

# ANNUAL REPORT

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ARID FOREST RESEARCH INSTITUTE

JODHPUR

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## SIGNIFICANT RESEARCH ACHIEVEMENTS OF AFRI

- During survey of 446 sites covering 336 forest blocks in Rajasthan to estimate carbon stock and vegetation diversity and characterise soil, a forest type of *Mangifera indica* has been identified.
- Root to shoot biomass ratio of *Leptadenia pyrotechnica* ranged from 0.29 to 2.63 (average of 0.97) with significant contribution of root in carbon accumulation.
- Conservation of soil and water in lower Aravalli enhanced number of grass/herbs species from 39 in 2005 to 92 number in 2009, reduced run-off loss by >2% of total rainfall and enhanced soil water and plant growth.
- *Eucalyptus rudis* performed the best with respect to growth, biomass and bio-drainage potential. *A. nilotica* and *Tamarix aphylla* were found tolerant to high salinity at shallow water logging.
- *Acacia bivenosa* performed the best under reclamation of saline alkaline soil.
- A combination of *Cordia gharaf* and *Cenchrus ciliaris* was found the best under silvipastoral model. *Zizyphus mauritiana* and *Colophospermum mopane* based agroforestry model found suitable with wheat grain production of 13.67 quintal ha<sup>-1</sup>.
- Seed of *Acacia nilotica* and *A. catechu* collected from seed production areas indicated better seeds parameter and germinations.
- Progenies of CPTs of Chohtan (Barmer) and Mohangarh (Jaisalmer) showed best growth in progeny trial of *Tecomella undulate* at Jodhpur and Bikaner sites, respectively.
- Five good general combiners among half siv families have been identified in Gujarat teak.
- Protocols for *in vitro* propagation of *Jatropha curcas* and *Commiphora wightii* developed.
- Fertilizer application enhanced number of culms per clump by 16% and 74% in *Bambusa bambos* and *Dendrocalamus strictus*.
- Female plants of *Ailanthus excelsa* performed better than male plants at two years of age.

- Performance trial of 24 elite accessions, native trial of 16 accessions, progeny trial of 30 CPTs, spacing and pollarding trials, clonal trial and seedling seed orchard of *Jatropha curcas* have been laid/ established. Performance and agri-trials of guggal established.
- Application of zinc fertilizer enhanced fruit yields of ten year old *Salvadora persica* tree.
- Infestation of *Achaea janata* and charcoal root rot disease caused by *Rhizoctonia bataticola* have been recorded on *Lawsonia inermis*.
- Yields of *L. inermis* and *Pumbago ovata* increased to 2.47 kg m<sup>-2</sup> and 104.88 kg Stover per 25 m<sup>2</sup>, respectively under treatment as compared to 2.0 kg m<sup>-2</sup> and 76.56 kg Stover per 25 m<sup>2</sup> areas, respectively under control.
- 16 insects, 2 mites, 3 nematodes and 13 diseases have been recorded in *A. nilotica*. Rust and mites exhibited strong host specificity with *A. nilotica* var. *indica*.
- Five AMF genera and 11 species of *Glomus* have been recorded in *L. inermis* and *Withania somnifera*. *G. fasciculatum* enhanced growth and vigour of *L. inermis*, while *Withania somnifera* performed best with indigenous mixed inoculums with dominance of *G. aggregatum*.
- Two VVK established one each at Rajkot, Gujarat and Bikaner, Rajasthan and trainings for farmers and forest field functionaries organized.



**ARID FOREST RESEARCH INSTITUTE, JODHPUR**  
**ANNUAL REPORT 2009-10**

**Executive Summary**

To address the forestry related research problems of the mandated areas of Rajasthan, Gujarat and Dadra & Nagar Haveli, AFRI has taken up 29 projects covering various themes and sub themes, established two Van Vigyan Kendra and organized trainings to the field functionaries and farmers. Out of 29, four projects were completed and six projects were initiated in 2009-10. A total of 446 sites covering 336 forest blocks in Rajasthan were surveyed to estimate carbon stock and vegetation diversity and to characterise & classify forest soils. During the survey *Mangifera indica* forest type was identified and reported for the first time from Rajasthan. Conservation of soil and water in lower Aravalli improved the biodiversity of grass and herbs species from 39 in 2005 to 92 in 2009. *Eucalyptus rudis* performed best with respect to growth, biomass and bio-drainage potential in Rajasthan. *A. nilotica* and *Tamarix aphylla* were found tolerant to high salinity at shallow water logging conditions. *Acacia bivenosa* proved to be the most hardy plant under reclamation of saline alkaline soil. A combination of *Cordia gharaf* and *Cenchrus ciliaris* was found the best under silvipastoral study in Gujarat. *Zizyphus mauritiana* and *Colophospermum mopane* based agroforestry model found suitable with wheat grain production in Rajasthan. Seed of *Acacia nilotica* and *A. catechu* collected from seed production areas from Gujarat indicated better seeds parameter and germinations.

Progeny trials of *Tecomella undulata* established in 2008 in Jodhpur and Bikaner are being monitored for performance. Multilocational trials of *E. camaldulensis* and *D. sissoo* established in RBD design in Gujarat in 2003 have been evaluated and 30 clones of *D. sissoo* and 35 clones of *E. camaldulensis* have been selected. Five good general combiners among half sib families were identified in Gujarat teak. Basic protocols for *in vitro* propagation of *Jatropha curcas* and *Commiphora wightii* were developed. Performance of female plants of *Ailanthus excelsa* was found better than male plants at the age of two years. Performance trial of 24 elite accessions, native trials from 61 accessions, progeny trial of 30 CPTs, spacing and pollarding trials, clonal trial and seedling seed orchard of *Jatropha curcas* are being evaluated. Application of zinc fertilizer enhanced fruit yields in *Salvadora persica*.

