Executive Summary

Executive summary of the report

- Identified best agroforestry system which sequestered maximum carbon.
- Identified suitable tree species for biodrainage purpose.
- Documented data on flora and fauna of Achanakmar – Amarkantak Biosphere Reserve.
- Documented prevailant medicinal plants in tribal areas and their sustainable utilisation.
- Standardised nursery techniques of *Strychnos nux-vomica, Strychnos potatorum* and *Terminalia chebula*.
- Developed teak-turmeric silvi-medicinal agroforestry system.
- *Bambusa vulgaris* observed to be suitable for plantation in yellow soil (granite) whereas *B. bambos, B. longispathus, B. tulda, B. nutans, Dendrocalamus strictus,* in black basaltic soil.
- Genomic DNA of 30 sandal trees growing in TFRI campus graded on the basis of oil content was amplified using 25 selected ISSR primers.
- A multilocational trial comprising of nine superior accessions of *Jatropha curcas* has been established in institute campus.
- Studies on sustainable management of medicinal plants in JFM areas in two agroclimatic zones of Madhya Pradesh have been conducted.
- Nutritive value and value addition of bamboo, *Bambusa bambos*, *B. tulda*, *Dendrocalamus asper* and *D. strictus* were studied. The best method for removal of anti-nutrients for *D. strictus* and *B. tulda* was 15 minutes boiling in 1% NaCl; *D. asper* 10 minutes boiling in 5% NaCl; *B. bamboos* 15 minutes boiling in 5 % NaCl. Different products such as bari, pickle, papad, petha, sauce and crunches were made from fresh shoots. Shoots were also preserved in salt solution and vinegar to use them after the season of availability.
- National multilocation trials comprising of 36 accessions and zonal trial with 14 accessions of *Jatropha curcas* have been established at institute campus.
- Injecting 10 ml water emulsion of dichlorvos 0.5% inside the borer hole caused by stem borer of chironjee (*Buchanania lanzan*), foliar spraying of redomil 0.2% against wilt disease caused by *Fusarium oxysporum* in nursery and monocrotophos 0.05%, endosulfan 0.05%, cypermethrin 0.03%, fenvalerate 0.03%, deltamethrin 0.002%, alphamethrin 0.003%, bipro super - *B. bassiana* 7 ml / lit, neemraj supreme- neem oil 0.5%, found significantly superior in killing the defoliator larvae.
- For the management of teak defoliator and skeletonizer in forest nursery, foliar spraying of neem 0.5% deterred over 80% egg laying followed by Spinosad 0.05% or Agropest *bt* 0.05%. or 5000 to 10000 infective juvenile nematode per litre to kill the larvae. PDBC strains of *H. indica* was found compatible with chemical insecticides viz., imidacloprid, monocrotophos, endosulfan, chlorpyriphos and Thiamethaxam (actara), and biopesticides like neem product, agropest *bt* and derisome (botanical products), bioprahar (Photorhabdus bacteria), conserve (Spinosad actinomycete product) and signa (Insect Growth Regulator). Petroleum ether extract *Annona squamosa* also proved to exhibit antifeedant activity against the larvae of teak skeletonizer.

- For the management of white grubs in teak nursery, foliar spraying of monocrotophos or dimethoate 0.05% on *Ziziphus* spp. surrounding the nursery beds twice at the interval of 15 days reduced the egg laying by the beetles of white grubs. Treatment of the teak beds within 1 week after the adult emergence with phorate/ methyl folidol @ 300g/ bed (size 12 m X 1.25m) in combination and alternately with the cadavars of EPN *H. indica* and *S. carpocapsae* @ 250 – 300/ bed in good watering conditions proved effective in reducing the incidence of seedling mortality.
- 12 species of braconid parasitoids viz. *Apanteles antipoda , A. machaeralis, A. hyblaeae, Dolichogenidea* sp, *A. tachardiae., Apanteles* sp., *A. caniae , A. tiracholae, Bracon jalgaonensis* sp. n, *Chelonus wardhaensis* sp. n, *Chelonus hingoliensis* sp. n, and *Doryctes indicus* sp. n. collected from different areas of Maharashtra.
- Bamboo is found to be damaged by leaf rollers *Cryptisia coclesalis*, *Pyrausta bambucivora*, grasshoppers *Hieroglyphus banian, Poecilecerus pictus, Scitocera gregari,* aphid *Oregma bambusae* and white grub *Holotrichia consanguinea*, diseases caused by leaf rust, *Dasturella divina* and leaf tip blight, *Helminthosporium solani* and hare.
- Wood decaying fungi belonging to 20 genera and 44 species were found to damage wood logs in wood depots of Maharashtra and Orissa.
- Toxicity of streptomycin, ivermectin and spinosad worked out against major insect pest of siris , bamboo and mahaneem.
- *Aspergillus* and *Trichoderma* spp. were found to promote growth of seedling in nursery. Application of plant growth promoting microbes (AM fungi, *Aspergillus* sp. *Azospirillum*) and above soil amendments (mix of *Leucaena*, teak leaves and FYM in equal ratio, v/v) increased 10-20% survival of sandal seedlings, when planted in the field. It is also increased plant height up to 43%.
- Nursery technique of *Pterocarpus marsupium* standardized.
- Seasonal variation in active chemical constituents of a medicinal plant hadjor, *Cissus quadrangularis* studied and harvesting time between December to March proved best.
- Shade drying was found to be best and economical way of retaining maximum amount of active constituent of hadjor, *C. quadrangularis*.
- Progeny trial of *Buchnania lanzan* established at Centre for Forestry Research and Human Development, Chhindwara.
- Agroforestry models with medicinal trees and herbs established and awareness created among the people.

Summary of projects:

Projects	Completed projects	Ongoing projects	New projects initiated during the year
Plan	11	10	3
Externally Aided	7	14	3

Contents

1. Introduction

Tropical Forest Research Institute (TFRI), Jabalpur is one of the institutions under Indian Council of Forestry Research & Education (ICFRE). It is situated on the bank of Gour river on Mandla Road 10 km south east of Jabalpur. It is spread over an area of 109 ha and enjoys semi-arid type of climate with mean annual precipitation of 1358 mm. It caters to the forestry research needs of four states of central India, viz. Madhya Pradesh, Chhattisgarh, Maharashtra and Orissa. Thrust areas of research in the institute relate to non-wood forest produce, rehabilitation of mined areas and other stress sites, development of and demonstration in agroforestry models, planting stock improvement, sustainable forest management, biodiversity conservation and control of forest diseases and pests. TFRI has established 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. A number of scientists, officers and staff of the institute participated in various national and international scientific seminars and symposia. They were actively involved in extension activities through its Van Vigyan Kendras. This has helped the institute not only in imbibing in its research programme ideas and concepts but also has helped in extending technologies developed by the institute.

Jurisdiction of the institute

Centre for Forestry Research & Human Resource Development, Chhindwara came into existence on 30th March 1995. It is a centre of Tropical Forest Research Institute, Jabalpur under the Indian Council of Forestry Research & Education, Dehradun. 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.

Jurisdiction of the centre

2. Research Highlights

- Thresh hold level of harvesting was found to be 80, 90 and 60 percent, respectively for *Andorgraphis paniculata, Buchnania lanzan* and *Asparagus racemosus.*

- 175 Candidate Plus trees (CPTs) of *Jatropha curcas* and 68 CPTs of *Pongamia pinnata* (Karanja) were selected from different agroclimatic regions of Madhya Pradesh.

- Significant variation among genotypes was observed in respect of oil content of 50 mature trees of sandal (*Santalum album* L.) collected from Bangalore. Similarly, 30 trees of sandal sampled of Jabalpur also showed lot of variation with regard to oil content and quality (α and β santalol and aldehyde content). Oil content did not exhibit significant correlation among 55 physiomorphological traits of sandal trees sampled from both the places.

- Genomic DNA were estimated from three ramets each of 96 plus trees of teak and 15-31 progenies each of nine plus trees from Chandrapur. Conditions for STMS touch down assay for teak genomic DNA were standardized.

- The maximum reserpine (0.099%) content in *Rauvolfia serpentina* was recorded in Perumbavoor (Kerala) accession followed by 0.095 % in Angul (Orissa) and 0.094% in Jassipur (Orissa), Maina (Goa) and Anjanakund (Kerala).

- The entomopathogenic nematode *Heterorabdditis indica* proved promising against teak skeletonizer @ 50,000 to 1,00,000 juveniles per litre in combination with bacterial biopesticide 0.05% spinosad (Actinomycete) 45% EC w/w, botanical biopesticide 0.05% agropest *bt*, an insect growth regulator 0.05% lufenuron (Cigna), 5.4% w/w, and was compatible with the highest recommended doses of chemical insecticides, imidacloprid, monocrotophos, endosulfan, chlorpyriphos and thiamethoxam.

- Toxin of soil bacterium, ivermectin proved highly effective as biopesticide against teak defoliator in concentration of 0.005%, leaf skeletonizer (0.03%), *Albizia* foliage feeder in concentration of 0.02%, bamboo leaf roller (0.1%) and mahaneem defoliator (0.05%) during their outbreak.

- Radio frequency drying method followed by shade drying method for stem of *Cissus quadrangularis* proved to be better for retaining maximum amount of active constituent.

- Technique for formulation of nutraceutical food products viz. biscuits, cookies, jelly, squash, chutney, pickle was developed. Chemical composition in each product was also determined.

- Method for estimation of ascorbic acid, total phenol, phenolic acids, macro elements from medicinal plants *Gymnema sylvestre*, *Withania somnifera* and *Stevia rebandiana* standardized.

- Seeds of *Pterocarpus marsupium* treated for 24 hrs in cold water before sowing in July have higher germination. Root-shoot cuttings treated with 400 ppm IBA for 24 hrs produce 96% healthy plants.

2.1 Ecosystem Conservation and Management

2.1.1 Overview

The institute is working on climate change, biodiversity and its conservation, tribals and their traditional knowledge system in central India.

2.1.1.1 Summary of the achievements under the theme

Ecotone sites were found to have more miscellaneous trees, shrubs, herbs and microflora as compare to teak and sal forest. The pH of the soil in ecotone zone was recorded comparatively less acidic than the soil of the sal forest. The species diversity in trees, underground miscellaneous shrubs and herbs in ecotone zone was also recorded high as compared to sal or

teak forest. The temperature and humidity in ecotone zone remain in between as recorded separately in sal and teak forest.

Developed regression equations for *Tectona grandis, Shorea robusta, Eucalyptus* hybrid, *Pongamia pinnata* and agriculture crop. Agroforestry system using *Tectona grandis* and *Dalbergia sissoo* with *Cicer arietinum* followed by *Triticum aestivum* and *Withania somnifera* proved to reduce maximum carbon sequestration.

Acacia nilotica, Albizia lebbek, A. procera, Dalbergia sissoo, Eucalyptus hybrid, *Pongamia pinnata* and *Terminalia arjuna* were planted along Bargi canal to study the effect on water table as well as on growth and biomass of the species.

Automatic Weather Station and Agrometeorological station has been installed at Kanha National Park, Bandhavgarh National Park and Madhav National Park to study grass biomass and soil moisture profile.

Documentation on floral and faunal species composition, their population status in all three zones of Achanakmar- Amarkantak Biosphere Reserve completed. The published information dessiminated to the stakeholders.

327 plants of medicinal value, being utilized by 80 traditional herbal healers for cure of various diseases prevailant among them, were documented.

2.1.1.2 Projects under the Theme

Projects	Completed projects	Ongoing projects	New projects initiated during the year
Plan	2	0	0
Externally Aided	1	2	3

2.1.2 Climate Change

Plant Diversity in sal and teak ecotone zone

Two ecotone sites, one in Jagdalpur (C.G.) and another in Umaria (M.P.) were selected for the study. Two sites dominated by sal and teak forest near ecotone zone have also been selected for comparative study. Number of trees, shrub and herb species were found comparatively more in ecotone zone than in teak and sal of both the study sites. The data showed that the surface soil of teak forest was neutral (7.0) to slightly alkaline in nature, whereas in sal forest soil was acidic (5.5). The pH of the soil of ecotone zone was found in between (6.2) of teak and sal forests. Organic carbon percentage was almost same (1.12%) in ecotone and sal forest where as in teak forest, the value was comparatively low (0.65%). The following indicator species are found in both the ecotone sites: *Dalbergia latifolia, Litsea gluiosa, Terminalia chebula, Sterculia urens and Holarrhena antidysentrica* tree species; *Litsea gluiosa* shrub and *Diospyros melanoxylon* in herb/seedling stage. Phytosociological study showed that the diversity of trees, shrubs and herbs were high in ecotone site. However in pure sal and teak forest the same was recorded comparatively low.

Among tree species *Tectona grandis* was found dominant and having highest IVI in ecotone zone of both sites. S*horea robusta* in sapling stage was found dominant species in Jagdalpur and at Umaria sites, *Cassia tora* was found to be having the highest IVI. Temperature difference of 1^{o} Cwas observed in general in both locations (inside and outside forest). Ecotone and teak forest showed very less variation but temperature was obviously higher than sal forest. The temperature of sal forest (inside forest) was recorded comparatively low.

Humidity percentage in sal dominated area of two sites was comparatively high whereas in teak dominated area of both the sites, the values were comparatively less. In ecotone zones, the values were found in between. Microfloral study revealed the fungal population in ecotone zone of Jagdalpur and Umaria site were comparatively more than pure sal and teak forest.

Teak trees in ecotone zone,Jagdalpur,CG

Sal and Teak trees in ecotone zone, Umaria, MP

Tropical Forest tree species for their potential as carbon sink

Developed regression equations for *Tectona grandis, Shorea robusta* and *Eucalyptus* hybrid and quantified carbon using these equations in plantations and agroforestry systems. Established agroforestry systems with *Dalbergia sissoo, Eucalyptus* hybrid and *Pongamia pinnata* and *Tectona grandis* as tree species and *Triticum aestivum, Cicer arietinum, Withania somnifera, Hordeum vulgare* and *Avena fatua* as agricultural crops. *Triticum aestivum* crop sequestered maximum carbon in agroforestry systems with *Dalbergia sissoo* and *Tectona grandis* as tree species, followed by *Withania somnifera* and *Cicer arietinum.* Maximum reduction in carbon sequestration in agroforestry systems with 15 years old *Tectona grandis* and *Dalbergia sissoo* occurred in *Cicer arietinum,* followed by *Triticum aestivum* and *Withania somnifera.* Two training programmes on 'Agroforestry and Climate Change' for farmers and tree growers were also conducted.

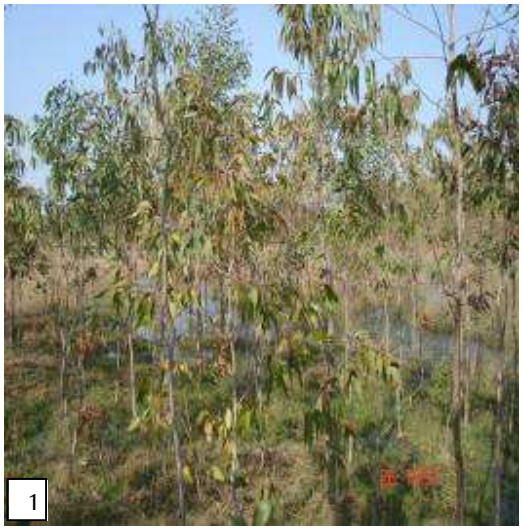
Agroforestry system consisting of *Tectona grandis* and *Hordeum vulgare* established at TFRI campus

Farmers' training organized in village Jamuniya (Jabalpur)

2.1.3 Ecology & Environment

Identification of suitable tree species for biodrainage

Effect of seven tree species including *Acacia nilotica, Albizia lebbek, Albizia procera, Dalbergia sissoo, Eucalyptus* hybrid, *Pongamia pinnata, Terminalia arjuna* and planted along left bank canal of Bargi command area, Jabalpur on underground water table was observed using observation wells. Simulated experiments were conducted in lysimetric tanks to observe the effect of tree species on water table as well as effect of water table on growth and biomass of the species.



