmark.
- Kundu, M., Schmidt, L. (Editor), 2012.*Dipterocarpus retusus Blume*. Seed Leaflet, No. 159., p-1-2.Forest & Landscape, University of Copenhagen, Denmark.
- Shri. N. D. Khobragade, Scientist-B, CFRHRD, Chhindwara delivered a Radio talk on Van Mahotsav on 1.7.2012

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 of state where the VVKs are established to the VVKs under it. During 2012-13 one training programme was conducted by VVK Maharshtra.

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" on 30/09/2012. 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.

S. No.	Technologies / package of practices	Name of the institute to be technologies belong	The Division / subject specialist in TFRI who will deal with the technology / package of practices.
1.	Sustainable harvesting of Arjuna Bark	TFRI, Jabalpur	Dr. A.K.Pandey, Scientist

			'F', NWFP Division
2.	Integrated Pest Management of white grubs in forest nurseries.	TFRI, Jabalpur	Dr. N.Kulkarni, Scientist 'F' Forest Entomology Division,
3.	Biological control of insect pest of teak in plantations	TFRI, Jabalpur	Dr. N. Roychoudhary, Scientist 'F' Forest Entomology Division
4.	Teak-turmeric silvi-medicinal system.	TFRI, Jabalpur	Dr. Nanita Berry,Scientist 'D' Agroforestry Division
5.	Draught type drum dryer techniques of drying seeds of important Non Wood Forest species.	TFRI, Jabalpur	Smt. Neelu Singh,Scinetist 'E', NWFP Division
6.	Tree species suitable for different stress sites (viz. water logged, Bhata land and Mine overburden sites etc.) in central India.	TFRI, Jabalpur	Dr. A.K.Bhomik, Scientist 'C', Forest Ecology & Rehabilitation Division
7.	VAM and *Azospirilum* production techniques for teak stump production	TFRI, Jabalpur	Dr. R.K.Verma,Scientist 'F', Forest Pathology Division
8.	Micro-propagation of *R. serpentina*	TFRI, Jabalpur	Dr. Yogeshwar Mishra, Scientist 'E', Genetics and Plant Propagation Division
9.	Development of a Metarhizium based Mycoinsecticide (peststat) for management of forest pests.	IWST, Bangalore	Dr. N.Kulkarni, Scientist F, Forest Pathology Division.
10.	Biopesticide product – Vilvekam – *Agle marmelos* seed oil based bio-pesticide.	IFGTB, Coimbatore	Dr. N.Kulkarni, Scientist' F' Forest Entomology Division
11.	Micro-catchment for plantation establishment.	AFRI, Jodhpur	Dr. A.K. Bhomik, Scientist 'C', Forest Ecology Division.
12.	Apparatus for preservative treatment of bamboos	RFRI, Jorhat	Dr.M.Kundu, Scientist 'E', Silviculture Division
13.	Handmade paper from *Lantana camara*	FRI, Dehradun	Smt. Neelu Singh, Scientist 'E', NWFP Division
14.	Demonstration of forest fire fighting tools and management of forest fire	FRI, Dehradun	Shri N.P.S. Nain, DCF, Silviculture Division.

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.

Three days training programme was organized on "Soil and Water Conservation for front line staff of the Forest Department and other Beneficiaries from 18-20 th Oct, 2011 at the Center of forestry Research & Human Resource Development, Chhindwara, M.P., by Tropical Forest Research Institute, Jabalpur. in this training programme 89 trainees of the forest department and 9 field farmers from 9 mille watershed areas of the district of Betul, Singrauli, Sidhi, Umaria and Chhinwara participated in the training programme.

Three days training programme organized on 25-27 th September, 2012 at TFRI, Jabalpur on various aspects of soil and water conservation techniques and rehabilitation of bamboo forests. The training was attended by forest range officers, forest guards from Chhattarpur, Tikamgarh, Panna, Sagar, and Damoh.