Infestation of *Achaea janata* and charcoal root rot disease caused by *Rhizoctonia bataticola* was recorded on *Lawsonia inermis*. About 16 insects, 2 mites, 3 nematodes and 13 diseases were documented in *A. nilotica*. The cross-infectivity and host specificity tests using the seven species of *Acacias* including *A. nilotica* var. *indica* revealed that the rust as well as mites exhibited strong host specificity. Five AMF genera and 11 species of

*Glomus* have been recorded in *L. inermis* and *Withania somnifera*. *G. fasciculatum* enhanced growth and vigour of *L. inermis*. *Withania somnifera* performed best with indigenous mixed inoculums with dominance of *G. aggregatum*.

### Significant Research Achievements of AFRI

- During survey of 446 sites covering 336 forest blocks in Rajasthan to estimate carbon stock and vegetation diversity and characterise soil, a forest type of *Mangifera indica* has been identified.
- Root to shoot biomass ratio of *Leptadenia pyrotechnica* ranged from 0.29 to 2.63 (average of 0.97) with significant contribution of root in carbon accumulation.
- Conservation of soil and water in lower Aravalli enhanced number of grass/herbs species from 39 in 2005 to 92 number in 2009, reduced run-off loss by >2% of total rainfall and enhanced soil water and plant growth.
- *Eucalyptus rudis* performed the best with respect to growth, biomass and bio-drainage potential. *A. nilotica* and *Tamarix aphylla* were found tolerant to high salinity at shallow water logging.
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#### Summary of projects

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	02	13	03
Externally Aided	02	06	03
	04	19	06

#### Contents

- 1 **Introduction:** Information about respective institute and centers (in one para only), Map showing institutes, Centers and their jurisdiction.  
**Institute- At a Glance**
  - Arid Forest Research Institute, Jodhpur (Rajasthan), is one of the eight institutes of the Indian Council of Forestry Research & Education (ICFRE), an autonomous organization of the Ministry of Environment & Forests, Govt. of India. The objectives of the institute are to carry out scientific research in forestry & allied fields to enhance the productivity & vegetative cover, to conserve the biodiversity and to develop the technologies for the end-users in Rajasthan, Gujarat and Dadra & Nagar Haveli.
  - The main thrust areas of the institute are soil, water & nutrient management, technologies for afforestation of stress sites, management of plantations, growth and yield modeling, planting stock improvement, bio-fertilizers and bio-pesticides, Agroforestry, JFM & extension, phytochemistry & non-timber forest products, integrated pest & disease management and forestry education and extension. During 2009-10, twenty nine projects were executed including ten externally funded projects from Rajasthan Forest Department, Gujarat Forest Department, Department of Bio-technology, Government of India, New Delhi, National Medicinal Plant Board, New Delhi, CSIR, New Delhi and IIRS, Dehradun.

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Fig 1. Mandated states of AFRI, Jodhpur

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## Research Highlights

### 2.1 Ecosystem Conservation and Management

#### 2.1.1 Overview

##### 2.1.1.1 Summary of the achievements under the Theme

- A total of 446 sites covering 336 forest blocks in 12 districts in Rajasthan have been surveyed to estimate carbon sequestration in forest soil and vegetation.
- A forest types with *Mangifera indica* has been identified in Sirohi forest division, Rajasthan.
- Vegetation carbon pool in 19 forest sites (76 plots) and 33 plots under tree outside forest (TOF) have been assessed in Shri Ganganagar, Hanumangarh, Churu, Jhunjhunu, Sikar and Jaipur districts of Rajasthan.
- Adoption of different rainwater harvesting techniques (contour trench, gradonie, box trench and V-ditch) on a degraded hilly area in Banswara has improved the biodiversity in the area, where number of grass and herbs species increased from 39 in 2005 to 92 in 2009.

##### 2.1.1.2 Projects under the Theme

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



## 2.1.2 & 3 Climate Change/Ecology and Environment

### NEW PROJECTS INITIATED DURING 2009-10

#### Externally Aided Projects

**Project 1. Vegetation carbon pool assessment in some districts in Northern Rajasthan (Funded by IIRS, Dehradun) (AFRI-97/FED/IIRS, D.dun/ 2009-11).**

*Principal Investigator: Dr. G.Singh*

Assessment of carbon in growing vegetation and carbon dynamics in the forests as well as tree outside forest (TOF) were carried out in Shri Ganganagar, Hanumangarh, Churu, Jhunjhunu, Sikar and Jaipur districts of Rajasthan. A total number of 19 forest sites (76 plots) and 33 plots under tree outside forest have been surveyed in these districts and trees and shrubs have been measured in cluster sample of four at each site in forests. In TOF some agriculture land, community land, state highway, national highway, railway tract, drainage line and village connecting roads have been surveyed and growth variables measured. Biomass of ultimate branches of a representative tree of different girth classes were recorded both for fresh and dry samples.

In Hanumangarh division 'Desert thorn forest' of *Prosopis cineraria* is dominating, but most of the forest are invaded and now dominated by *P. juliflora* and the plantation of *Acacia tortilis*. Forest types covers in Sikar division are *Anogeisus pendula* dominated and intermingled with *Boswellia serrata*. In Jhunjhunu, 'desert thorn forest' dominated in the area with dominant species of *A. senegal*.