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1. Plantation along left bank canal of Bargi command area, Jabalpur.
2. Lysimetric experiments conducted at TFRI campus

Utilization of Automatic weather station/Agrometeorological station data for agriculture, forestry and hydrological applications

Sites were selected near Automatic Weather Station (AWS) and Agrometeorological Station (AMS) in Kanha National Park (KNP), Bandhavgarh National Park (BNP) and Madhav National Park (MNP). Grass biomass studies were conducted in the selected sites. Soil moisture profile up to the depth of 1.50 m was measured at an interval of 30 cm. Surface and sub-surface soil samples were collected and analysed in laboratory.

1. Conducting soil moisture profile studies near AMS at Kanha National Park.
2. Conducting grass biomass studies near AWS at Kanha National Park.

2.1.4 Biodiversity

Achanakmar-Amarkantak Biosphere Reserve

Documentation of data on vegetation status, number of species of flora, fauna, threatened species and human population of all three zones of BR from various published and other sources were done and existing information about BR was updated. The inventory of flora includes 1111 species of angiosperms, 16 gymnosperms, 40 pteridophytes, 16 bryophytes, 130 lichens, 178 fungi and 7 species of algae. The inventory of fauna included 27 species of mammals, 142 birds, 15 lizards & snakes, 10 amphibians, 16 pisces, 27 beetles & cricket, 85 butterflies & moth and 5 species of centipedes. Survey of NTFP's in the BR revealed nearly 39 species in village market trade. A database of published work resulting from BR area was also prepared. During the project period 6 meetings with BR managers were held to discuss various issues and collect information on various aspects of BR and its management. Biannual Biosphere Reserve Infornmation Series (BRIS) Vol. 1 (1 & 2) was published and circulated among scientists and BR managers. Besides this a questionnaire proposed by Seville strategy under Madrid action plan was prepared. A complete document on Achanakmar- Amarkantak Biosphere Reserve for nomination in the World Network of Biosphere Reserve was prepared and submitted to State Forest Department of Chhattisgarh.

2.1.6 Tribals and Traditional Knowledge System

Utilization pattern of plants in enthno-medicinal uses prevalent in tribal pockets of Satpura plateau in Madhya Pradesh

Field survey was conducted to identify rich tribal pockets in Mandla, Jabalpur, Katni and Chhindwara districts of MP for documentation of traditional knowledge from traditional herbal healers. In all 327 plants of medicinal value, which are being utilized by 80 traditional herbal healers of tribal pockets of above four districts for cure of various diseases prevailing among tribal / local people were documented.

Existing utilization pattern alongwith formulation and duration of treatment etc. of medicinal plant being utilized by traditional herbal healers against various common diseases were also documented.

Survey of Mandla, Jabalpur, Katni, Satna, Chhindwara, Bhopal and Sagar districts of MP were carried out to document the channels involved in marketing of herbal plants. 37 traders involved in trading of herbal plants/parts were contacted to collect the information on trading. The price structure of sale of raw herbal medicinal plant parts was collected from local traders. Market day of tribal villages of Mandla, Jabalpur, Katni and Chhindwara districts, where trading of raw and finished products take place, were also visited and the information on Trade recorded.

Details of medicinal plants, traditional herbal healers and traders documented

District	**Medicinal plants documented**	**Traditional herbal healers**	**Traders**
Mandla	85	23	08
Jabalpur	102	27	04
Katni	59	16	06
Chhindwara	81	14	10
Sagar	-	-	02
Bhopal	-	-	05
Satna	-	-	02
TOTAL	**327**	**80**	**37**

Awareness was created through local contacts to the tribal people, traditional herbal healers and villagers of the study area regarding utilization of medicinal plants, importance and sustainable uses of herbal medicinal plants and their conservation during the field visits. Pamphlets and slogan were also published on uses and conservation of medicinal plants for distribution and creating awareness among tribal and local communities.

Potar (*Smilex zeylenica* , Fam.- Liliaceae): A medicinal plant.

Hathfan (*Leea macrophylla,* Fam.- Vitaceae): A medicinal plant.

2.2 Forest Productivity

2.2.1 Overview

Studies on nursery techniques of threatened forestry species like *Strychnos* spp. and *Terminalia chebula*, development of medicinal plant based agroforestry system, evalution of productivity of maize in *Dalbergia sissoo* plantations, sustainable development of bamboo based agroforestry systems for increased income generation, bamboo species suitability for different non forest areas, seed physiology, their maturity and storage were conducted at the institute. The centre is engaged to standardize the technology of some less explored forest species like bijasal, *Pterocarpus marsupium* and on evaluation of agroforestry model for the farmers of Madhya Pradesh.

2.2.1.1 Summary of the achievements under the Theme

Soaking of seeds of *Strychnos nux-vomica* and *S. potatorum* in cow dung slurry proved best to give 88% and 54% germination respectively. Nitrogen and phosphorus separately or in

combination significantly boosted the growth of seedlings. Soaking of seeds of *Terminalia chebula* in water for 7 days and then drying for 2 days proved best to give 82% germination.

On the basis of experiments conducted to develop medicinal plant based agroforestry system, teak-turmeric system proved significantly best. Productivity of maize in *Dalbergia sissoo- Zea mays* agroforestry system also studied. The data proved that the tree distance of 5x5m with 60cm tree to crop line spacing proved best for maximum yield of maize crop.

Litter samples from different layers have been collected for study of microflora and fauna involved in decomposition of litter. In all 45 isolates of fungi isolated and maintained in the laboratory. Carbon flux in sites was recorded. Identification and documentation of selective decomposing fungi is under progress.

Suitability of different bamboo species in non forest areas was also studied. It was observed that *Bambusa vulgaris* had maximum height in yellow soil (Granite), whereas *B. bambos , B.longispathus, B.tulda, B.nutans , and Dendrocalamus strictus* showed maximum growth increment in black (basaltic soil).

The seeds collected from the plus trees of *Pterocarpus marsupium* treated with cold water for 24 hrs before sowing in July gave higher germination. Potting mixture consisting of 80% organic compost, 20% soil and 250cc size root trainer found to produce healthy seedling. Branch cutting from mature tree collected in February-March and treated with 500, 1000, 1500 and 200 ppm for 24 hours resulted only shoot formation after 14 days in mist chamber. Root-shoot cuttings treated with 400 ppm IBA for 24 hours produced 96% healthy plants.

A field trial on agroforestry model by growing tomoto and potatos in between *Emblica officinalis* and *Moringa oleifera*, medicinal plants *Andrographis paniculata, Asparagus racemosus, Rauvolfia serpentina,R. tetraphylla* and *Withania somnifera* under *Aegle marmelos* and *Moringa oliefera* developed.

2.2.1.2 Projects under the Theme

Projects	Completed projects	Ongoing projects	New projects initiated during the year
Plan	4	2	0
Externally Aided	1	1	0

2.2.2 Silviculture

Standardization of nursery technique of *Strychnos nux-vomica* and *Strychnos potatorum:*

Seed germination studies of *Strychnos nux-vomica* and *Strychnos potatorum* under different physical and hormonal treatment were conducted. Seeds of *S. nux-vomica* and *S. potatorum* were sown in polythene bags to conduct fertilizer trial in order to accelerate the growth of seedlings. Data on germination, survival and growth of both the species under different experiments were recorded. On the basis of three year's observation it may be inferred that 72 hrs soaking of seeds of *S. nux-vomica* and *S. potatorum* in cow dung slurry gave maximum 88% and 54% germination respectively. Nitrogen and phosphorus separately or in

combinations significantly boosted the growth of seedlings height, root length and collar diameter. The highest value for the different components of the seedlings was observed to be under the treatment receiving 100 ppm nitrogen with 100 ppm phosphorus.

Development of nursery techniques for *Terminalia chebula* Retx. (Harad)

Studies on seed germination of *Terminalia chebula* under different physical and hormonal treatment were conducted from the seeds collected from Chandrapur (Maharashtra), Bhilaigarh (Chhattisgarh), Tamia (Madhya Pradesh) and Sambalpur (Orissa). The maximum 82% germination was noted under 7 days soaking and 2 days drying of seeds collected from Sambalpur (Orissa).The maximum 86% germination was observed under IBM 500ppm + 7 days soaking and 2 days drying of seeds collected from Sambalpur (Orissa).

Seed physiology of the tropical forest species with special reference to their maturity and storage

Seed storage trials were continued this year on *Schleichera trijuga, Hardwickia binata, Sapindus laurifolia, Rauvolfia serpentina, Moringa oleifera, Mimusops elengi, Holoptelea integrifolia* and *Emblica officinalis, Terminalia chebula,* for assessment of viability and moisture contents. The results from the effect of temperature and moisture content on viability of seeds indicated that the seeds of *Schleichera trijuga, Hardwickia binata, Sapindus laurifolia, Rauvolfia serpentina, Moringa oleifera, Emblica officinalis, Holoptelea integrifolia and Terminalia chebula* are of orthodox type as there was negative relation between them. Storage experiments on *Mimusops elengi* seeds supported its intermediate nature. The viability constants for the orthodox seeds were estimated for prediction of storability of seeds at a particular storage condition. Protein and carbohydrate contents of different stages of three types of seeds were estimated and data were analyzed.

Standardization of nursery technology of *Pterocarpus marsupium*

Seeds of *Pterocarpus marsupium* (*bijasal*) were collected from healthy trees from Gondia (Maharashtra) region and experiments were carried out in the nursery to study the effect of different seed treatments on the germination and growth of seedlings in the nursery. The seeds treated with cold water for 24 hours showed better germination compared to hot water treatment. The bigger sized seeds gave higher germination percentage and germination value as compared to the small size seeds. Higher germination percentage observed in July and minimum percentage of germination was recorded in January. Potting mixture in the ratio of 80% organic compost + 20% soil was found to be best combination where as 250cc size of root trainer gave better results with respect to root and shoot biomass production. Urea, di ammonium phosphate and murate of potash @ 2, 4 and 6 gm respectively per plant was applied, but initially no effect of inorganic fertilizers on growth and development of seedlings was observed. Collected branch cutting from matured tree of *P. marsupium (Bijasal)* in the month of February and March and experiment was laid out in mist chamber by treating the cuttings with different concentration of IBA 500,1000,1500 and 2000 ppm for 24 hours. Shoot formation was recorded after 14 days but no root formation was observed. Root shoot cuttings of *P. marsupium* treated with different concentration of IBA 100, 200, 300 and 400 ppm for 24 hours produced 62%,76%,84% & 96%

healthy plants. A field trial of different types of seedlings (seedlings raised in polybags, root-trainers and root-shoot cuttings) has been established at CFRHRD campus with three replications at spacing of 5x5 meter in randomized block design for evaluating the planting stocks of *P. marsupium.*

2.2.3 Social Forestry, Agro-forestry/Farm Forestry

Evaluation of medicinal plant based agroforestry system (Silvi- medicinal) under existing teak plantations

Developed medicinal plant based agroforestry (Silvi-medicinal) system viz. teak-turmeric, teak-*keokand* and teak-*kalihari*. The developed models were transferred to the user groups through demonstration of field trial and training. Among these three silvi-medicinal systems, teak –turmeric system was widely appreciated by the user groups.

Field demonstration to the farmers of Jabalpur district

Evaluation of productivity of maize in *Dalbergia sissoo* - *Zea mays* Agroforestry system

Laid out an OSR trial with hybrid maize at TFRI campus in two year old *Dalbergia sissoo* plantation with 21 plots of size 10m x 10m at 3 different spacings of 4m x 4m, 5m x 5m and 6m x 6m and 3 plots were kept as blank outside the plantation area. Hybrid maize seeds were sown at same spacing of 60cm x 20cm with tree to crop line spacing of 60cm and 120cm following Randomized Block Design. The maize crop was harvested and yield data recorded, tabulated and analyzed statistically. The tree distance of 5x5m with 60cm tree to crop line spacing proved best for maximum yield of maize crop. Growth parameter i.e. collar diameter and height of *Dalbergia sissoo* plant was recorded at the time of planting and harvesting of maize crop. Maximum increase in height and collar diameter were observed in block with the tree spacing of 5m x 5m. Soil samples collected at the time of planting and harvesting of maize crop were analyzed for pH, EC, organic carbon, available N,P,K and Ca++, Mg++.

View of *D.sissoo-Z.mays* agroforestry system being developed

Samples of harvested maize intercropped under Sissoo-maize system

Sustainable Development of new Bamboo Agroforestry techniques for increased income generation in Central India

Harvesting of wheat from the Bamboo-Wheat Agroforestry System established as an On Station Research (OSR) trial in the Agroforestry Experimental Plot at TFRI, Jabalpur was done in the month of April 2009 and wheat yield was estimated following threshing and cleaning.

The casualty replacement was done in the two bamboo species, i.e., *Dendrocalamus strictus* and *Bambusa nutans*. Soil samples were collected from the Bamboo-Wheat agroforestry system after the harvesting of wheat and analysed for various physico-chemical properties and constituents.

A participatory Rural Appraisal (PRA) exercise was conducted to identify progressive farmers at the Rawan Range, Barnawapara Project Division, Chhattisgarh. Training on the benefits of adapting bamboo based agroforestry system was imparted to the farmers on the 14-15 May 2009. Thereafter polypot seedlings, as per needs expressed by the farmers were provided for planting on their agricultural field boundaries. Similar exercise was conducted to identify progressive farmers at the Bamboo Centre Gwalior, Madhya Pradesh. Training on the benefits of adapting Bamboo based agroforestry systems was imparted to these farmers on 25-26 May 2009. Thereafter polypot seedlings, as per needs of the farmers were provided for planting on their agricultural field boundaries.

A Bamboo-*Urad* (Black gram) agroforestry system was established as an OSR by sowing *Urad* seeds in the Bamboo plantation created while establishing bamboo-wheat agroforestry system. The growth data, viz, collar diameter and height of every bamboo plant of *D.strictus* and *B.nutans* present in the OSR were recorded before the sowing of *Urad* seeds. Soil samples were collected from the experimental plot before the sowing of *Urad* seeds and are being analysed for various physico-chemical properties and constituents in the laboratory.

The growth parameters i.e. collar diameter and the height of the leading culm of *D. strictus* and *B.nutans* were recorded and tabulated. Soil samples were collected after the harvesting of *Urad* and are being analysed for their chemical constituents and physical properties.

The experimental plot was prepared for sowing of wheat to establish a Bamboo-Wheat agroforestry system as an OSR trial in the second cycle. Soil samples were collected before the

sowing of wheat were analysed for various physic-chemical and physical properties and constituents. The growth parameters i.e. collar diameter and the height of the leading culm of the two bamboo species viz, *D. strictus* and *B.nutans* were recorded before the sowing of wheat.

Wheat was sown using a seed driller among the two planted bamboo species i.e. *D.strictus* and *B. nutans* for establishing a Bamboo-Wheat Agroforestry system in the several cycle as an OSR trial. Germination of wheat was observed and the said Agroforestry system so established is being maintained till date.

Training on the benefits of adopting Bamboo based Agroforestry systems.

Bamboo – *Urad* Agroforestry System established.