7.3.2. Seminar/Symposia/Workshops Organized

SN	Date	Title
1	November 30, 2012	One day workshop on 'Strengthening Network for Outreach of Research Findings' was organized by Forest Extension Division of the institute on 30/11/2012 to extend the research findings of TFRI, Jabalpur and other ICFRE Institute. Research findings of following technologies were disseminated to forest department, NGOs, SHGs and others.
2	March 4-7, 2013	A workshop-cum-Training programme on "Recent Advances in Forestry Research and Sustainable N.T.F.P. Harvesting" was organized by Forest Extension Division during 4th to 7th March for the officials of Maharashtra State Forest Department.
3	23 March, 2013	Organized workshop-cum-training on Achanakmar-Amarkantak biosphere reserve and developed training materials for the front line staff of Acahanakmar-Amarkantak biosphere reserve, Chhattisgarh Forest Department at Bilaspur, C.G.

7.3.3 Special Activities: During 2012-13 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

- World Day to Combat Desertification on 17/6/2012
- Hindi Pakhwara on 1-15 Sept 2012
- Sadbhawna pakhwara on 20/8/12 to 3/9/12

- Wild Life Conservation Week during 1-7 October 2012.
- Vigilance Awareness week 29/10/12 to 3/11/12

(b) CFRHRD, Chhindwara

- WildLife Week during Octorber 02-04, 2012

7.4 Consultancies Services

Conducting studies on 'Assessment of green cover and its tangible and intangible benefits and tree cover management plan for STPP-Korba Project'.

7.5 Activities of Rajbhasa

1 हिन्दी पखवाडे का आयोजन :- राजभाषा विभाग, भारत सरकार द्वारा जारी दिशा निर्देशों की अनुपालन में उष्णकटिबंधीय वन अनुसंधान संस्थान, जबलपुर में दिनांक 03 सितम्बर 2012 से 17 सितम्बर 2012 के दौरान ''हिन्दी पखवाडा'' मनाया गया जिसमें हिन्दी को बढावा देने के उद्देश्य से विभिन्न प्रतियोगिताओं का आयोजन किया गया - हिन्दी प्रश्न मंच प्रतियोगिता, प्रशासनिक हिन्दी भाषा ज्ञान प्रतियोगिता, वैज्ञानिक तथा तकनीकी शब्दावली का हिन्दी ज्ञान प्रतियोगिता, हिन्दी व्यवहार प्रतियोगिता, हिन्दी में तकनीकी लेखन प्रतियोगिता तथा हिन्दी कविता पाठ प्रतियोगिता।

हिन्दी पखवाडे के समापन दिनांक 17 सितम्बर 2012 को मुख्य अतिथि के रूप में श्री गोकुल शर्मा, सम्पादक, सलाहकार ग्रुप दैनिक भास्कर एवं वरिष्ठ पत्रकार दैनिक भास्कर को बुलाकर उनकी अध्यक्षता में काव्य पाठ प्रतियोगिता का आयोजन किया गया जिसमें संस्थान के अधिकारियों, कर्मचारियों एवं अनुसंधान अध्येयताओं ने बढ चढ कर भाग लिया।

2. **राजभाषा विभाग की हिन्दी में कार्य करने हेतु प्रोत्साहन योजना** - संस्थान में राज भाषा विभाग द्वारा जारी की हिन्दी में कार्य करने वाले कर्मचारियों के प्रोत्साहन हेतु लिए नकद पुरूस्कार योजना भी लागू की गयी है। इस योजना के अन्तर्गत प्रतिवर्ष हिन्दी में किए गए कार्यो के लिए 10 कर्मचारियों को प्रथम, द्वितीय एवं तृतीय पुरूस्कार एवं 5 सांत्वना पुरूस्कार दिए जाते हैं। वर्ष 20011-12 के दौरान संस्थान के कर्मचारियों द्वारा हिन्दी में किये गये कार्यो के मूल्यांकन के आधार पर उन कर्मचारियों को नकद राशि के रूप में राज भाषा प्रोत्साहन पुरूस्कार प्रदान किये गये।

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.

8.2 Sevottam

Activities related to the Citizen/Client 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. 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 D.V. Niware, Section Officer	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- Bioshpere Researve

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