### PROJECTS CONTINUED DURING 2009-10 (PLAN)

**Project 2. Studies on carbon sequestration in different forest types of Rajasthan (AFRI-98/FED/ 2008-2012).**

*Principal Investigator: Dr. G. Singh*

With the objective to provide an estimate of carbon stock of forests in Rajasthan, twelve districts covering 336 forest blocks and 446 sites in these blocks have been surveyed and growth of trees and shrubs measured and shrub/herbage biomass recorded. Litter, plant and soil samples have also been collected from the plots. Per cent soil organic carbon (SOC) and inorganic carbon (SIC) varied widely among the district. SOC varied from 0.17% in Hanumangarh district to 0.99% in Banswara, whereas, SIC varied from almost nil in Jhunjhunu to 1.12% in Chittorgarh district. Fresh aboveground and belowground biomass of *Leptadenia pyrotechnica* ranged from 0.09 to 19.0 kg and 0.05 to 20.0 kg, respectively with R/S ratio ranging from 0.29 to 2.63 (average of 0.97).

Sand dune scrub in Barmer district are found to be dominated partly by *Calotropis procera* with tree girth of 92 cm, height of 6.5 m and crown diameter of 6.6 m and with root:shoot ratio of 0.68. *Capparis decidua* tree dominated area with growth variables of 190 cm girth, 5.5 m height and 5.6 m crown diameter have also been observed in Jalore forest division. In growth variables of *Leptadenia pyrotechnica* collar girth, height and crown ranged from 5.26-40.50 cm, 55.0-233.0 cm and 36.0-380.0 cm, respectively. During the survey, a mixed forest of *Mangifera indica* has been observed in Sirohi forest division.

			
Mangifera indica mixed forest in Sirohi		Desert dune scrub of <i>L. pyrotechnica</i> and <i>Colligonum polygonoides</i> in Barmer	
			
Capparis decidua in desert dune scrub in Jalore	Euphorbia caducifolia scrub forest in Barmer	Calotropis procera in desert dune scrub in Barmer	

#### 2.1.4 Biodiversity

**Project 3. Efficacy and economics of water harvesting devices in controlling run-off losses and enhancing biomass productivity in Aravalli ranges (Funded by the State Forest Department, Rajasthan and ICFRE) (AFRI-39/EED/ 2005-11).**

*Principal Investigator: Dr. G. Singh*

Adoption of different rainwater harvesting techniques (contour trench, gradonie, box trench and V-ditch) on a degraded hilly area in Banswara has improved the biodiversity in the area. There is increase in number of grass and herbs species in the experimental plots and 92 numbers of species recorded in October 2009 as compared to 39, 75, 81 and 81 species in 2005, 2006, 2007 and 2008, respectively. Number of species was lowest in 10-

20% slope ( $4.99 \text{ m}^{-2}$ ) and increased downward being highest in <10% slope ( $6.22 \text{ m}^{-2}$ ). Dry matter production was  $246.82 \text{ g m}^{-2}$  in <10% to  $355.86 \text{ g m}^{-2}$  in >20% slope. Among the treatments, dry matter production was  $336.99 \text{ g m}^{-2}$  in V-ditch plots as compared to  $272.81 \text{ g m}^{-2}$  in control plots. As a result of protection and afforestation, there was increase in water, fodder and fuel wood availability in the area.

2.1.5 Forest Botany

2.1.6 Tribals and Traditional Knowledge System



Figure 1 and 2. Collection of fuel-wood and fodder from the area, Gauapada, Banswara.

## 2.2 Forest Productivity

### 2.2.1 Overview

#### 2.2.1.1 Summary of the achievements under the Theme

- Soil profiles have been studied at 210 places covering Sri ganganagar, Hanumangarh, Jhunjhunu, Sikar, Bikaner, Nagaur, Barmer, Sirohi, Jalore and Jaisalmer districts in 170 forest blocks in 89 ranges in order to characterize forest soils of Rajasthan.
- Under assessment of bio-drainage potential of tree species, *Eucalyptus rudis* performed the best with respect to growth, biomass, transpiration rate and overall bio-drainage potential where ground water level receded by 145 cm within a period of 54 months.
- In a lysimetric study, *A. nilotica* and *Tamarix aphylla* showed higher tolerance towards salinity as compared to *E. camaldulensis*. However, under water logging condition at shallow depth *E. camaldulensis* outperformed *A. nilotica* and *T. aphylla*.
- Effect of different rainwater harvesting techniques (contour trench, gradonie, box trench and V-ditch) and hill slopes on plant growth, runoff loss and soil moisture status were studied on a degraded hill in Banswara district. Performance of *E. officinalis*, *S. cumini*, *A. catechu* and *H.integrifolia* were better in contour trench plots, *G. arborea* and *Z. mauritiana* in box trench plots. *A. indica* and bamboo performed better in V-ditch plots. Contour trench reduced run-off losses to a greater extent.
- *Acacia bivenosa* proved to be the most hardy plant surviving the extremely harsh conditions of high salinity, heat stress and drought conditions and achieving adequate growth on highly saline black soil after 30 months of growth.