Agro forestry model with medicinal trees and herbs

Quality seeds of important medicinal plants and trees were collected from identified sources. About 30,000 seedlings of *Aegle marmelos, Andrographis paniculata, Asparagus racemosus, , Moringa oleifera, Rauvolfia serpentina, R. tetraphylla Withania somnifera* etc. were raised in the nursery and distribution to farmers. *Emblica officinalis* and *Moringa oleifera* based agroforestry plantations were established with the existing annual crop like tomato and potato. Established medicinal plants plot of *Andrographis paniculata, Asparagus racemosus, Rauvolfia serpentina, R.tetraphylla, Withania somnifera* under the shade of *Aegle marmelos, Moringa oleifera* as well as in the open to study the effect of shade on growth of medicinal plants. FYM and biofertilizer, soil and sand has been purchased and distributed to the 12 farmers under the project. To make awareness among the people about the importance and cultivation of medicinal plants to get additional benefit both from top storey of medicinal plants and other agricultural crops, 100 people has been given training under the project.

2.2.4 Forest Soils & Land Reclamation

Litter decomposition in sal forests of central India and its impact on nutrient status of soil:

Study sites were selected from sal forest of MP, CG and Orissa. Litter samples from different layers were collected for study of microflora and fauna involved in decomposition of litter. 45 isolates of fungi are maintained in the laboratory. Carbon flux in 3 different sites was

recorded. Identification and documentation of selective decomposing fungi is under progress. The present study will highlight litter decomposition and its conversion into nutrients which will be recycled and used by sal for their growth and biomass production.

Bamboo species suitability for different non forest areas of M.P.

Selected 9 different bamboo plantation sites in non forest areas of M.P. namely Sinduri bharri (Shahdol), Majgaon (Katni), Ghugri (Jabalpur), Sanaidongri (Lakhnadon), Rajgarh (Rewa), Barelipar & Dhokli (Sarni/Betul)), Delakhadi & Sonapipri (Chhindwara) for undertaking observations on growth performance (average height & collar diameter) of bamboo culms. Two pot culture experiments were laid out at TFRI nursery to study a) Suitability of different bamboo species in two different parent material of soil, and b) Performance of *D.strictus* in three different parent material of soil. Growth data of bamboo seedlings raised in two different pot culture experiment are being recorded quarterly. Growth increment of three months old bamboo seedling indicate that *B.vulgaris* had maximum height in yellow soil (Granite), whereas rest of other bamboo species viz. *Bambusa bambos , B.longispathus, D.strictus, B.tulda, B.nutans* had maximum growth increment in black (basaltic) soil.

Bamboo plantation in non-forest degraded area at Ghugri, Shahpur

2.3 Genetic Improvement

2.3.1 Overview

Studies on vegetative propagation, vegetative growth acceleration, varietal improvement of *Rauvolfia serpentina* and *Tinospora cordifolia*, regeneration techniques of *Saraca indica*, evaluation and prediction of oil bearing capacity of sandal germplasm using physiomorpho-molecular marker, molecular characterisation of *ex-situ* conserved germplasm and identification of good quality traits in *Tectona grandis* are being conducted in the institute. The centre has initiated research on genetic improvement of *Buchnania lanzan*.

2.3.1.1 Summary of the achievements under the Theme

Germplasm of two medicinal plants viz. *Rauvolfia serpentina* and *Tinospora cordifolia*, collected from 39 localities, were multiplied for raising at ecologically different localities to study their growth performance or most promotive genotype. Similarly, studies on *in vitro* regeneration of plantlets and their genetic fidelity in the vulnerable medicinal plant species, *Saraca indica*, showed a maximum of 35.2% sprouting of auxillary buds in summer season in 2-3 yr old plants.

Five clones of *Dalbergia sissoo* viz. GBW, JB, FXB, FZK and RB were multiplied to study the genetic variation for *in vitro* morphogenetic potential and evaluation of their field performance. Investigations were also carried out to find out endogenous auxin level and its relationship with adventitious rooting potential in *D. latifolia*. The works are in progress.

Studies on prediction of oil bearing capacity of sandal germplasm using physiomorpho-molecular marker. Genomic DNA of 30 sandal trees of TFRI origin were graded on the basis of oil content by using 25 selected ISSR primers. The sample trees exhibited an average of 64% polymorphism. Further work on evaluation of oil bearing capacity is in progress.

To study the molecular characterization of *ex-situ* conserved germplasm 12 half-sib progenies of each of the 10 plus trees were collected and their genomic DNA was extracted by using CTAB method. Extracted genomic DNA of half sib progenies was sent to The Energy Research Institute(TERI), New Delhi for STMS analysis.

Seeds of *Buchnania lanzan* collected from phenotypically superior candidate plus trees were dried in shade and put in polybags for germination. Germination percentage was recorded to be 41 to 97 % in different seed lots. The progeny trial has been established at the centre.

2.3.1.2 Projects under the Theme

Projects	Completed projects	Ongoing projects	New projects initiated during the year
Plan	0	3	0
Externally Aided	2	2	1

2.3.3 Tree Improvement

Varietal improvement of *Rauvolfia serpentine* and *Tinospora cordifolia* through germplasm selection, evaluation and breeding

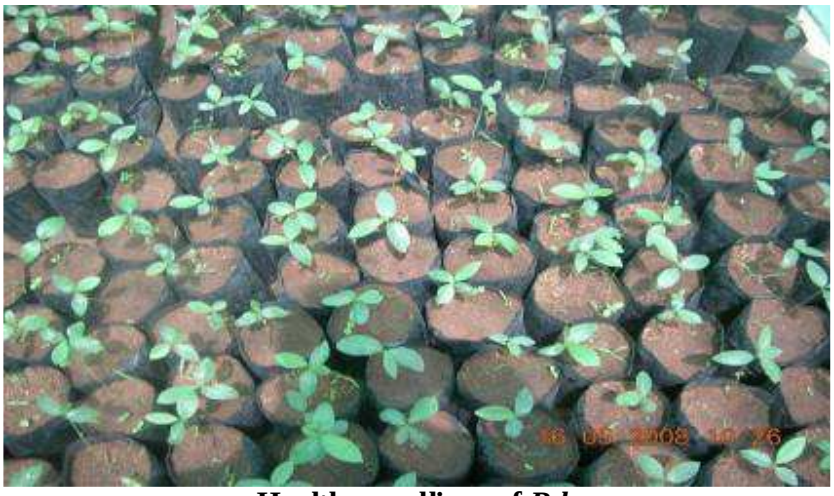
Germplasm of *Rauvolfia serpentina* and *Tinospora cordifolia* were gathered from 39 locations across the country to provide a broad base of the gene pool. These germplasm were been maintained and multiplied by developing various propagation techniques in order to have sufficient number of plants for performance trial followed by multi location trial. In the initial performance trial, 15 accessions were planted under identical conditions in the propagation field at the TFRI and their growth performance recorded for various morphological features. After completion of rotation of crop i.e, 18 months, the growth performance was recorded and root samples were tested for contents of the active principals. The multilocation trials established in

three locations viz., Raigarh (Chhattisgarh), Chandrapur (Maharashtra) and Jabalpur (M.P) showed considerable variation in the climatic and edaphic conditions and it is hoped that because of these factors they will also exhibit considerable variation in the secondary metabolite contents and the active principles. The growth performance was recorded and root samples collected and tested for contents of the active principals and based on DUS characters these have been marked to arrive at the most promising genotypes. It is proposed to carry out additional test of the promising genotypes prior to recommending them for distribution amongst the farmers and cultivators for growing on a commercial scale.

Genetic improvement of *Buchnania lanzan*

Extensive surveys were conducted and 13 phenotypically superior candidate plus trees at Amarwada and Delakhari block of Chhindwara Forest division, 12 phenotypically superior candidate plus trees from Gondia and Shahada forest division of Maharashtra and 8 candidate plus trees from Raigarh Forest division of Chhattisgarh were selected. Seeds were collected from 25 candidate plus trees of *B. lanzan.* Collected seeds were dried in the shade and put in polybags for germination. Germination percentage and growth data were recorded. 41-97 percentage germination was recorded in various seed lots.

Progeny trial of *B. lanzan* has been established in the Centre for Forestry Research and Human Development campus with 9 trees / family / replication with three replications in a randomized block design has been laid out. Survival data has been collected. Progeny trial is being maintained and growth data recorded.



Healthy seedlings of *B.lanzan*

2.3.4 Vegetative Propagation

Genetic variation for *in vitro* morphogenetic potential of *Dalbergia sissoo* Roxb clones and evaluation of their field performance

Shoot multiplication of five clones (GBW, JB, FZB, FZK, RB) was evaluated by conducting two way factorial experiment. The effect of different doses of GA_3 viz., 1.25, 2.50, 5.0 1.0 mg/l was evaluated in five clones. Among five clones tested, clone GBW 4 was found to produce maximum shoot number (2.89) which was significantly higher than other clones. The dose of 5.0 mg/l GA_3 was invariably found to be suitable dose as compared to other doses and reported to produce 2.98 shoots. In the interaction study also GBW and 5.0 mg/l GA_3 (Fig.A) produced significantly higher shoot number (3.98) as compared to other clones and GA_3 doses. In another experiment, the effect of BA (0, 0.5, 1.0mg/l) and IBA (0, 0.5, 1.0mg/l) doses was studied and the combination of 0.5mg/l BA+0.5 mg/l IBA was found significantly higher than other combinations. For studies on rooting and other related parameters, the experiments were laid out as per published report, which showed IBA as suitable auxin for *in vitro* rooting and 1.0 mg/l IBA enriched ½ MS semi solid medium proved to be the best among the three auxins (IBA, IAA, NAA) and their different concentrations used for all rooting parameters. Following documented literature, rooting was not achieved satisfactory on account of very low and late rooting response with profuse callus formation in the bottom of shoots in all these clones (Fig.B). Therefore, further study is underway to standardize the role of nutrient media with amendments of the hormonal doses and use of non-conventional coumarin for augmenting rooting response in these clones.

Fig.A : Maximum shoot multiplication in the medium with 5mg/l GA3 in GBW clone

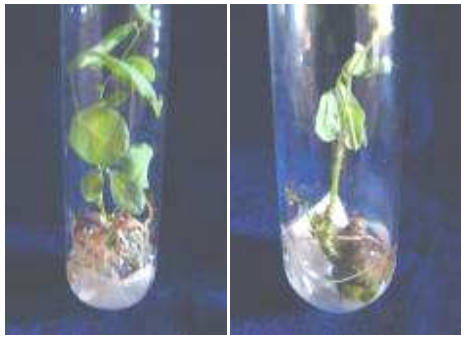


Fig.B : Low rooting response with profuse callus formation in GBW clone

Studies on endogenous auxin level and its relationship with adventitious rooting potential in *Dalbergia latifolia* Roxb

Significant seasonal/genotypic variation was recorded in endogenous auxin (IAA) in *Dalbergia latifolia* trees from Jabalpur. IAA was minimum (1.742 µg g^{-1} fresh weight) in March and maximum (3.640 µg g^{-1} fresh weight) in July. This is due to the emergence of new buds and new vegetative growth, accelerating the IAA synthesis which moves downward. Maximum IAA was in tree 8 (3.117 µg g^{-1} fresh weight) and minimum in tree 1 (2.334 µg g^{-1} fresh weight). Ten trees were selected each from Chandrapur (MS) and Jagdalpur (CG). Samples were collected from selected trees for endogenous auxin studies. Significant genotypic variation in endogenous auxin was also recorded among selected trees from Chandrapur (MS) and Jagdalpur (CG).

Experiments conducted for testing rooting potential in selected trees of Jabalpur, Chandrapur and Jagdalpur. 4 hrs basal dip treatment of IAA (5mM) and IBA (5mM) was given along with control. A basal dip treatment of 5mM IAA for 4 hours promoted adventitious rooting up to 11.33% compared to 1.33% in control in cuttings of selected trees of Jabalpur. Literature reveals only up to 5% rooting and categorized the species as "very difficult to root". Estimation of endogenous auxin in seedlings of selected trees of Jabalpur and experiment on rooting potential of raised seedlings is in progress and under observation.

Adventitious rooting in shoot cuttings of *Dalbergia latifolia*

Studies on *in vitro* regeneration of plantlets in *Saraca indica* Linn., a vulnerable medicinal tree and their genetic (molecular) fidelity:

The effect of different seasons and sterilizing agents on aseptic culture establishment was studied. Highly significant effect of seasons was observed on sprouting of axillary buds with maximum sprouting (35.2%) obtained in summer season in 2-3 year old plants. Sterilizing treatments also had significant effect on sprouting of buds with 0.2 % $HgCl_2$ treatment resulting in maximum sprouting (38.9%) which was on par with sprouting (27.8%) obtained with 0.1 % $HgCl_2$ treatment. Season and sterilizing treatments did not have significant effect on sprouting of terminal buds from 20 year old mature tree. B_5 medium supplemented with 2.2 µM BA was screened out as the most suitable medium for bud sprouting and elongation of regenerated shoots from nodal segments. On modification of KNO_3 in B_5 medium, the modified strengths of KNO_3 had statistically significant effect on sprouting of buds and number of shoots after four weeks of culture. On 0.25x strength of KNO_3, maximum shoots (1.12) were obtained. Significant differences were observed between treatments for number of shoots after eight weeks of culture also and maximum shoots (1.92) were obtained on 0.25x strength of KNO_3 which was statistically on par with 1.36 shoots obtained with 0.50x strength of KNO_3. The modified strengths of KNO_3 did not significantly affect the elongation of shoots. Similarly, four strengths of $CaCl_2$ along with three doses of BA were tried and no significant effect of $CaCl_2$ was observed on shoot formation. Shoot formation from embryonic axis of immature seeds was

obtained on B_5 medium supplemented with 2.5 µM BA. Zeatin doses and interaction between Zeatin and BA did not have significant effect on number of shoots. Maximum callus formation (64%) on embryonic axis was obtained on B_5 medium supplemented with 2.5 µM BA. In another experiment with embryonic axis, the interaction between 2, 4-D and TDZ had a significant effect on number of shoots with 3.56 shoots obtained on 2 µM 2, 4-D and 10.0 µM TDZ. Leaf pieces were tried for organogenesis. Significant effect of auxin type was observed for callus formation on leaf pieces with picloram resulting in maximum (62.50 %) callus formation. Zeatin doses and their interactions with auxins did not have any significant effect on callus formation on leaf pieces. Similarly, in another experiment with TDZ and 2, 4-D only significant effect of 2, 4-D on callus formation on leaf pieces was observed. Shoot formation from leaf pieces was not observed in both the experiments. On B_5 medium supplemented with 13 µM NAA, 6 % rooting of shoots was obtained. Three basal nutrient media were tried for *in vitro* rooting, but no rooting was achieved. Effect of 5 durations of pulse treatment with 200 µM IBA in 1/2 strength MS liquid medium was studied and pulse treatment of 5 days duration resulted in 37.5 % *in vitro* rooting of shoots. Plantlets were hardened in soilrite soaked with half strength MS medium in culture room and later shifted to shade house.

2.3.5 Biotechnology

Evaluation and prediction of oil bearing capacity of sandal (*Santalum album* L.) germplasm using physiomorpho-molecular marker

Nitrate reductase activity was determined in leaves of 27 selected trees from TP and 3 trees from TO plantation area. TP-1 from TP selection and TO-1 from TO selection had maximum enzyme activity. On the other hand, the lowest enzymatic activity was recorded in TP-6, TP-7 and TO-17 trees among their selections.

Peroxidase activity was determined in leaves of selected 30 trees each from TP and TO plantation area. Trees from TP selection exhibited more enzyme activity than those from TO selection. TP-9 and TO-13 in the second quarter and TP-15 and TO-10 in the fourth quarter had maximum enzyme activity from their respective selections. On the other hand, the lowest enzymatic activity was recorded TP-24 and TO-15 in the second quarter and TP-12 and TO-12 in the fourth quarter exhibited minimum enzyme activity from their respective selections. As for situation in the third quarter, the peroxidase activity of 27 sandal trees of TP and 3 trees of TO was recorded. TP-11 from TP selection and TO-1 from TO selection had maximum enzymatic activity and TP-6, TP-7 and TO-17, the lowest activity.