- *Cordia gharaf* and *Cenchrus ciliaris* combination was the best silvipastoral on arid sandy degraded forest soil at Bhuj after 38 months of establishment.
- Agroforestry model being maintained at farmer's field at village Harsh, Bilara, District - Jodhpur. *Sesbania aculeata* (Dhaincha) was grown during the year in the field for green manuring. Performance of *Ziziphus mauritiana* was found the best as horticultural species and *Colophospermum mopane* was the best as silvicultural species. The plant growth was higher in agroforestry plots as compared to the control (without crop). Wheat crop production was recorded 13.67 quintal /ha during the year.
- Seed germination studies were conducted on seeds of *Acacia nilotica* and *A. catechu* collected from various seed sources of Gujarat.

#### 2.2.1.2 Projects under the Theme (in table as given at 2.1.1.2)

Projects	Completed Projects	Ongoing Projects	New Projects Initiated During the Year
Plan	Nil	03	Nil
Externally Aided	1	01	Nil

#### 2.2.2 Silviculture

##### PROJECTS CONTINUED DURING 2009-10

##### Externally aided

**Project 1. Enhancing productivity of saline wastelands in Kachchh- through improved tree planting techniques and silvipastoral study (Gujarat SFD sponsored project- 77/NWFP/SFD/AFRI-2006-11).**

*Principal Investigator: Dr.Ranjana Arya*

##### Silvipastoral study:

Silvipastoral trial was laid in 2007 in Bhuj. Survival rate of plant species was more than 90% in both the experiments at 38 months of age. Species wise maximum survival was *Cordia gharaf* (99.5%), followed by *Zizyphus mauritiana*, (92.5%) and *P. cineraria* (91.2%). Overall periodic percent survival recorded was 95.64 in *Cenchrus setigerus*, and 93.8% in *C. ciliaris*, there was slight decrease, 1.9% with *C. setigerus* and 2.3% with *C. ciliaris* as compared to survival at 24 months). However, survival with grass was higher in case of *C. ciliaris* (97.5% to 90.1 % in control) as compared to *C. setigerus* (92.0% to 98.1% in control). At 38 months, maximum mean tree height was recorded with *C. ciliaris* (162.4 cm), followed by *C. setigerus* (142.8 cm). Mean tree height was significantly higher for control trees as compared to with grass in case of *C. setigerus*. However, trees with *C. ciliaris* grew 3-5% taller. Species wise, maximum mean height was recorded in *Z. mauritiana* (203.5 cm), followed by *C. gharaf* (192.3 cm) and *P. cineraria* (62.1 cm). Except for *Z. mauritiana*, other species did not record crown growth. *Z. mauritiana* recorded 31.3% and 14.2% incremental growth for control and with grass treatment at 38 months of age.

Based on mean height and crown diameter component wise, aboveground biomass estimation was carried out for *Z. mauritiana* and *C. gharaf* in control and with grass treatments. With *C. setigerus* sowing was done at high seed rate biomass yield for control trees was 2-3 fold more with *C. gharaf* (7.5 kg/tree) and *Z. mauritiana* (4.0 kg/tree) as compared to trees grown with grass *C. gharaf* (4.8 kg) and *Z. mauritiana* (1.6 kg tree). While, in case of *C. ciliaris* (sown in scattered manner at low seed rate) biomass yield was 4.5 to 5.3kg/tree for *Z. mauritiana* and 8.0 to 8.6 kg/tree for *C. gharaf* with grass and control treatments, respectively. Result suggest that at low seed rate grass sowing promote tree growth.

During the year 2009 total rainfall was 419 mm and most of which (202 mm) was received late in August in three days (29-31, 2009) after a long dry spell of nearly 30 days. The mean yield was 1.01 Kg m<sup>-2</sup> for *C. ciliaris* and 0.76 Kg m<sup>-2</sup> *C. setigerus*. It was 57.5% and 61.7% more as compared to last year. Tree growth did not influence the grass yield and green grass yield was maximum with *C. gharaf* (1.11 Kg/m<sup>2</sup>) for *C. ciliaris* and *Z. mauritiana* (0.83 Kg/m<sup>2</sup>) for *C. setigerus*, respectively, which was comparable to control. A green weedmass of 0.35 kg/m<sup>2</sup> mainly unpalatable grasses was obtained from the experimental area.

#### Improved tree planting techniques

Research trials were laid with *A. ampliceps*, *A. bivenosa* (exotic) and *S. persica* (indigenous) on black silty clay (medium), soil depth: 40-75 cm at Kordha, Sami Range in Patan, Gujarat at the fringe of WAS in July, 2007 to find out suitable exotic and indigenous fodder plant species with appropriate planting practice. *S. persica* proved to be most hardy plant surviving the extremely harsh conditions of high salinity, heat stress and drought conditions and suffered minimum casualties and maintained high rate of survival (92.8%) at 30 months of planting, followed by *A. bivenosa* with 77.3% survival at 30 months.

Among the selected species *A. ampliceps* suffered the maximum damage due to salt laden hot winds from rann side in May 2009, probably due to its being on the border area and also with maximum height. Initial resprouting was observed in most plants. However, there was 41% decrease in mean survival (which was 44.1% at 30 months and 74.6% at 12 months).

All the three plant species displayed shrubby nature favoured more crown diameter than height after two years of growth. In *S. persica* mean height was 120.8 cm as compared to mean crown diameter 154.2 cm at 24 months. Comparatively *A. bivenosa* attained maximum crown growth among all the plant species at 24 months. The mean height, 112.6 cm, was significantly less than the mean crown diameter (208.5 cm). Two factor ANOVA analysis showed that treatments influenced the growth and both FYM and Wheat husk treatments favoured significant higher growth (height and crown diameter) as compared to other treatments. The individual plant had 4-19 branches in different treatments. Initially, up to 18 months, *A. ampliceps* attained very high growth and flowered and produced viable seed within a year, but after heat shock growth in term of height showed declined trend. Nearly 90 % plants of *S. persica* flowered in Jan 2010, however, fruit setting was in 6 % plants in March 2010. No flowering was observed in *A. ampliceps* and *A. bivenosa* in a deficient monsoon year.

Percent soil moisture was ranging from 8.1 to 12.6 % in 0-25 and 25-50 % soil layer inside plant pit for *A. bivenosa* in Jan 2010 (there was 8 mm rain on 14 Dec, 2009), which was reduced to 2.4 to 4.73 % in the upper soil layer inside plant pit. Soil working may have resulted in moisture loss as moisture content in inter row space was more (3.02 to 5.01%) in upper soil layer. Soil pH and EC were analysed from *A. ampliceps* in summer 2009. The soil pH values were in normal

range. However, EC values were higher ranging from 1.7 to 4.06 dSm<sup>-1</sup> and 2.30 to 4.01 dSm<sup>-1</sup> in 0-25 and 25-50 cm soil layer. EC values after the heat shock were ranging from 1.2 to 3.9 dSm<sup>-1</sup> and 1.4 to 5.5 dsm<sup>-1</sup> indicating that salinity levels were high during heat shock.

Plantation activities promoted weed growth, *Chloris virgata* was the most dominant species, followed by *Sueada fruticosa*, *Aristida spp* and *Zygophyllum simplex*. Overall, 517.3 gm<sup>2</sup> yield was recorded, however, tree species wise, variation was observed and it was 503.8 gm<sup>2</sup> (*A. bivenosa*) and 530.8 gm<sup>2</sup> (*A. ampliceps*).

## PROJECTS CONTINUED DURING 2009-10 (PLAN)

**Project 2. Studies on seed traits of seeds collected from seed stands / SPAs / SSOs / CSOs of important species of Gujarat state (AFRI-80/Silvi/2007-12).**

*Principal Investigator: Dr. D. K. Mishra*

Due to poor seeding in the Gujarat state, SFD was unable to supply quality seeds of desired species. Instruction manual for establishing seed certification system has been prepared and submitted to CCF/DCF, Gandhinagar and Rajpipla for implementation.

Seed samples of 12 seed sources (2 seed stands and 10 CPTs) of *Acacia catechu*, 14 *Jatropha* CPTs were collected and tested for seed parameters. Seeds were examined physically and none was defective and all seeds were healthy. Seeds of *A. catechu* were golden-brown in colour. *Acacia catechu* seedlot no. 2557 showed 77.5% germination and 143.38 vigour Index, while seeds collected from outside area (accession no. 2558) showed 77.5% germination and 145.7 of vigour Index. Seeds of 10 CPTs of *A. catechu* showed variation in 100 seed weight from 3.79-5.48g, seed germination from 69 to 91.5% and vigour index from 88.14 to 152.73. Removal of seed coat from seeds of *Terminalia chebula* enhanced percent germination from 10% control to 72% after kernel removal. Number of seeds in 10g of seed weight in 14 CPTs of *Jatropha* varied from 17-23 and oil from 27.6 to 41.1% on seed basis.

### 2.2.3 Social Forestry, Agro-forestry/ Farm Forestry

**Project 3. Development of economically viable and integrated Agroforestry models for arid region (AFRI-55/Silvi/2006-12).**

*Principal Investigator: Dr. Bilas Singh*

Agroforestry model established and maintained at farmer's field at village Harsh, Bilara, District - Jodhpur. *Sesbania aculeata* (Dhaincha) was grown during the year in the field for green manuring. Performance of *Ziziphus mauritiana* (grafted Ber) species was found the best as horticultural species, while *Colophospermum mopane* was the best as silvicultural species.

*C. mopane* plants attained (average) maximum height of 181 cm, followed by *Prosopis cineraria* (173 cm), *Cordia mixa* (169 cm), *Ailanthus excelsa* (165 cm) and *Ziziphus mauritiana* (136 cm). Collar diameter was maximum in *A. excelsa* (5.96 cm), followed by *Cordia mixa* (5.83 cm), *C. mopane* (4.52 cm) and *P. cineraria* (4.19 cm). The plant growth was higher in agroforestry plots as

compared to the control (without crop). Wheat crop production was recorded 13.67 quintal /ha during the year.