Genomic DNA of 30 TFRI sandal trees graded on the basis of oil content was amplified using 25 selected ISSR primers. Figure below depicts amplification of genomic DNA by two primers. The sampled trees exhibited an average of 64% polymorphism. Primer UBC 801 detected the highest polymorphism followed by UBC 900, 880, 899 and 808 in that order. Primer UBC 830 and 856 produced the least percentage of polymorphism.

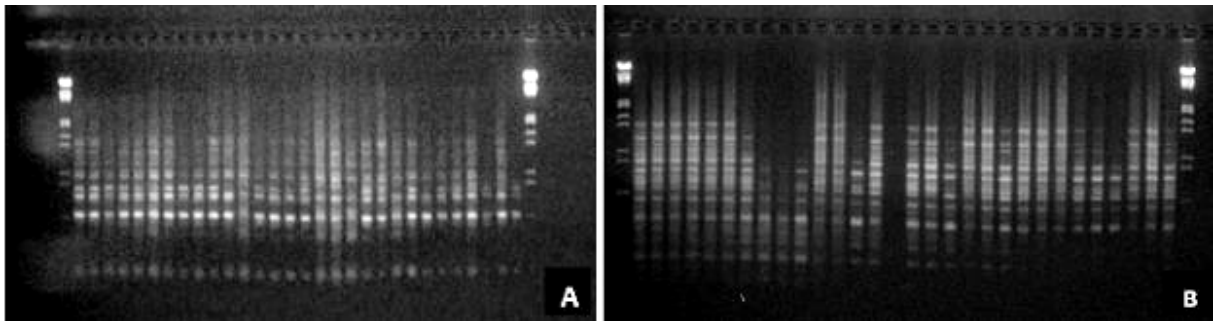
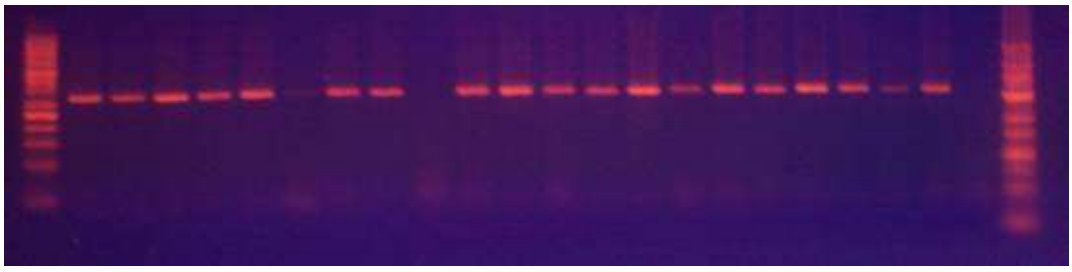


Fig. Amplification of sandal genomic DNA of 30 sandal trees (TP1-TP11, TP15-30, TO1, TO17 and TO25) by ISSR primers: (A) UBC 822 (B) UBC 841

Molecular characterization of *ex-situ* conserved germplasm and identification of molecular marker associated with wood quality traits in *Tectona grandis* L.f.

Two factorial randomized experiments were conducted: (1) to screen quantities (10, 20 and 30 ng) of genomic DNA, primer (Tg-08) concentrations (0.165, 0.33,0.65 µM) and their all possible combinations and (2) $MgCl_2$ concentrations (1.5, 2.0 and 2.5mM) and Taq polymerase (0.5,1.0 and 1.5 U) under either hot-start or touch-down PCR conditions on optimum amplification. The other assay conditions included 50mM KCl, 10mM Tris HCl and 10µ mole dNTPs. Initially, 2.5% high resolution agarose was used; but subsequently, the same concentration of lab grade agarose was found to exhibit similar sharpness of bands. Therefore, the lab grade agarose was recommended for further investigation. It was found that touch down PCR provided better amplification than hot-start PCR. The lowest quantity of genomic DNA(10ng), $MgCl_2$ (1.5 mM) and Primer concentration (0.165 µM) and the highest Taq polymerase (1.5 U) resulted in excellent amplification of STMS markers and were recommended for touch down PCR (60^0C-50^0C, 1^0C) for STMS analysis of teak plus trees and progenies, using 2.5% lab grade agarose.



STMS amplification of genomic DNA of teak plus trees withTg19 SSR (L-R): 50bp DNA ladder, APKEA-23, APNPL-9, AC-II, G+10,ST-17, ST-, KLK-1, PT-41, PT-3, MHSC-A3, MHSC-A1, ORBUB-11,ORPBU-6,TNT-8,TNT-10,UP-M,UP-A,WB, WB+4, AI-N, AI-1 and 25bp DNA ladder.

State Forest Research Institute, Jabalpur raised a progeny trial of MP plus trees in 1998, which included 54 half-sib progenies each of ten plus trees (KEKC-2, BSC-24, NRLC-26, NRLC-16, BBC-10, BBC-14 NRLC-10 NRLC-8 BBC-15, NRLC-17) in a simple randomized block design with three replications at Katni. In all, 12 progenies from each of ten plus trees were collected and their genomic DNA extracted from 500 mg eaves using CTAB method. To

avoid RNA contamination, 20µg/ml RNAse was used. The quality (A260/A280) of genomic DNA of half sib families were determined. The quantity of genomic DNA of these families varied from 80-2.94 µg and visualized on 0.8 % agarose gel. The extracted genomic DNA of half sib-progenies was sent to TERI, New Delhi for STMS analysis.

2.6 Non-wood and Forest Products (NWFPs)

2.6.1 Overview

Studies on resource development of biofuel species *Jatropha curcas,* development of Karanj, *Pongamia pinnata*, sustainable harvesting of some medicinal plants in JFM areas, chemistry, value addition, utilization of some medicinal plants and bamboo species are being conducted at the institute. The centre is conducting research on resource development and management, chemistry and value addition of *hadjor, Cissus quadrangularis.*

2.6.1.1 Summary of the achievements under the Theme

Multilocational trials of 9 superior accessions of *Jatropha curcas* were raised at the institute in 2008 and 19 accessions in 2009. On the basis of growth attributes, two accessions HAP-41 and HAP-44 (Garhwal, Uttarakhand) were recorded to give higher number of branches without prunning.

A national multilocation trial comprising of 36 accessions of *Jatropha* were established at the institute. Accession TFRI-2 performed better with respect to growth, number and size of fruits. Sustainable harvesting of medicinal plants viz. *Andorgraphis paniculata, Asparagus recemosus, Chlorphytum borivillium* and Chironji fruits, *Buchnania lanzan* was studied. Harvesting of 80% *A. paniculata*, 60% *A. recemosus* and *C. borivillium* was proved sustainable without affecting the regeneration. Regeneration of *B. lanzan* was found unaffected even on the harvest of 90% fruits.

Experiments initiated to standardize the various means of sustainable harvesting methods such as strip harvesting, alternate harvesting and opposite harvesting of barks from tree trunk, branch, twig, leaves, flowers, roots, etc. of *Bauhinia veriegata, Holorrhena antidyrentrica, Oroxylum indicum, Saraca asoka* and *Terminalia arjuna*.

Physical and chemical properties of polysaccharides in the tubers of *Curcuma augustifolia, C. pseudomontana, Dioscorea bulbifera, D. hispida* and seeds and aerial parts of *Hyptis suaveolens* were studied.

Nutritive value of bamboo shoots were also investigated. Boiling shoots of *Bambusa tulda* and *Dendrocalamus strictus* in 1% NaCl solution in water for 15 minutes, *D. asper* in 5% NaCl for 10 minutes and B. bamboos in 5% NaCL for 15 minutes proved best for removal of anti-nutrients. Different products like bari, pickels, papad, petha, sauce and cruches were made from the shoots.

Tubers of *Asparagus racemosus* were sown in nursery beds and 70% sprouting was recorded at a depth of 2.5 to 5 cms. The data showed that size of the tuber grown in stress condition are comparatively bigger than the irrigated one. Chemical analysis of tubers for saponin indicated large variation at all the selected sites.

2.6.1.2 Projects under the Theme

Projects	Completed projects	Ongoing projects	New projects initiated during the year
Plan	1	2	2
Externally Aided	0	5	0

2.6.2 Resource Development of NWFPs

Establishment of multilocational trials of superior accessions of *Jatropha curcas* under the network program of DBT

A multilocational trial comprising of nine superior accessions of *Jatropha curcas* was established in October 2008 at institute campus. Another half sib progeny trial comprising of nineteen accessions received from different participating institutes were laid out at institute in July 2009. The experimental field was divided into 57 equal size blocks and five plants were planted in each block at the distance of 3x3 meter. The trial is performing well with a survival of 95%. Regular observations on growth attributes like height, collar diameter, number of branches, flowering, incidences of pests and diseases has been recorded on monthly basis and also sent to Biotech Park Lucknow for compilation. Minimal irrigation and maintenance was provided to the trials as and when required. In multilocational trial, two accessions HAP 41 and HAP 44 (HNB, Garhwal) are showing higher number of branches without pruning. Some plants showed flowering in the month of September-October 2009. Fruits were formed in following accessions: H4 (HAP 41, HNB, Garhwal, B2 (BTP-U, BTP, Lucknow), N2 (JA-9, NBRI, Lucknow), N3 (JA-126, NBRI, Lucknow) and H5(HAP 42, HNB Garhwal). In Half sib progeny trial initiation of flowering has been observed in March 2010 in following accessions: JA-9, JA-126, JA-88 (NBRI, Lucknow), MSSRF-10, MSSRF- 16 (MSSRF, Chennai), HAP- 41, HAP-42 and HAP-44(HNB, Garhwal). In multilocational trial, first pruning was done in the month of February 2010. Mulching was done in both the trials in the month of March 2010 to prevent the moisture loss.

Standardization of cultivation protocol for *Asparagus racemosus*

Site of open land has been selected at TFRI, Jabalpur campus and near CFRHRD, Poama, Chhindwara for establishment of experimental plantation. *Asparagus racemosus* tubers collected from nearby places of Chhindwara in which Tamia, Delakhari, Bichua, Betul has been covered. Preparation of nursery beds was done and seeds were sown in nursery beds at 2.5 to 5.0 cm spacing. Farm yard manure and compost was applied. 70% germination response was observed at the depth of 2.5 to 5 cm. Experiment was laid out to study the effect of different spacing viz. 45x45 cm, 60x45 cm, 60x60 cm and 45 x 30 cm and harvesting age of *A. racemosus* on farmers field at Jabalpur, Poama and Chhindwara. The experiment was also laid out to study the effect of above spacings in combination with different types of organic fertilizers (F.Y.M., Vermicompost and VAM) with three replications in a randomized block design at CFRHRD nursery. The experiment was also laid out to study the effect of irrigation on growth of *Asparagus racemosus*.

The tuber of stress condition crop is slightly bigger than the irrigated one. Soil testing of CFRHRD nursery, Chhindwara and farmers field was done. 5% mortality of *Asparagus racemosus* plants was observed in farmer's field. Experimental plots are being maintained. Chemical analysis of *Asparagus racemosus* (Satawar) tubers for saponin content at an interval of 45 days from all 4 sites was done and there was large variation noticed.

Developing methodology and parameters for selection of CPTs of NTFP species:

Extensive survey was carried out for development of methodology and parameters for selection of candidate plus trees of non timber forest produce (NTFP) species.

For *Terminalia chebula* growth and fruit data recorded from four locations viz. Delakhari, Amarwada , Chichpalli and Bamni forest range for important traits. On the basis of analysis, the direct effect of girth, CBH and crown volume was found high and positive; and their correlation were also high which showed that they have a real significant effect on yield.

For *Terminalia bellarica* growth and fruit data were recorded. On the basis of analysis, the direct effect of crown diameter and no. of fruit/kg were high and positive; and their correlations were also high which showed that they have a real significant effect on yield.

For *Pongamia pinnata* growth and fruit data were recorded from four locations and data analysed. The result revealed that the direct effect of crown volume was high and positive; and their correlation was also high which showed that it had a real significant effect on yield.

For *Acacia catechu* growth data has been collected from four locations. On the basis of analysis the direct effect of girth, CBH and crown diameter were high and positive and their correlation was also high which showed that they had a real significant effect on yield. In case of *D. melanoxylon* girth was highly and positively correlated with height, which was positively correlated with CBH.

2.6.3 Sustainable Harvesting and Management

Sustainable management of medicinal plants in JFM areas in different agro-climatic zones of Madhya Pradesh

Studies on sustainable management of medicinal plants in JFM areas in two agroclimatic zone of Madhya Pradesh have been conducted. Sample plots for the study of sustainable harvesting of *Andorgraphis paniculata* (Kalmegh) was laidout in Satnur, Naunichhapar, Delakhadi and Umaranala Forest area, Chhindwara Forest Division. Sample plots for the study of sustainable harvesting of *Buchanania lanzan* (Chironjii) was laid out in Sitadongri, Delakhadi, Khumbhadeo, Batkakhapa and Ojhaldhana Forest Area, Chhindwara Forest Division. Sample plots was also laid out as per statistical design in Umariya Forest Area, Katni Forest Division for the study of sustainable harvesting of *Asparagus recemosus* (Satawar) and *Chlorphytum borivillium* (Safed Musli).

Data on sustainable harvesting collected from the field was statistically analysed and interpreted. On the basis of three year's observation it may be concluded that regeneration of *A. paniculata* is sustainable at all harvesting level (20-80%) and thus, entire plant of *A. paniculata* to the extent of 80% can be harvested for maximum productivity and without loss in regeneration. Regeneration of *B. lanzan* is sustainable at all harvesting level (60-90%) and thus upto 90% fruits of *B. lanzan* can be harvested for maximum productivity and without loss in regeneration. Regeneration of *A. racemosus* and *C. borivillium* is sustainable at the harvesting

level (20-60%) and thus for maximum productivity and without loss in regeneration 60% *A. racemosus* and *C. borivillium* plants with roots can be harvested.

Studies on developing alternative methods of sustainable harvesting of medicinal plants

Surveys were conducted to various regions of Madhya Pradesh, Chhattisgarh, Maharashtra and Orissa for selection of targeted tree species *viz. Bauhinia veriegata* (Kachnar), *Holarrhena antidysenterica* (Kutaj), *Oroxylum indicum* (Sheonak), *Saraca asoka* (Ashoka) and *Terminalia arjuna* (Arjuna). Population of *Oroxylum indicum* is scanty in all the states and *Saraca asoka* population could not be found out in the state of Madhya Pradesh and Chhattisgarh. Experiments were laid out for standardization of alternative harvesting practices of designated species in the forests areas of Jabalpur, Rewa, Balaghat (M.P.); Harishankar, Champagarh, Bolangir (Orissa); Bilaspur, Raigarh (Chhattisgarh) and Allapally, Chandrapur (Maharastra). Different plant parts i.e. trunk bark, branch bark, twig bark, twigs, leaves, flowers, roots etc. were collected and analysed for their phytochemical constituents like tannins, alkaloids, flavanoids and phenols. Various harvesting methods such as strip, alternate and opposite harvesting were tried. Regenerated bark was also collected to compare major active ingredients. Regular observations were recorded on bark regeneration. Data on bark regeneration revealed that bark recovery is faster in first 6 month in younger trees having GBH <50 cm. Phytochemical analysis of various plant parts revealed that trunk bark contains maximum amount of active ingredients. Original bark contains higher amount of phytochemical constituents than regenerated bark. Different plant part samples (Arjuna-48, Kachnar-18, Ashoka-16, Sheonak-24 and Kutaj-40) were sent to Central Institute of Medicinal and Aromatic Plants, Lucknow for chemical and biological analysis.