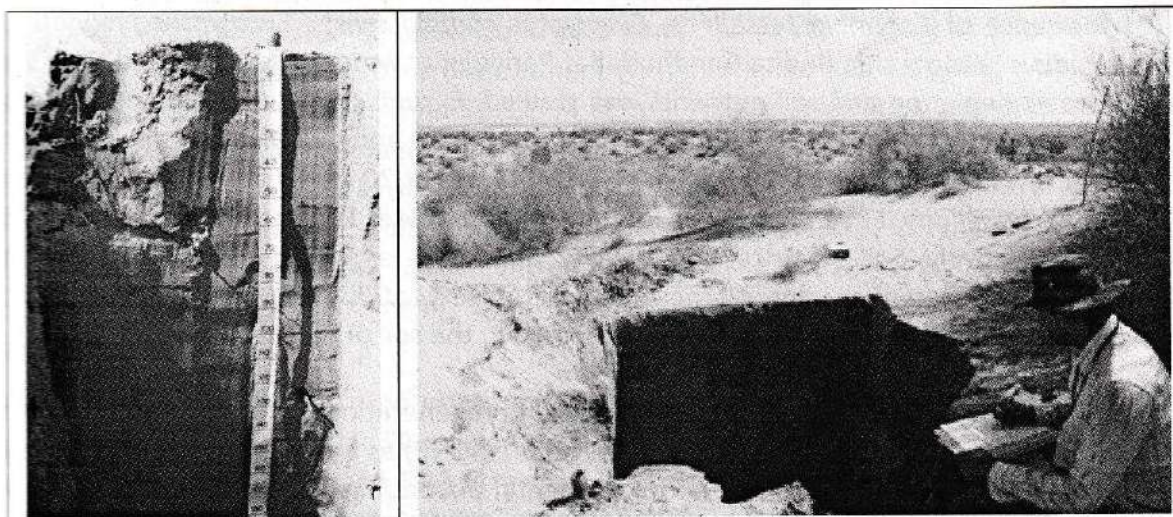
#### 2.2.4 Forest Soils & Land Reclamation

**Project 4. Characterization and classification of forest soils of Rajasthan (AFRI-85/FED/2007-2012).**

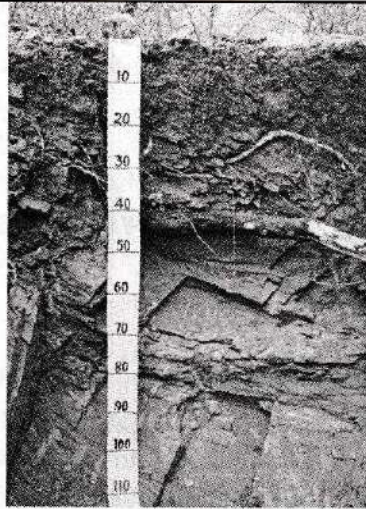
*Principal Investigator: Mr. N. Bala*

With the objective to characterize and classify the forest soils of Rajasthan, following the USDA classification system, soil profiles have been studied at 210 places covering Sri ganganagar, Hanumangarh, Jhunjhunu, Sikar, Bikaner, Nagaur, Barmer, Sirohi, Jalore and Jaisalmer districts in 170 forest blocks in 89 ranges. Physico-chemical characterization of the soils has been done in the field as well as in laboratory. Soil structure, consistency, colour, pH, electrical conductivity, organic carbon,  $\text{NO}_3$  and  $\text{NH}_4$  – nitrogen and phosphorus have been estimated for 751 samples. Ecological study in an area of 0.1 ha near each of the soil profile pit has been completed. Soils in Shri Ganganagr district are mainly aeolian deposits in the form of desert dunes, inter-dunal plane and old alluvial plains, where no vertical development of horizon has taken place, indicating nature of Entisol. Soil carbon stock varied greatly among different sites, depending on % organic carbon and depth of soil, being high in Gander, Pratapgarh (341 Mg per ha). Very low stock of carbon was estimated for Panch kunda ( $12.6 \text{ Mgha}^{-1}$ ) and Kala Bhakar ( $13.5 \text{ Mgha}^{-1}$ ) blocks in *Euphorbia* scrub and *Anogeissus pendula* scrub, respectively having very shallow soil depth and low soil organic carbon.

#### SOME TYPICAL FOREST TYPES AND SOIL PROFILES



Desert dune scrub (61S1) on deep aeolian deposit in Ganganagar; pH: 8.67; Ec:  $0.16 \text{ dSm}^{-1}$ ; SOC: 0.11-0.13; Carbon stock:  $31.9 \text{ Mgha}^{-1}$



Northern dry mixed deciduous forest (5B/C2) on very shallow soil, Ratapani, Dungarpur; pH: 6.32-6.45; Ec: 0.06-0.09  $\text{dSm}^{-1}$ ; SOC: 0.27-1.26; Carbon stock: 22.1  $\text{Mgha}^{-1}$

### PROJECT COMPLETED (EXTERNALLY AIDED)

**Project 5. Studies on characteristic features pertaining to biodrainage potential of some selected tree species (AFRI-38/FED/MOWR/2004-2010).**

*Principal Investigator: Mr. N. Bala*

Performance of *Corymbia tessellaris*, *Eucalyptus camaldulensis*, *Eucalyptus fastigata* and *Eucalyptus rudis* in a canal side (Indira Gandhi Nahar Pariyojana) waterlogged area and their impact on ground water depletion and soil nutrients was studied. *E. rudis* performed the best among the tree species with respect to growth, biomass, transpiration rate and overall bio-drainage potential. Ground water level receded by 145 cm (from stagnant water of 20 cm to a depth of 125 cm) in *E. rudis* plot. In *C. tessellaris*, *E. camaldulensis* and *E. fastigata* water level receded by 90 cm, 70 cm and 60 cm, respectively. Soil electrical conductivity, SOM,  $\text{NH}_4$  and  $\text{NO}_3 - \text{N}$  and  $\text{PO}_4 - \text{P}$  varied significantly among different species. All these parameters, except  $\text{PO}_4 - \text{P}$  were high in *E. rudis* and low in *E. fastigata*. No significant variation was observed in the soil pH in these species.

Interesting observation was also on heavy natural regeneration of *Eucalyptus camaldulensis* in a water logged area in Indira Gandhi Nahar Pariyojana (IGNP) as a result of soil working (tractor ploughing) that was done before raising an experimental plantation. The regenerated plants were mostly concentrated between 6 and 10 m from the tree trunk of the mother trees situated at the edge of the experimental site. Number of seedlings varied between 13 and 36 per  $\text{m}^2$  area. Ground water table has receded from 25 cm to 201 cm depth within a period of five and half year. Apart from the planted species, *Prosopis juliflora*, *Tamarix dioca* and *Saccharum munja* also have come up in the area with recession of ground water table as natural succession and contributed significantly for further lowering of ground water table and increasing productivity.



Minimum and maximum range of initial plant growth parameters of the accessions (CPTs) raised in seedling seed orchard of *Jatropha curcas* at AFRI, Jodhpur and Haldughati, Udaipur 6 months of planting.

No of CPTs supplied	AFRI, Jodhpur			Haldughati, Udaipur		
	Range of mean height (cm)	Range of mean no. of branches	Range of mean collar diameter (cm)	Range of mean height (cm)	Range of mean no. of branches	Range of mean collar diameter (cm)
4	134.0-156.0	3.00-3.40	4.33-5.29	77.50-98.90	1.21-1.67	2.23-3.31
21	100.0-185.0	1.67-4.50	3.37-6.07	54.60-90.90	1.00-1.40	2.28-3.30
18	91.0-163.0	1.33-3.80	3.04-4.79	37.80-88.90	1.00-1.73	1.63-3.16
22	81.0-166.0	1.60-3.00	2.73-5.90	49.50-88.00	1.00-1.75	2.42-3.29
6	127.0-172.0	2.25-3.00	4.34-5.50	60.00-84.50	1.00-1.91	2.18-2.95
45	105.0-171.0	1.80-4.00	3.30-5.60	53.90-97.00	1.00-1.63	2.15-3.23
116						

**4. Genetic improvement of *Jatropha curcas* for adaptability and oil yield (AFRI/CSIR/2005-12).**

Principal Investigator : Dr. D.K. Mishra

Performance trial of *Jatropha* accessions (185 accessions; 24 elite and 161 native) were selected/exchanged with participating Institutes and planted in September, 2005 and August, 2006. At present 161 accessions are surviving. Now, it has been decided that only 17 elite and 61 native accessions will be monitored for vegetative and seed yield parameters.

Survival of elite accessions varied from 13% (FRI-UA-Teh-1005-DD-EL-1 and NBPGR-GUJ-SKN-0605-Chhatrapati) to 100 percent in CSMCRI-GUJ-Panch-0106-C3. Mean plant height, number of branches and collar diameter varied from 128.12cm in NBPGR-GUJ-SKN-0605-Chhatrapati to 137cm in CRIDA-JJ-06, 1.7 in NBPGR-GUJ-SKN-0605-Hansraj to 2.75 in FRI-UA-Teh-1005-DD-EL-2 to 3.55cm in FRI-UA-Teh-1005-DD-EL-1 to 7.11cm in CRIDA-JL-06, respectively. Only 11 accessions produced seeds and range was from 4 to 30.00 g per plant.

Plant survival of native accessions varied from 33 to 100 percent. Mean plant height, number of branches and collar diameter varied from 120cm to 272.50cm, 1.0 to 6.0 and 2.63cm to 4.5cm, respectively. Seed yield per plant varied from 10.0g to 432.50g in various accessions. Out of 161 accessions, only 48 seeded and remaining 13 have no fruits.

Spacing trial was initiated in RBD design with 16 plants per treatment and in five replications in July 2007. The spacing was 2m x 2m, 2.5m x 2.5m, 3m x 3m and 4m x 4m. Observations of height from ground mean numbers of branches were recorded after 30-months of planting. The mean plant height varied from 176.50±15.71 cm to 194.16±26.38cm, mean number of branches 3.22±0.31 to 3.62±0.63 and collar diameter from 5.84cm to 6.84cm.

Irrigation and fertilizer trial was laid out in split plot design at 2.5m x 2.5m spacing with four replications at four levels of irrigation treatments (I0 = Life saving irrigation, 60 days or as required, I1 = 15 days, I2 = 30 days, and I3 = 45 days) and five levels of fertilizer treatments (F0 = no organic manure i.e. FYM, F1 = 2 kg/pit FYM, F2 = 5 kg/pit FYM, F3 = Nitrogen 10g+ P 20g, K, 10g per pit, F4 = 2 kg FYM, Nitrogen 10g+ P 20g, K, 10g per pit).

Observations have been recorded on above ground height, number of branches and collar diameter after 28 months of planting. The irrigation treatments were imposed in February, 2008. Average height was 184.7±3.027819cm in control and varied up to 213.71±10.30675cm in I1. Irrigation at 15 days interval has significantly affected height and collar diameter of the plants. However, application of fertilizer has significant effect on number of branches only. Plant height and collar diameter remain unaffected by the fertilizer treatments at present

Pollarding trial was established in July, 2007 in RBD design with five replications and four treatments (T0: No Pruning; T1: Pruning height 30cm; T2: Pruning height 45cm and T3: Pruning height 60cm. The number of plants per treatment was 10.

The mean height and collar diameter ranged within 141.8±25.36 to 142.6±23.84 cm and 5.895±0.989 to 5.209±1.19 cm, respectively. Whereas, the mean number of branches were maximum in T2 (11.36±0.868), followed by T3 (10.18±3.432) and minimum in T0 (7.58±1.089) Analysis of variance suggested that there is non-significant effect of pruning on average plant height and number of branches.