Harvesting time of some selected medicinal plants for their natural antioxidants constituents

Survey was conducted in Tamia and Delakhari natural forest and Medicinal Plants Conservation Area, Delakhari for the availability of the selected species under study. *Gymnema sylvestre* species was available in Rainikheda beat, compartment no. P-36, Jhirpa range. *W. somnifera* and *Stevia rebaudiana* plantations established in CFRHRD nursery at the spacing of 75x75cm and are being maintained. Collected *M. oleifera* and *G. sylvestre* leaves from existing plantations of the centre and natural forest on monthly basis. Method standardized and estimated antioxidant constituents viz. ascorbic acid, total phenols, phenolic acids and macroelements.

2.6.4 Chemistry of NWFPs, Value Addition and Utilization

Determination of polysaccharides for the development of bioproducts :

Collected tubers of *Curcuma angustifolia, C. pseudomantana, Dioscorea bulbifera,* D. *hispida,* seeds and aerial parts of *Hyptis suaveolens* for isolation of polysaccharides. Samples were processed , polysaccharide isolated and estimated. Physical and chemical properties of polysaccharides – starch samples were determined. Starches from different species were modified by acetylation and hydroxy-propylation. Degree of sustitution was evaluated. Native

and modified starch–lignin and starch-polyols polymers were prepared. Physical and chemical properties of polymers were studied

Nutritive values and value addition of some bamboo species of central India

Bamboo shoots of different species *viz. Bambusa bamboos, B. tulda, Dendrocalamus asper* and *D. strictus* were brought from different regions of Madhya Pradesh, Chhattisgarh, Maharastra and Orissa. Fresh shoots were analyzed for nutrient and anti-nutrient constituents. Shoots were boiled in different concentrations of sodium chloride (salt) solution to find out the best method for removal of anti- nutrients while preserving the nutritive value. The best method for removal of anti-nutrients for *D. strictus* and *B. tulda* was 15 minutes boiling in 1% NaCl; *D. asper* 10 minutes boiling in 5% NaCl; *B. bamboos* 15 minutes boiling in 5 % NaCl. Different products such as bari, pickle, papad, petha, sauce and crunches were made from fresh shoots. Shoots were also preserved in salt solution and vinegar to use them after the season of availability. Chemical analysis of preserved shoots and prepared products was done at regular intervals to determine the shelf life. Results revealed that preserved shoots could be consumed within 4 months and bari within 5 months. Studies to determine the shelf life of pickle and papad are under progress.

Seasonal variation in active chemical constituents of Hadjor, *Cissus quadrangularis*

Cissus quadrangularis (Hadjor) plant samples were collected from Chhindwara, Bhopal, Jabalpur (Madhya Pradesh), Nagarjuna Botanical Garden, Akola, Nagpur (Maharashtra), Janjgir, Raigarh (Chhattisgarh) and NRCAF, Jhansi and established in nursery beds of the centre and are being maintained. Fresh stem samples were collected on monthly basis and analysed for total phytosterols, ascorbic acid, macroelements and trace elements content. Macroelements viz. calcium, magnesium, potassium were analyzed and trace elements viz. zinc, copper, manganese, iron and selenium content were estimated on AAS. All the parameters have a synergistic effect on bone fracture healing, bone related problems and general weakness. Analysis of active constituents viz. total phytosterols and ascorbic acid in *C. quadrangularis* fresh stem samples collected from various places were also analysed simultaneously. The sample collected from Chhindwara was found to be the best in total phytosterols content followed by Akola. The sample collected from Piparia was best followed by Raigarh in terms of its ascorbic acid content. The best harvesting time based on its active chemical constituents was found to be December to March. Survey was conducted in some places of Chhattisgarh and Madhya Pradesh viz. Rajnandgaon, Khairagarh, Kapsi, Tamia and Betul district and collected information from the tribals and traditional herbal healers regarding their knowledge on best harvesting time of *C. quadrangularis*.

Stems (peel and core) *C. quadrangularis* were analyzed separately for moisture, yield, ash, phytosterols, ascorbic acid and phenols. Maximum amount of active constituents was found in peel as compared to pulp. Dehydration studies of stem were carried out from Department of Food Technology, Nagpur University, Nagpur which included solar drying, shade drying, oven drying and radio frequency drying treatments. Radio frequency drying method was found to be the best followed by shade drying in retaining maximum amount of active constituent. From economic point of view, shade drying could be recommended for large scale drying of the herb.

Technology was developed for formulation of nutraceutical food products. Six nutraceutical food products viz. biscuits, cookies, jelly, squash, chutney and pickle were developed as per FPO (Food Products Order) & Prevention of Food Adulteration Act (PFA) specifications in collaboration with Dept. of Food Technology, Nagpur. All the products were tested for consumer acceptance level by conducting the chemical and sensory evaluation of the finished products. The research results were disseminated to the user groups through training programmes. Brochures were published in English and Hindi.

Nutraceutical food products (squash, jelly, biscuits, cookies, chutney and pickle) developed of *Cissus quadrangularis* stem.

2.6.5 Biofuels and Bioenergy

National network on integrated development of Jatropha and Karanj

Jatropha: National multilocation trials comprising of 36 accessions and zonal trial of 14 accessions were established at institute campus. In national trial, TNMC-22, TFRI-2, Guj-1, RJ - 92 and NRCJ-17 and in zonal trial TFRI-1, TFRI-2 and IGAU-2 performed better in tropical climatic conditions of Jabalpur. Maximum fruiting was observed in TFRI-2 and PDKV-1 (National trial) and RRL-1 (Zonal trial). Two progeny trials comprising of 20 progenies each were also established at CFRHRD, Chhindwara and Baraha, Jabalpur. Dalka Mandla-1 and Timrikala in Chhindwara; Gesani Shivpuri-2 and 3 in Baraha, Jabalpur were found most promising progenies. Package and practices trial were also established to standardize agronomic practices of Jatropha. Seeds were collected from established multilocational trials and analysed for their morphological characters and oil content. The maximum fruit and seed size was found in TFRI-2, Palampur-1 and IGAU-1. The oil percentage varied from 30 (SFRI-1and Palampur-1) to 41 (TNMC-22). Pruning was done in the month of February 2010. Mulching was done in the trials in the month of March 2010 to prevent the moisture loss.

Karanj: National trial comprising of 5 accessions and zonal trial of 17 accessions were established at institute campus in the year 2005 and 2006. TNMP-14 and RAK-5 are performing better in national trial whereas IGAU-1 and IGAU-2, JNKVV-29 and JNKVV-15 in zonal trial. A progeny trial comprising of 20 progenies was established at Balaghat. Kushmeli Chhindwara,

Sikharpur, Chhindwara and Lalpur Satna were found most promising genotype among other progenies. The fruiting was observed in IGAU-3 accession of zonal trial.

2.7 Forest Protection

2.7.1 Overview

The institute is engaged in research on identification of insects, pathogens, beneficial microbes and protection of forest seeds, seedlings, saplings, trees in plantation, stored wood depots from insect and pathogen pests.

2.7.1.1 Summary of the achievements under the Theme

Wilt disease caused by *Fusarium oxysporum* in nurseries of *Buchnania lanzan* was found to be controlled by foliar spraying of redomil 0.2%. The attack of leaf defoliators was minimised by foliar spraying of monocrotophos 0.05% or endosulfan 0.05% or cypermethrin 0.03% or fenvalerate 0.03%. Attack of stem borer, *Botocera rufomaculata*, which girdles the main tree bole was found to be controlled by injecting 10 ml water emulsion of 0.5% dichlorvos.

Teak defoliator, *Hyblaea puera* and skeletonizer, *Eutectona machaeralis* are major leaf feeders in forest nurseries. Petroleum ether extract of seeds of *Annona Squamosa* was recorded to exhibit 72.99 to 75.43% antifeedant activity against the larvae of *E. machaeralis* and *H. puera*. It is followed by seed extract of *A. squamosa* in ethyl acetate. Foliar spraying of 0.5% neem commercial formulation was recorded to inhibit 80% egg layings besides 90% antifeedant effect on young larvae. Surviving remaining larvae were observed to be killed by foliar spraying of 0.05% spinosad (actinomycetes) or 0.05% agropest or 0.05% cigna or 5000 infective juveniles (ij) of entomopathogenic nematodes (EPN) *Steinernema* spp. or *Heterorhabditis* spp./lt. The EPN proved compatible with some chemical and biopesticides at higher humidity. Two exotic and four native population of EPN are being maintained to test their effectiveness against the termites and white grubs. The larvae of *Hyblaea puera* were recorded to be parasitized by 5 species of parasitoids, 4 species of predators, an entomopathogenic fungus and the larvae of *E. machaeralis* were recorded to be parasitized by 8 species of larval parasitoids, 3 species of predators and 3 species of entomopathogenic fungi. In an another project, 12 species of braconid larval parasitoids were recorded to be distributed in forests and agroforestry areas of 15 districts of Maharashtra.

Teak nursery is severely attacked by root feeding insects called whitegrubs. The beetles of these grubs emerge during rain to feed on foliage of *Ziziphus jujuba* and *Z. mauritiana* before egg laying in soil. Foliar spraying of monocrotophos or dimetheate 0.05% twice at an interval of 15 days proved effective in reducing beetle population. Soil treatment with phorate or methyl folidal @ 300gm/bed (size 12m x 1.25m) in combination and alternatively with EPN juveniles @ 250-300/ bed proved effective in reducing the seedling mortality.

Different species of bamboo were recorded to be attacked by insect leaf rollers, grasshoppers, aphids, whitegrubs and diseases caused by leaf rust, leaf tip flight in nurseries. In plantation, however, onlyleaf rollers, grasshoppers, aphids, culm borers, hare and disease caused by a leaf rust were recorded from central India. An information system associated with sal,

shisham, bamboo, teak insects and their management has been developed and fine tuning related to software development is in progress.

Out of 745 specimens of wood decay collected from wood depots of Maharashtra and Orissa, 20 genera and 44 species of decaying fungi were identified. Four genera and seven species of them have been recorded for the first time on sal and bijasal.

Growth promoting microbes and soil amendments were also studied to enhance the growth of *Gmelina arborea*, *Dalbergia sissoo* and *Jatropha curcas*. The microbes *Aspergillus* sp. and *Trichoderma* spp. were recorded as growth promoting organisms. Application of plant growth promoting microbes and soil amendments proved to enhance 10-20% survival and 43% height of sandal seedlings.

2.7.1.2 Projects under the Theme

Projects	Completed projects	Ongoing projects	New projects initiated during the year
Plan	4	3	0
Externally Aided	3	3	2

2.7.2 Insects pests, diseases and control

Chemical control of insect pests and diseases of *Buchanania lanzan*

Out of 7 chemicals viz. dichlorvos 0.5%, monocrotophos 0.07%, endosulfan 0.05%, dimethoate 0.05%, petrol, kerosene and para- dichorobenzene + kerosene- 10 ml each; water emulsion of dichlorvos 0.5% (10 ml) showed cent per cent killing of stem borer *Batocera rufomaculata* within 60 days in natural stand of *B. lanzan*. Out of 6 treatments viz. dithane 0.1%, 0.2%, bavistin 0.1%, 0.2%, redomil 0.1% & 0.2%, foliar spraying of redomil 0.2% followed by redomil 0.1% proved highly effective against wilt diseases caused by *Fusarium oxysporum* in nursery stage. Out of 4 chemicals viz monocrotophos 0.05%, endosulfan 0.05%, bavistin 0.2% & alpha NAA 40 ppm); foliar spraying of combination of endosulfan 0.05% + bavistin 0.2% + alpha NAA 40 ppm proved best for maximum number and weight of fruit production of *B. lanzan*. Foliar spraying of monocrotophos 0.05%, endosulfan 0.05%, cypermethrin 0.03%, fenvalerate 0.03%, deltamethrin 0.002%, alphamethrin 0.003%, bipro super - *B. bassiana* 7 ml / lit, neemraj supreme- neem oil 0.5%, found significantly superior over control in killing of larvae within 72 hrs.

Evaluation of biopesticidal products for the management of teak defoliator and skeletonizer in forest nursery

Planned and time-bound use of a neem based biopesticide 0.5% observed to cause 90% antifeedant effect to the larvae of teak skeletonizer. It was also proved to inhibit over 80% egg laying of teak defoliator. Spraying with biopesticides like, 0.05% of spinosad (Actinomycete) 45

% EC Actinomycete Biological Product; botanical combination agropest *bt* @ 0.05%; cigna 5.40% W/w (Insect Growth Regulator) for direct mortality with 3 – 7 days residual effects against teak defoliator and skeletonizer in forest nursery. EPNs *H. indica* and *S. carpocapsae* were reared and their bioefficacies evaluated for the first time against forest insect pests. EPN, *H. indica* in laboratory bioassay (dose-range 3 to 30 ijs larva^{-1}) in 72 hrs post-exposure caused mortality up to 76.47 % at 10ijs larva^{-1} 100% at 30ijs larva^{-1}. Leaf treatment method (dose-range 32 to 280 ijs larva^{-1} or 3.88ijs to 32.00ijs cm^{-2}) resulted in mortality range of 78.94% at 130ijs larva^{-1} or 15.53 cm^{-2} and 100% at 265ijs larva$^{-1,}$ or 32.00 cm^{-2}. Field spraying experiment indicated requirement of 5000 to 10000 infective juveniles/ litre for the mortality. First time 3 native EPN populations (1 *Steinernema* spp. and 2 *Heterorhabditis* spp.) were isolated and being maintained successfully, as no previous reports from the central Indian forest floor is available. PDBC strains of *H. indica* was found compatible with chemical insecticides, viz., imidacloprid, monocrotophos, endosulfan, chlorpyriphos and Thiamethaxam (actara), and biopesticides like neem product, agropest *bt* and derisome (botanical products), bioprahar (*Photorhabdus* bacteria), conserve (Spinosad actinomycete product) and signa (Insect Growth Regulator). Taking clues from tolerance of EPNs with chemical insecticides and biopesticides, combination with EPN @ 5000 and 10,000/ litre proved effective in presence of good amount of atmospheric relative humidity.

Studies on the natural enemies of teak pests, *Hyblaea puera* and *Eutectona machaeralis* in Madhya Pradesh

Periodical surveys were conducted in teak forests of Madhya Pradesh for collection of natural enemies (parasitoids, predators and pathogens) of major insect pests of teak, *Hyblaea puera* and *Eutectona machaeralis*. The larvae of *H. puera* were noticed to be attacked by five species of parasitoids namely, *Echthromorpha notularia*, *Trophocampa indubia*, an unidentified species of *Brachymeria* and three unidentified species of *Sturmia*, three species of insect predators namely, *Calleida splendidula*, *Canthecona furcellata* and *Chrysoperla carnea*, one species of bird predator namely, *Corvus macrohynchos* and unidentified spiders, and a species of fungal pathogen namely, *Aspergillus flavus*. The larvae of *E. machaeralis* was observed to be attacked by eight species of parasitoids namely, *Apanteles machaeralis*, an unidentified species of *Apanteles*, *Brachymeria* and *Sturmia*, *Cremastus hepaliae*, *Trophocampa indubia* and *Xanthopimpla cera* and an unidentified species of nematode, two species of insect predators namely, *Canthecona furcellata* and *Chrysoperla carnea*, and unidentified spiders, and three species of fungal pathogens namely, *Aspergillus niger*, *Beauveria bassiana* and *Fusarium oxysporum*. Carried out laboratory culture of *A. flavus*, *A. niger* and *B. bassiana* and conducted pathogenecity tests against target pests. Developed rearing technique of a potential polyphagous insect predator, *C. furcellata* and its alternative hosts.

Isolation and evaluation of insecticidal phytochemicals from *Annona squamosa* against teak defoliator *Hyblaea puera* and *Eutectona machaeralis*

Out of five solvent extract and one water extract of 0.05% *Annona squamosa* were evaluated for antifeedant activity against teak skeletonizer larvae, petroleum ether extract exhibited 72.99% antifeedant activity ($P<0.005$), followed by 69.99% by ethyl acetate ($P<0.05$), as compared to other extracts. Further, confirmatory bioassays with concentrations/doses ranging

from 25ppm to 3000ppm of each promising extract for the determination of optimum doses exhibited over 70% antifeedancy above 800ppm of crude ethyl acetate extract (P<0.001). These two extracts also inhibited feeding in teak defoliator larvae with antifeedancy being 75.43 and 78.84 percent over control (P<0.001, df. = 24, F= 14.00, SE(d)± = 10.85, $LSD_{(P<0.05)}$ = 22.40). Effective concentration for 50% antifeedant effect for ethyl acetate was calculated to be 524.80 ppm with upper and lower fiducial limits, respectively being 769.80 and 435.78. EC_{50} for petroleum extract was 220.80 with upper and lower fiducial limits being 357.78 and 114.52. Column Chromatography allowed isolation of three major fractions from petroleum ether extract, as confirmed by TLC, time to time, codes 6a, 6b and 6c and four chromatographic fractions from ethyl acetate extract; codes 3a, 3b1, 3b2 and 3b, which exhibited antifeedant and growth regulatory effect. Results indicated 3b1 fraction at higher concentration of 0.08 to be effective with significantly superior (P<0.001, df. = 30, F= 8.34, SE(d)± = 10.64, $LSD_{(P<0.05)}$ = 21.95) antifeedant activity over other treatments against teak skeletonizer, *Eutectona machaeralis*, with over 74.49% leaf protection. Nevertheless, concentration of 400ppm was statistically at par with 800 ppm with 47.83% leaf protection (P<0.038, df = 29, F= 2.94, SE(d)± = 17.92, $LSD_{(P<0.05)}$ = 37.38). Lowest concentration of fraction 3b2 was at par with control with no significant antifeedant activity (P>0.05). Fraction 3b of ethyl acetate proved most promising with significantly superior antifeedant activity (P<0.001, df. = 30, F= 174.01, SE(d)± = 3.97, $LSD_{(P<0.05)}$ = 8.10) at and above 0.05% (500 ppm) concentration (89.79% leaf protection). Increase in activity was noticed after increasing the concentration of the extract. The full grown larval weight after being, pre-pupal fed continuously on treated leaves and pupal weights were significantly affected with mortality at larval and pre-pupal stages, as compared to control (P<0.05). While there was statistically non-significant (P>0.05) difference in initial larval weights, concentrations above 400 ppm were significantly superior (P<0.033) in affecting the final larval weights. Similarly, pre-pupal weights were also affected. There was no development of pupae in treatments above 100 ppm. Similar results were obtained with ethyl acetate extract against teak skeletonizer, *Eutectona machaeralis* at and above 400 ppm. In this case, there was no pupal development, even at the lowest concentration tested.

Development of model for the management of white grubs in teak nursery under the concept of Integrated Pest Management

Monitoring, observations and experimentations on *Holotrichia. rustica*, *H. mucida* and *Schizonycha ruficollis* since the initiation of the emergence of beetles in the field revealed relationship of beetles emergence and rising relative humidity. Data indicate that in all the years, there was a marked increase in humidity (approx 40 – 60% increase over a few days) along with a noticeable decrease in temperature (approx. $5\ ^0$C over the same period 6-9 days prior to the first emergence of beetles. Rainfall 2 - 3 weeks prior to the date of emergence did not induce beetle emergence, due possibly to the lower atmospheric relative humidity (< 50%). After the increase in RH, even moderate amount of rains induced the emergence of beetles. Spraying on *Ziziphus jujuba* or *Z. mauritiana* host-traps with monocrotophos or dimethoate 0.05% twice at the interval of 15 days proved effective in reducing the egg laying by the adults. Laboratory experiments with the EPNs against laboratory produced white grubs proved effective. Treatment of the teak beds within 1 week after the adult emergence with phorate/ methyl folidol @ 300g/ bed (size 12 m X 1.25m) in combination and alternately with the cadavars of EPN *H. indica* and *S. carpocapsae* @ 250 – 300 juveniles(ijs)/ bed in good watering conditions proved effective in

reducing the incidence of seedling mortality. The ijs were also recovered after 1 month of the release proving their survival in the released soil. Based on the observations, a model guideline for the management of white grubs developed.

Development of integrated insect pest and disease control system for *Emblica officinalis* pests

Survey was conducted in Clonal Seed Orchard (CSO) of *Emblica officinalis* at Sonaghati (Research & Extension Circle, Betul) for monitoring the status of insect pests and diseases. Incidence of bark eating caterpillar *Indarbela quadrinotata* was recorded in seven different varieties viz. Krishna, Francis, NA-6, Chakaiya, Kanchan, NA-7 and local variety of *E. officinalis*.

Taxonomy of Braconid parasitoids (Hymenoptera) from central India

Survey of important forestry and adjoining agro-forestry areas of Maharashtra, covering localities of districts: Akola, Washim, Hingoli, Parbhani, Wardha, Yavatmal, Nanded, Latur, Beed, Osmanabad, Solapur, Jalgaon, Nashik, Thane and Mumbai were carried out for collection of braconids. Over all, 176 samples of insect fauna were collected by sweeping method out of which 876 braconids were sorted out and preserved. 213 samples of leaf miners, defoliators, gall forming insects and larvae / pupae of insect pests were collected for emergence of braconids from various forest tree species. In all, 8 species of braconids were recovered. *Apanteles antipoda, A. machaeralis* from teak skeletonizer, *Eutectona machaeralis*; *A. hyblaeae* from the larvae of teak defoliator, *Hyblaea puera*; *Dolichogenidea* sp. and *A. tachardiae* from defoliator of *Acacia nilotica; Apanteles* sp. from an unidentified semilooper on *Bridelia retusa*; *A. caniae* from *Papilio demoleus* and *Apanteles tiracholae* from *Agrotera basinotata,* defoliator of *Lagerstroemia parviflora.* Four species viz *Bracon jalgaonensis* sp. n, *Chelonus wardhaensis* sp. n, *Chelonus hingoliensis* sp. n, and *Doryctes indicus* sp. n. collected by sweeping method were recorded as new species to science.

Insects and diseases of bamboo occurring in central India and their management

Seeds of bamboos were sown in the institute's nursery beds as well as in poly bags. They were surveyed periodically throughout the year at 15 days interval. In all, 4 types of insects namely leaf rollers, grasshoppers, aphids and whitegrubs were collected, their incidence in field was recorded regularly, reared and identified. The leaf rollers were identified as *Cryptisia coclesalis, Pyrausta bambucivora;* grasshoppers as *Hieroglyphus banian, Poecilecerus pictus* and *Schistocerea gregaria;* aphids as *Oregma bambusae;* and white grub as *Holotrichia consanguinea.* Similarly, the samples of leaves infected were collected from seedlings, cultured and identified in laboratory as leaf rust, *Dasturella divina* and leaf tip blight, *Helminthosporium solani.* Different species of bamboos in plantations were also surveyed periodically throughout the year at 15 days interval. In all, 4 types of insects viz., leaf rollers, grasshoppers, aphids, culm borers and hare (Fig.1) were recorded to damage the different species of bamboos. The incidence percentage of each of them was recorded. Similar observations on the diseases were also taken. Leaf rust caused by *Dasturella divina* was recorded on leaves of different bamboo species from December 2009 to January 2010. Morphological descriptions of insects and

pathogens collected were noted and described in detail. The photographs of these species were also taken for the authenticity of their identification. One year old seedlings of bamboo, (*Bambusa nutans* and *Dendrocalamus strictus)* were planted in 1.5 ha plantations for conducting field experiments during the monsoon period 2010.

Fig.1 Bamboo culms damaged by hare

Entomopathogenic nematode based strategy for the management of termites and white grubs

Laboratory culture of waxmoth, *Galleria mellonella* was maintained round the year. The mature larvae of the same were periodically separated out of the culture and utilized as fictitious host. The culture of 2 exotic and 4 native populations of entomopathogenic nematode was maintained round the year on fictitious host, i.e., waxmoth larvae in laboratory. Experiments were laid out relating to improved parameters for economical and successful mass-multiplication of the native populations/ isolates from central Indian states. Experiments were carried out for bioassaying potentiality of native populations/ isolates of EPNs against termite and white grub pests. For isolating more populations from central India, surveys were carried out and 40 samples from two sites comprising of teak plantation areas of Kundam Project (M.P. Forest Development Corporation, Jabalpur (Slimnabad, Jirri, Dhimarkheda) and Dindori Forest Division, Dindori, (Karanjia, Jagatpur, Amarkantak) in Madhya Pradesh. Investigation on insecticidal-tolerance/ compatibility of EPNs to commonly used insecticides/ biopesticides has been initiated.

Development of an information system for forest tree species associated insects and their management

Data has been collected for nine forestry tree species viz. *Shorea robusta, Dalbergia sissoo, D. latifolia, Acacia catechu, A. nilotica, Albizia lebbek, Ailanthus excelsa,* bamboo, *Tectona grandis,* for the insect pests associated, distribution, host range, nature of damage, period of occurrence and management techniques. Different user interface forms have been designed and listed successfully. These forms are integrated to design complete user interactive system. Presently data of four species viz sal, shisham, bamboo, teak related information has been entered in the software. All the user queries are performing as per requirement. Software related fine tuning is in progress.

Wood decay and its control in stored tropical timber

Seven hundred forty five specimens of wood decaying fungi were collected on wood logs of 34 host species from 12 wood depots of Maharastra and 25 wood depots of Orissa. 20 genera

and 44 species of wood decaying fungi were identified. Out of these, 4 genera viz. *Hapalopilus, Ceriporiopsis, Schizopora*, and *Postia;* 7 species: (*Hapalopilus nidulans, Ceriporiopsis merulinus, Trametes ochraceae, Postia placenta, Schizopora paradoxa, Pycnoporus coccineus,* and *Pycnoporus cinnabarinus*) were recorded for the first time from Orissa and Maharashtra on sal and bija-sal. 25 cultures were also maintained for further studies. 1154 specimen of wood decaying fungi were maintained in herbarium. An experiment was conducted to test toxicity (*in vitro*) at different concentration of urea and zinc sulphate against decay resistance to *Flavodon flavus.*

Studies on diseases of important medicinal plants and their bio-control

Isolation of 15 antagonistic bacteria, a fungus and an actinomycetes from the soil samples were collected from different localities of MP and CG. Identification and pathogenicity tests were also conducted on plants of *W. somnifera*, *R. serpentina* and *C. borivillianum*. Bioassay test against four fungal pathogens were confirmed with antagonistic microorganisms isolated from soils of different nurseries and with biopesticide (cow urine + *Azadirachta indica* leaves + *Ailanthus excelsa* leaves + *Calotropis procera* leaves). Four antagonistic bacteria/actinomycetes showed their effectiveness in controlling growth of pathogen *in vitro*.

2.7.3 Mycorrhizae, rhizobia and other useful microbes

Toxins of soil actinomycetes against major forest insect pests

Out of 340 soil samples collected from forests of Madhya Pradesh, Maharashtra and Chhattisgarh, 9 actinomycetes/bacteria were isolated on potato dextrose agar plates following serial dilution technique and pour plate method. Among the 3 actinomycetes isolated, *Streptomyces* sp. was identified and confirmed at Institute of Microbial Technology, Chandigarh. Developed culture technique of soil actinomycetes for production of toxins, protocol for extraction of antibiotics and its fractions for chemical characterization of toxins of isolated actinomycete, *Streptomyces* sp. Conducted toxicity tests of its culture filtrate, isolated antibiotics and different fractions against major insect pests of teak, siris and mahaneem. Evaluated commercially available bioproducts (ivermectin and spinosad) of soil actinomycetes against major insect pests of teak, siris, bamboo and mahaneem and worked out their relative efficacy and toxicity (LC_{50}) through Probit analysis. Conducted field-cum-laboratory tests of ivrmectin and spinosad against the early last instar larvae of major insect pest of above noted species. Carried out field trial in nursery stage at insectary of this institute to test the toxicity of ivermectin and spinosad. The results revealed that management of these pests may be achieved by foliar application of bioproducts (ivermectin and spinosad).

Growth promoting microbes and soil amendments to produce improved seedlings of forest trees :

Germplasm of growth promoting organisms were collected from 11 different localities of M.P. Experiment on *Gmelina arborea, D.sissoo* and *J.curcas* were conducted in root trainers

and growth promoting organism were selected for these species. Twenty different fungi isolated from rhizosphere soil were screened for plant growth promoting properties (germination% and height). Out of them *Aspergillus* sp., and four *Trichoderma* spp., were found growth promoting and selected for use in nursery. Application of plant growth promoting microbes (AM fungi, *Aspergillus* sp. *Azospirillum*) and soil amendments (mix of *Lucaena*, teak leaves and FYM in equal ratio, v/v) increased 10-20% survival of sandal seedlings, when out planted in the field it also increased plant height up to 43%.

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3. Education vistas /Activities

3.2 Trainings organized

National

Shri R.S. Pal, IFS, Head, Agroforestry Division conducted PRA exercise and identified 40 progressive farmers under Nawan Range, Baranawapara Project Division, Raipaur, Chhattisgarh and imparted training to them on the benefits of adopting bamboo based agroforestry systems on the 13 and 14 May, 2009.

Shri R.S.Pal,IFS, Head, Agroforestry Division indentified progressive farmers after conducting a PRA exercise and imparted training to them on the benefits of adopting bamboo based agroforestry systems at Gwalior on 25-26 May 2009.

Shri R.S.Pal,IFS, C.F. Head, Agroforestry Division attended one week compulsory training for IFS Officers on 'Forest Research Methodolgy" at IIM, Lucknow as nominated by MoEF, Govt.of India during 1st to 5th June,2009.

Dr.N.Berry, Scientist 'C' imparted training on lac and and medicinal plant based agroforestry system for Maharashtra" to the selected farmers of different villages of Yeotmal and Chandrapur districts of Maharashtra held from 27 – 30 October at Yeotmal and Chandrapur, Maharashtra organized in association with BAIF, Pune..

Dr.N.Berry, Scientist 'C' delivered lecture on medicinal plant based agroforestry system for Madhya Pradesh to the farmers and field forest officials of Seoni, Katni, Mandla and Jabalpur districts of Madhya Pradesh held from 4 – 5 December,2009 at State Forest Research Institute, Jabalpur.

Dr.N.Berry, Scientist 'C' imparted training on Harvesting and processing of Mahua to the forest officials of Orissa held in January,2010 at Tropical Forest Research Institute, Jabalpur.

Dr.N.Berry, Scientist 'C' imported training on medicinal plant based agroforestry system to the farmers and forest officials of Raipur and Dhamtari districts of Chhattisgarh held from 24 – 25 February,2010 at Van Vigyan Kendra, Raipur, Chhattisgarh.

Dr.N.Berry, Scientist 'C' attended one week training programme on Ethnic issues of communities under DST programme held at IIFM, Bhopal from 18th -22nd January, 2010.

Dr. N. Berry, Scientist 'C' imparted training to the Training for Trainers (TOT) on "Mahua collection and its storage practices" on 9-11 April, 2009 at Chhattisgarh Minor Forest Produce Federation, Raipur.

Shri R. B. Singh, Research Officer, imparted training on bamboo based agroforestry system to the selected farmers of different villages of Yeotmal and Chandrapur, Maharashtra held from 27 – 30 October at Yeotmal and Chandrapur, Maharashtra organized in association with BAIF, Pune.

Shri R. B. Singh, Research Officer imparted training on Development of waste land through agroforestry systems to the SFD officials, NGOs and farmers of Madhya Pradesh held from 4 – 5 December, 2009 at VVK, Jabalpur.

Dr. P.K. Khatri, Scientist – C, Dr. S.N. Mishra, R.A. – I and Shri Swaroop Aharwar, Sr. Steno has attended one week computer training on MI-Concepts of IT and MS-Officer Suite 2007 held at TFRI, Jabalpur during July, 2009.

Dr.V. Nath, Scientist – F and HOD and Shri Alfred Francis, R.A. – II has attended the one week computer training on MI-Concepts of IT and MS-Officer Suite 2007 held at TFRI, Jabalpur on 31 July to 4th August, 2009.

Dr. P.K. Khatri, Scientist – C attended one week training on Carbon Sequestration held at BCC Division, ICFRE, Dehradun from 5 October to 9 October 2009.

Dr. Avinash Jain organized training on 'Plantation, agriculture and climate change' on 26th February, 2010 at village Jamuniya, Jabalpur for farmers and tree growers. Field trip for the trainees was conducted to plantations and agroforestry models established along left bank canal of Bargi command area, Jabalpur.

Dr. Avinash Jain delivered lectures on Environmental Impact Assessment, Kyoto Protocol, Environmental Legislation, Carbon sequestration, ISO 14001 and Clean Development Mechanism to the management students of Xavier Institute of Development Action Studies (XIDAS), Jabalpur on 1-2 December, 2009.

Dr. N. Roychoudhury, Scientist 'F' attended five days training programme on "Concepts of IT and MS Office 2007" held on 25-27 July 2008 at Indian Institute of Forest Management, Bhopal.

Dr. Nitin Kulkarni, Scientist 'F', delivered lecture and demonstrated techniques in field to the front-line staff of office of the Chief Conservator of Forests (CCF), Research and Extension, Gwalior on August, 20th 2009 on "रोपणियों तथा रोपण क्षेत्रों में कीटों के प्रभाव का नियंत्रण एवं प्रबंधन करना".

Dr. Nitin Kulkarni, Scientist 'F', delivered lecture to the front-line staff of Madhya Pradesh Forest Development Corporation (MPFDC), Jabalpur on 2nd February, 2010 "वन रोपणियों में व्हाइट ग्रब्स का प्रकोप एवं निदान".

Dr. Nitin Kulkarni, Scientist 'F', attended as resource person a farmers training programme organized at Van Vigyan Kendra, Raipur on 4th – 6th March 2010 and delivered three lectures (i) कृषि-वानिकी में उपयोगी वृक्ष प्रजातियों के वन रोपणियों में लगनें वाले नाशीकीटों का प्रकोप व उनका निदान (ii) कृषि-वानिकी में उपयोगी प्रजातियों के वृक्षों में लगनें वाले नाशीकीटों का प्रकोप व उनका निदान (iii) एकीकृत कीट्नाशी प्रबन्धन के अन्तर्गत नाशीकीटों के नियंत्रण के संबंध में कुछ नये आयाम.

Dr. Nitin Kulkarni, Scientist 'F' delivered a lecture on "कृषिवानिकी संबंधित वृक्ष प्रजातियों को नुकसान पंहुंचाने वाले नाशिकीट तथा उनका प्रबंधन" to the farmers on 2nd February 2010.

Dr. Nitin Kulkarni, Scientist 'F', delivered training lecture in Farmers Training Programme organized at State Forest Research Institute, Jabalpur (M.P.), March, 12th 2010 on बाँस हेतु एकीकृत नाशिकीट प्रबंधन.

Dr. P. B. Meshram, Scientist 'E', attended 5 days (17.8.09 to 21.8.09) training programme on 'MI Concepts of IT & MS Office Suite -2007 under e -Governance Project ENV ISIOG sponsored by CMC Ltd. Bombay at TFRI, Jabalpur.

P. B. Meshram, Scientist'E', organised one day training programme on "Insect pests and diseases of chironji, *Buchanania lanzan* and their control measures" for the SFD officials of at Batkakhapa, East Forest Division, Chhindwara on 8th January 2010.

Dr. P. B. Meshram, Scientist 'E', organised one day training programme on "Insect pests and diseases of teak, *Tectona grandis* and their control measures" for the SFD officials at Belkund, Kundam Forest Project Division, (M.P. Forest Development Corporation), Jabalpur on 24th February 2010.

Dr. P. B. Meshram, Scientist 'E', organised one day training programme on "Insect pests and diseases of aonla, *Emblica officinalis* and their control measures" for the SFD officials at Wamandehi, Research & Extension Circle, Seoni, on 10th March 2010.

HOD, Extension organised training on "Application of Biofertilizers in Nurseries and Plantation" for the field personnel of Forest Development Corporation of Maharashtra, Nagpur from 16 to 17 November, 2009.

Dr. R.K. Verma attended short term training programme on Identification and use of mycorrhizal fungi in forestry held on 26.05.2009 to 04.06.2009 at Department of Agricultural Microbiology, Centre for Plant Molecular Biology, Tamil Nadu Agriculture University, Coimbatore.

Dr. K. K. Soni and Avinash Jain received training on Dendroclimatology and climate change held on 7 to 12 December, 2009 at Indian Institute of Tropical Meterology, Pune.

Dr. C.K.Tiwari participated in the specialized training programme on Isolation, identification and preservation of fungi held on 18-23rd January 2010 at FRI, Dehradun.

Sh. S.D. Sonkar imparted training on "Nursery techniques of important forestry species of central India " to the farmers and field functionaries of SFD, Madhya Pradesh held on 11 to 12 August,2009 at Dindori.

Sh. S.D. Sonkar imparted training on "Nursery techniques of important forestry species" to the farmers and field functionaries of SFD, Orissa held on 26 to 27 August and 16-17 September 2009 at Van Vigyan Kendra, Koraput.

Sh. S.D. Sonkar imparted training on "Nursery and plantation technology of bamboo to the farmers and field functionaries of SFD of Gujrat under BTSG of bamboo mission held on 7 to 8 September, 2009 at Tropical Forest Research Institute, Jabalpur.

Ten training programmes on different aspects of forestry and environment related issues were organized during the year at the centre.

One day training programme on “Soil Conservation and Watershed Management” was organized on 04.06.2009 at CFRHRD for the farmers of Satnur village, Chhindwara.

Two days training programme on “Cultivation, Uses, Processing, Marketing of Medicinal Plants and Development of value added Food Products” was organised for the farmers and tribal women of Tamia block, Chhindwara on 22-23 September 2009.

3.3 Visits Abroad

Dr.S.A.Ansari attended 4th Bio Nano Tox and Applications Research Conference, University of Arkansas, Little Rock, USA, October 21-22, 2009 and presented a research paper entitled "AFLP marker analysis for genetic configuration of plus trees and populations of Indian teak (*Tectona grandis* L.f" and Chaired Session VII : Plant Biology, Nano and Biotechnology for Agriculture Use.

Dr. Nitin Kulkarni attended IUFRO Working Party 7.03.04: Diseases and Insects in Forest Nurseries held on 12-16 July 2009 at United States Department of Agriculture (USDA) Forest Service, Hilo, Hawaii, USA and presented a paper entitled Biology and management of white grub complex in teak forest nursery in India.

3.4 Participation in Seminars/Symposia/Workshops/Trainings

PARTICIPATED

Conference (National)

Dr. N. Roychoudhury attended a national conference on Biodiversity Conservation and Management of Bioresources held on 28-29 October 2009 at Andhra Pradesh University, Visakhapatnam and presented a paper entitled Ivermectin-induced larval toxicity in bamboo leaf roller, C*rypsiptya coclesalis* Walker (Lepidoptera : Pyralidae).

Dr. P. B. Meshram attended national conference on Biodiversity Conservation and Management of Bioresources held on 28-29 October 2009 at Department of Zoology, Andhra University, Visakhapatnam and presented a paper entitled Environmental degradation and diversity of some forest insects in central India.

Dr. P. B. Meshram attended IV National Forestry Conference held on 9-11 November 2009 at FRI, Dehradun and presented a paper entitled Impact of pest problem in chironji, *Buchanania lanzan* in central India.

Dr. V.S. Dadwal attended IVth National Forestry Conference held on 9-11 Nov. 2009 at Forest Research Institute, Dehradun and presented a paper entitled Laboratory evaluation of chemical fungicides and antagonistic microorganisms for the disease management of some important medicinal plants.

Dr. Fatima Shirin attended a National Conference on Biotechnology for the 21st century: New Horizons held on 18-19th December, 2009 at St. Aloysius College, Jabalpur and presented a paper entitled *In vitro* propagation of *Saraca indicia* L., a commercially important vulnerable medicinal tree.

Dr. A.K.Pandey attended IV National Forestry Conference held on 9-11 November 2009 at Forest Research Institute, Dehradun and presented paper entitled Development of sustainable harvesting protocols for some important fruit yielding medicinal plants in Chhattisgarh.

Dr. A.K. Mandal attended 97th session of Indian Science Congress Association of Kerala University, Trivandrum on 5 - 7 January 2010 and presented a lead paper Forest Invasive Species in India and also chaired a technical session.

Conference (International)

Dr. Nitin Kulkarni attended 5th International Conference on Biopesticides: Stakeholders Perspective (ICOB-V-2009) held on 26-30 April 2009 at Tata Energy and Resources Institute, New Delhi and presented paper entitled "Tolerance of EPN, *Heterorhabditis* indica to some common insecticides useful for developing IPM strategy against forest insect pests".

Dr. Nitin Kulkarni attended 2nd International Conference on Biowealth Management for Sustainable Livelihood, ICBMSL-2009, held on 20-22 November, 2009 at Institute of Forest Productivity, Ranchi and presented a paper entitled Compatibility of entomopathogenic nematode, *Heterorhabditis indica* to some selected biopesticides".

Dr. P. B. Meshram attended Second International Conference on Biopesticide held on 26-28 November, 2009 at St. Xavier's College, Palaymkottai, T.N. and presented a paper entitled Role of some biopesticides in management of some forest insect pests.

Dr. Puja Ray attended 5th International Conference on Biopesticides: Stakeholders' Perspectives. 26-30 April 2009 at Tata Energy and Resources Institute, New Delhi and presented a paper entitled Braconids as potential biocontrol agents of insect pests - an over view.

Dr. R.K. Verma attended 5th International Conference on 'Plant Pathology in the Globalized Era', held on 10-13 Nov. 2009 at IARI, New Delhi and presented two papers entitled (1) Diversity of fungi causing diseases in forest trees of central India (2) Effect of soil amendments and plant growth promoting microbes on growth and survival of sandal (*Santalum album*).

Dr. A.K.Pandey attended Ist International Conference on New Frontiers in Biofuels held on 18-19 January, 2010 at India Habitat Centre, New Delhi and presented paper entitled Performance evaluation of superior accessions of *Jatropha curcas* in tropical climate of Madhya Pradesh, India.

Dr. A.K.Pandey attended first International Conference on Conservation, Marketing and Patenting of Medicinal Plants (ICCMP) held on 14-15 March 2010 at Raipur and presented paper entitled sustainable harvesting of medicinal plants in tropical forests of Chhattisgarh, India.

Ku. Swati Yadav attended International Conference on Medicinal Plants and Herbal Drugs: Challenges and Opportunities in Cultivation, Sustainable Utilization and Conservation held on 4-

6 March, 2010 at Chennai and presented paper entitled Sustainable harvesting of *Holarrhena antidysentrica* R.Br.Sans (Kutaj) bark.

Meetings (National)

Dr. P.K. Khatri, Scientist – B attended meeting of steering committee of IIFM-ITTO research project held on 14th April 2009 at IIFM, Bhopal.

Dr. P.K. Khatri, Scientist – C attended meeting with Member Secretary, M.P. State Biodiversity Board, Bhopal on 8th May, 2009.

Dr. N. Roychoudhury attended state level steering committee meeting on Achanalmar-Amarkantak biosphere reserve, held on 8 June 2009 at PCCF Office, Raipur.

Dr. A.K.Pandey attended meeting on Researchable issues on medicinal plants and their integrated development held on 10.7.2009 at PCCF office of Madhya Pradesh at Bhopal.

Dr. A.K.Pandey attended meeting on Development of DUS descriptors of *Jatropha curcas*, Neem and Karanja at NRC Agroforestry held on 3.12.2009 at National Research Centre for Agroforestry, Jhansi.

Dr. A.K. Pandey attended users meeting on Sophisticated Analytical Instrument Facility held on 7.12.2009 at Central Drug Research Institute, Lucknow.

Dr. A.K.Pandey attended meeting on NOVOD sponsored project on Development of data base of important TBOs held on 29-30 March 2010 at ICFRE, Dehradun.

N.D.Khobragade attended Research Advisory Meeting at Krishi Vigyan Kendra,Chandangaon, Chhindwara on 13.05.09

Suneesh Buxy delivered a lecture on Traditional Knowledge of Medicinal Plant in the meeting of Bharia Vikas Pradhikaran, Tamia Chhindwara on 21.10.09.

Suneesh Buxy attended National Science Congress at Govt. Jawahar Higher Secondary School, Chhindwara on 5.11.09 and delivered a keynote address on "Biodiversity Conservation of Medicinal Plants.

Workshop (National)

Dr. V. Nath, Scientist – F attended one day consultative workshop on development of criteria and indicators for sustainable NTFP management held on 12th October 2009 at TFRI, Jabalpur jointly, organized by IIFM,Bhopal and TFRI, Jabalpur.

Dr. Avinash Jain attended workshop on Clean Development Mechanism (CDM) held on 11 August 2009 at Bhopal and presented a paper entitled Reasons for slow progress in the development of CDM A&R Projects.

Dr. Avinash Jain attended national workshop on Rehabilitation of degraded lands held on 6-7 October 2009 at CSFER Allahabad and presented a paper on Performance of tree species under water logged conditions in Bargi command area, Jabalpur.

Dr. Avinash Jain attended a workshop on Utilization of automatic weather station and agrometeorological station data for M.P. held on 7 October 2009 at SFRI, Jabalpur.

Dr. R.K. Verma participated in the Group Discussion on C&I Framework for NTFPs in the Consultative Workshop on Development of Criteria & Indicators for Sustainable NTFP Management held on 12th October 2009 at TFRI, Jabalpur.

Dr. A.K.Pandey attended National Workshop on Emerging Horizons in Biofuel Research and Application held on 25-27 July 2009 at R.B.S. College, Agra and presented a paper entitled Identification of superior germplasm of Jatropha curcas in Madhya Pradesh as a base for genetic improvement.

Dr. A.K. Mandal attended national workshop on Agroforestry on 5-6 July 2009 at College of Agriculture, Nagpur and presented a lead paper on Tree Improvement for Agroforestry. Also, chaired primary session of the workshop.

Mrs. Neelu Singh attended Brain Storming Workshop on Utilization of Chemistry held on 10-11-2009 at Home Science College, Jabalpur and delivered a lecture on Scope of chemistry in the field of forestry.

Dr. A.K. Pandey and Neelu Singh attended Consultative Workshop on Development of Criteria & Indicators For sustainable NTFP Management held on 12.10.2009 at Tropical Forest Research Institute, Jabalpur.

One day workshop on "Traditional knowledge of Medicinal plants of Patalkot" was organised on 30.06.09 which were attended by traditional healers and Vaidyas of Chhindwara District.

Workshop (International) - Nil

Symposia (National) - Nil

Seminar (National)

Dr. M. Yousuf attended national seminar on Current Trends in the Field of Biodiversity and Sustainable use of Natural Resources, held at Mata Gujri Mahila Mahavidyalaya, Jabalpur, from 16-17 November 2009 and presented a paper entitled Braconid parasitoids (Hymenoptera: Braconidae) of teak pests and need to conserve their biodiversity.

Dr. M. Yousuf, attended 2nd Bhartiya Vigyan Sammelan & Expo 2009 on Green Technologies for Sustainable Development held at Devi Ahilya Vishva Vidyalaya, Indore, from 1-3 December 2009 and presented a paper entitled Biodiversity of braconid parasitoids of lepidopterous pests from central India and their implication in balancing the ecosystem.

Dr. M. Yousuf attended national seminar on Biotechnology for the 21st Century : New Horizons, held at St. Aloysius College (Autonomus), Jabalpur from 18-19 December 2009 and presented a paper entitled Microgastrine wasps (Hymenoptera: Braconidae) from Maharashtra and their role in insect pest management.

Dr. N. Roychoudhury attended a national seminar on Productivity Enhancement and Value Addition of Bamboos, 9-10 March, 2010 Institute of Forest Productivity, Ranchi and presented a paper entitled Spinosad-a potential biopesticide for management of greater bamboo leaf roller, *Crypsiptya coclesalis* (Walker) (Lepidoptera : Pyralidae).

Dr. Nitin Kulkarni attended national seminar on Current Trends in the Field of Biodiversity & Sustainable Use of Natural Sources held on 16-17 November 2009 at MGM Mahavidhyalaya, Jabalpur and presented a paper entitled Custard apple, *Annona squamosa* – a potential source of biopesticidal compounds against major insect pests of teak (*Tectona grandis*).

Dr. A.K. Mandal attended National Seminar on Development, Environment and We at Institution of Engineers, Jabalpur on 4th July 2009 and presented a lead paper Environmental Planning for Jabalpur.

Dr. A.K. Mandal attended National Seminar on Designing crops for the changing climate of Birsa Agricultural University, Ranchi on 29-31 October 2009 and presented a paper Carbon sequestration potential of agroforestry systems with *Tactona grandis* in central India.

Dr. P. B. Meshram attended Second Bhartiya Vigyan Sammelan & Expo 2009 on Green Technologies for Sustainable Development held on 1-3 December 2009 at D.A.V. Indore and presented a paper entitled Effect of some green biopesticide cakes against white grubs, *Holotrichia* species in teak nursery M.P.

Dr. P. B. Meshram attended national seminar on Biotechnology for the 21st Century: New Horizons held on 18-19 December 2009 at Department of Zoology and Biotechnology, St. Aloysius College, Jabalpur and presented a paper entitled Screening of certain varieties of *Emblica officinalis* for resistance to insect pests and diseases.

Dr. C.K. Tiwari attended National Seminar on Fungal Bio-diversity and Bioprospecting in the age of Global warming held on 29- 30 Oct. 2009 at Department of Botany, Goa University, Goa and presented two papers (1) Variation in production of glucanase by *G. lucidum* (Curtis) p. karst. and (2) Biodiversity of wood-decaying fungi in forest wood depots of Chhattisgarh.

Dr. C.K.Tiwari attended National Seminar on Biotechnology for the 21st Century: New Horizon" held on 18 -19 Dec, 2009 at Department of Zoology and Biotechnology, St. Aloysius College, Jabalpur and presented two papers (1) Occurrence and Distribution of wood decaying fungi in Eastern part of Chhattisgarh (2) *Ganoderma lucidum* root rot in central India.

Dr. S.A.Ansari attended National Seminar 2010 on Plant Biotechnology : Advances, Impact and Relevance, at Botany Department, AMU, Aligarh on March 20, 2010 and delivered an invited lecture entitled "Molecular markers for analysis of plant genetic diversity clonal fidelity.

Miss Vijayalakshmi Ojha attended Bhartiya Vigyan Sammelan held on 1-3 December 2009 at Indore and presented paper entitled Standardization of processing methods for removal of anti-nutrients in bamboo shoots.

Miss Vijayalakshmi Ojha attended National Seminar on Productivity Enhancement and Value Addition of Bamboos held on 9-10 March 2010 at Institute of Forest Productivity, Ranchi and presented paper entitled Value addition in bamboo shoots to augment its utilization as food products.

Miss Swati Yadav attended Bhartiya Vighyan Sammelan 2009 held on 1-3 December 2009 at Indore and presented poster entitled "Non-destructive harvesting of *Gymnema sylvestre* (Gurmar) and variation in gymnemic acid content".

Sh. Sonkar, S.D. attended national seminar on Rehabilitation of Degraded Lands held on 06-07 October, 2009 at CSFER, Allahabad and presented a paper entitled Impact of silvicultural systems on species richness and regeneration of woody perennials and ground flora in degraded forests.

Dr. Pramod Kumar participated in national seminar on "Productivity Enhancement and Value Additions of Bamboos" on 09-10 March, 2010 at IFP, Ranchi and presented a paper entitled "Conservation and improvement of bamboo through macro propagation"

4. Extension Panorama / Activities

4.1 Report on Van Vigyan Kendra (VVK) and Demo Village (DV)

1. Training organized for farmers and field functionaries of Chhattisgarh through VVK, Raipur (Chhattisgarh), 10-11 Feb, 17-18 Feb, 24-25 Feb and 4-5 March, 2010.

2. Training organized for farmers and field functionaries of Maharashtra through VVK, at Jalna (19-20 Jan. 2010) and at Shahpur (18-19 March, 2010).

3. Training organized for farmers and field functionaries of Orissa through VVK, Koraput from 26-27 August, 2009 and 16-17 September, 2009.

4. Training organized for farmers and field functionaries of Madhya Pradesh through VVK, at Dindori (11-12, Aug, 2009) at Katni (4-5 Sept, 2009), at Jabalpur (4-5 Dec., 2009) at Mandla (21-22 March, 2010.

5. Training organized for SFDs, Chhattisgarh on " Tissue culture of Bamboos" from 11-15 Jan. and 18-23 Jan, 2010 in two batches.

6. Four technologies developed by the institute related to the areas of agroforestry, NWFPs, biofertilizer and insect resistance are being demonstrated.

Training on Identification and Management of Nursery diseases, insects and pests at VVK, Raipur (Chhattisgarh)

Training at VVK, Maharashtra at Jalna

4.2 Technology transferred

A one day demonstration programme was organised for transferring of technology on silvi- medicinal system to the 50 farmers of four villages namely Padariya, Khamariya , Neemkheda and Saliwada villages of Jabalpur districts on 1st December,2001 at Tropical Forest Research Institute, Jabalpur.

4.3 Research Publications

Book (National): Book chapter

Pandey A.K. (2009). The Cymbopogons- Harvest and post harvest management. In: Essential Oil Bearing Grasses: The Genus Cymbopogon (Eds. Akhila Anand) CRC Press, Taylor and Francis Group, New York, pp 107-133.

Pandey, A.K., Bhargawa, P. and Mandal, A.K. (2009). Performance evaluation of superior accessions of *Jatropha curcas* in tropical climate of Madhya Pradesh, India. In: New Frontiers in Biofuels (Eds. P.B.Sharma and Naveen Kumar), SciTech Publications India Pvt. Ltd. pp 409-421.

Pandey, A.K. and Kori, D.C. (2010). Variation in tannin and oxalic acid content in *Terminalia arjuna* (Arjuna) bark. In: Utilisation and Management of Medicinal Plants (Eds. V.K. Gupta, Anil K. Verma and Sushma Kaul*),* Daya Publishing House, New Delhi, pp 391.

Kumbhare Vishakha (2009). Career as a women scientist: A road for the future. *In*: Working Women and Job Satisfaction (ed. Anita Mishra). Sunita Book Depot, MP Nagar, Bhopal (M.P.), India, pp. 41-44.

Book (International) - Nil

Journal (National)

Bhowmik A.K., Singh R. B. and Singh R. K. (2009). Influence of mulching on growth yield and biomass production of *Albizia procera* in lime stone mine over burden. *Indian Journal of Tropical Biodiversity* 16 (2):191-194.

Jain A., Bhowmik, A.K. Nath, V. and Benerjee, S.K. (2009) Impact of plantation on ecosystems development in drastically disturbed coal mine overburden spoils. In: *Sustainable rehabilitation of degraded ecosystems* (eds. O.P. Choubey, V. Bahadur and P. K. Shukla), SFRI Publication Jabalpur. pp :190-205.

Jain Avinash and Jain Rakesh (2009). Management of underground water by biodrainage. *Vaniki Sandesh* **33(1)** : 13-15.

Bhowmik, A.K. and Jain Avinash (2008). Evaluation of forest tree species in pot culture using limestone mine spoil. *Indian Agriculturist* **52(3&4)** : 151-157.

Jain Avinash, Bhowmik, A.K. Nath, V. and Banerjee, S.K. (2009). Impact of plantation on ecosystem development in drastically disturbed coal mine overburden spoils. In : Sustainable rehabilitation of degraded ecosystems. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) pp 190-206.

Yousuf, M. and Ray Puja (2009) Record of *Chelonus* Panzer (Braconidae: Cheloninae) from central India. *Journal of Biopesticides* **2** : 145-149.

Kulkarni, N. and Joshi K.C. (2010) Persistent antifeedant effect of *Annona squamosa* extract against bamboo leaf roller, *Crypsiptya coclesalis* Walker (Lepidoptera: Pyralidae) in nursery. In : Conservation and Management of Bamboo Resources (Eds. S. Nath, S. Singh, A. Saha, R. Das and R. Krishnamurthy). Institute of Forest Productivity, Ranchi, pp 73-79.

Roychoudhury, N. (2009) Australian insect flying on eucalypts of the nation. *CURE Env. Bull.* **15** : 25-28.

Roychoudhury, N. (2010) Screening non-preference response in bamboos against key insect pest, *Crypsiptya coclesalis* Walker (Lepidoptera : Pyralidae). In : Conservation and Management of Bamboo Resources (Eds. S. Nath, S. Singh, A. Saha, R. Das and R. Krishnamurthy). Institute of Forest Productivity, Ranchi.

Roychoudhury, N. and Soni, K.K. (2009) Sal heartwood borer, *Hoplocerambyx spinicornis* Newman, in Bastar Forest Division, Chhattisgarh. *Vaniki Sandesh* 33 : 1-4.

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Brochure – Nil

News Article – Nil

Technical Bulletin

Six technical bulletins and 14 pamphlets in Hindi, and 5 and 15 technical bulletins and pamphlets, respectively in Marathi were published during the year.

One bulletin on Hadjor, *Cissus quadrangularis* Linn. was published in Hindi

4.4 Seminar/Symposia/Workshop Organized/Specialized Lecture

Organized a one day consultative workshop on development of criteria and indicator for sustainable NTFP management in association with IIFM, Bhopal on 12th October 2009 at TFRI, Jabalpur.

Lecture on "Biodiversity and Invasive Alien species" by Dr. S.S. Tomar was organized on 21-05-2009.

Lecture on "Vigilance Awareness" by Shri A.K. Shrivastava, IFS and Shri K.V. Diwakar, IFS was organized on 05-11-2009.

Lecture on "Beneficial role of nematodes in soil and plant health" by Dr. S.S. Husaini was organized on 08-02-2010.

Lecture on "Implementation and Institutional challenges under Forest Right Act 2006" and " Community Forest Resources and Community Forest Rights" by Mr. Sanjay Upadhyay, Advocate, Supreme Court was organized on 22-03-2010.

Lecture on "Fulbright programme opportunities for scientists and research scholars" by Ms. Sarina Paranjpe was organized on 23-03-2010.

Lecture on "Transgenic approaches to plant improvement" by Dr. Sharad Tiwari was organized on 24-03-2010.

4.5 Consultancies

Survey of flora and fauna in Maihar (Dist. - Satna). Reliance Cementation Pvt. Ltd.

Assessment of green cover and its tangible and intangible benefits and tree cover management plan for NCPP-Dadri awarded by National Thermal Power Corporation, Dadri.

4.6 Technical Services

The institute provided technical services in insect-pest and disease management in the natural and plantation forests of MP, CG, MS and Orissa.

4.7 Activities of Rajbhasa

Organized Hindi week.
Organized training/workshop in Hindi for the ministerial and technical staff of the institute.

4.8 Awards and Honours

P. B. Meshram awarded Applied Zoological Research Association (AZRA) Award 2009 for outstanding research contribution in the field of plant protection on 28 October 2009 at Department of Zoology, Andhra University, Visakhapatnam .

Dr. R.K. Verma, Scientist-D, Dr. V.S.Dadwal, Scientist-C and Shri A.K.Thakur, RA-II received BRANDIS PRIZE AWARD in the field of Silviculture for the year 2008 from the Indian Forester for the research paper entitled"Economics of biofertlizer application on production of planting propagules of teak in a commercial nursery" *Indian Forester* Vol.134 (7):923-931, July, 2008.

Shri Suneesh Buxy, Deputy Conservator of Forests was awarded "Certificate of Excellence" for his contribution on ecotourism and documentation of medicinal plants of Tamia and Patalkot, M.P.

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

Celebrated Van Mahotsava, World Environment day, World Forestry Day, Independence Day, Republic Day, Annual Sports etc.

5 Administration and Information Technology

Introduction

5.1 Information Technology

Hardware and software management

The 100 MBPS fast Ethernet fiber optic backbone LAN is functional at TFRI and is working smoothly. Eleven new computers with 1 UPS were procured and installed during the year.

Video Conferencing facility has also been extended through out the year. Overall a total of 22 number of sessions held through out the year.

Conduction of training courses.

Under the capacity building program, four training courses on "Basic Computer Skill" were conducted to enhance the computer operation capability of users to meet day to day task through the use of MS OFFICE software and internet application for the technical and administrative staff.

Besides this a training program was also organized by Ministry of Environment and Forests for all the employees of TFRI, Jabalpur.

Website Management

Time to time updation of institutes' website was done for research, publication, employee's bio data as well as other related information. This enabled extension of research as well as other related activity of the institute.

5.2 Sevottam:

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

Action has been initiated to formulate the Charter for the TFRI, Jabalpur and its subordinate centre at Chhindwara. The formulation of the charter is being initiated under the chairmanship of Shri Graham Durai, Dy. CF, Head, Extension Division.

5.2.2 Action taken to implement the Charter

The implementation of the Charter will be initiated soon after its finalization.

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

NIL

5.2.4 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.

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

Evaluation of implementation of Charter is to be initiated.

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

ICFRE Dehradun, has reconstituted the SC/ST/OBC Grievance Redressal Cell for the welfare of the community. Director, TFRI, has executed a committee to initiate necessary steps to form a union under the guidance of Liaison Officer of the institute and preparation of byelaws of the union is in progress. The union will conduct a meeting every year in March. The committee has listed out the existing strength of ST/ST/OBC communities in the institute during 2009-10 and same has forwarded to ICFRE, Dehradun for the approval of competent authority.

6. Annexures

1. RTI

NAMES AND ADDRESSES OF PUBLIC INFORMATION OFFICERS AND APPELLATE AUTHORITIES UNDER THE RIGHT TO INFORMATION ACT 2005 IN ICFRE AND ITS INSTITUTES

Headquarter / Institute	Appellate Authority	Public Information Officer	Subject matter(s) allocated
Tropical Forest Research Institute, Jabalpur	Dr. A.K. Mandal, Director, TFRI, Jabalpur	Dr. K.C. Joshi, Scientist-G	As per provision and guidlines provided under RTI Act, 2005.

2. Email and Postal addresses

TROPICAL FOREST RESEARCH INSTITUTE
(*Indian Council of Forestry Research & Education*)
(An Autonomous Council under the Ministry of Environment & Forests, Govt. of India)
P.O. – R.F.R.C, Mandla Road, JABALPUR – 482 021 (M.P)
Phones: 0761 – 4044002, 2840483(O)
FAX : 0761 – 4044002, 2840484
e-mail – dir_tfri@yahoo.co.in , dir_tfri@icfre.org

3. Intellectual Property

3.1 Patents Granted – Nil

3.2 Others - Nil