**Project 5. Network research project on guggal *Commiphora wightii* Arn. Bhandari (AFRI-76/Silvi/NMPB/2008-13).**

*Principal Investigators : Dr. D.K. Mishra, Dr. R. Arya and Dr. Tarun Kant*

The clonal performance trial was established in RBD design with 4 replications and each replication has 8 plants per accession in September, 2007. Survival varied from 44% of Jalore to 100 percent of Jaipur accession, followed by 94 % (Barmer, Bikaner and Dausa). Mean Plant height varied from 93.17cm of Bharatpur to 172.25cm of Tonk, mean crown diameter from 96.69cm in Jalore to 162.91cm in Sikar source and mean number of branches from minimum (3.06) in Jaisalmer to maximum (5.14) in Jhunjhunu source. Fruit density was highest 12.16 per sq. ft. in accession from Dausa, followed by 11.50 per sq. ft. from Kota and least in 3.22 per sq. ft. from Jalore . Analysis of variance showed that the overall result of growth parameter and fruit density are of high-significance. Values for all the parameters except fruit density in clonal sources of Dausa and Tonk are at par from rest of the districts, whereas, for plant height and crown diameter clonal sources from Jaipur and Jhunjhunu also showed values at par beside Dausa and Tonk. Collections from Barmer, Bikaner, Dausa, Kota and Sikar showed fruit density at par from rest of districts.

Flowering was initiated in December and fruit formation was observed in March. In *Commiphora wightii* only monoecious flowers were observed. Seeds collected during last season were separated into black and off-white types with 56% and 2% germination, respectively.

The effect of various treatments applied on guggal agri-trial after 32 months of planting in the field. In all irrigation treatment (plants provided water after 30, 45 and 60 days of interval) the mean plant height was almost same ~152cm, whereas, the number of branches was maximum 4.12 in I2 treatment to almost 3.7 in remaining treatments. The mean crown diameter was minimum 156.17cm in I3 treatment and maximum 165.64cm in I1 treatment, followed by 162.20cm in I2 treatment. Analysis of variance shows non-significant effect of irrigation.

Vegetative propagation by stem cuttings is possible in this species. The optimum size was of 1.5cm in diameter, which favoured highest number of rooted plants. The best time for collecting stem cuttings was from April to August under Jodhpur conditions.

The macropropagation and seedling plant field trial was established in July, 2009 in RBD, with five replicates and has 10 plants/replication. Plant survival after six-months of plantation was 94-percent in seed raised plant as compared to clonally raised plants (94%).

#### **Component II To develop methodology for enhanced/non-destructive gum production**

Trial was maintained in Kumatia enclosure, Kailana forest area near Jodhpur. Growth data (height and crown diameter) and vegetation status were recorded in Aug-Sep, 2009. Protection measures (application of termiticide and fungicide) were applied in May, 2009. Stem cuttings from plants started dying were taken and planted in the same field, irrigation was applied two three times in summer months. Nearly all the cuttings were sprouted after rains in July, 2009.

Phenological observations were recorded on monthly basis. New leaf appearance occurred in April –May 2009. Plants were lush green after rains in monsoon (July to Sept, 2009) with occasional fruiting. Leaf started yellowing in late October and all the plants were completely leafless and fruit less in Nov., 2009.

Tapping experiments were initiated, in third week of March, 2009. Ethephone doses were modified (0, 100, 200 & 300 mg in place of 0, 150, 300 and 450 mg) and injected at two to three places in a tree, simultaneously. Gum was collected after six days to fifteen days. First gum was collected after six days and subsequently every fifteen days till April, 2009, yield was 4.5 g – 60.5 g /plant) and treatment wise 14.5 g in C1I0 to 107.5 g in C3 I1. So far all the trees are healthy till March, 2010.

In new trial sixteen new plants were selected and were given 5 kg compost and 40 g Zn SO<sub>4</sub>/plant in the month of Sept.–Oct., 2009. Monsoon almost failed during 2009 and protection measures (application of termiticide and fungicide) were followed in the month of October, 2009. Only one irrigation 40 lit / plant was given in first week of Jan., 2010. Growth data (height, crown diameter) were recorded. Flowering was noticed in Jan., 2010 in all the plants with leaf initiation in some plants. Sporadic fruiting was observed in Feb. 2010. Percent moisture in thinner branches (pre-ethephone treated plants) was ranging from 39.5 - 45.5% in various treatments in the month of Jan. 2010. Twigs (Pre & post ethephone treatment in 2009-10) were pulverized and soxhlet extraction with petroleum ether and ethyl acetate was carried out. Tapping experiments were

initiated in first week of March, 2010. Ethephone doses were modified (0, 150, 200 & 250 mg) and injected at one place in a tree, and 2-3 cuts were given after 24 hours. Gum yield obtained so far varied from 5 (0) - 55 g (200 mg) according to the treatment. Gum was collected after six days to fifteen days. So far all the trees are healthy.

### Component III: Scaling-up the tissue culture protocol

Embryogenic callus cultures of *Commiphora wightii* (guggul) were maintained through monthly sub-culturing on modified MS medium (MMS) supplemented with BAP (0.25 mg/l), IBA (0.1 mg/l) and activated charcoal (0.5%). Embryogenic calli was regularly used from the maintained cultures to hormone free MMS medium for embryo maturation. Experiments on synchronization of somatic embryos were carried out through establishment of suspension cultures in liquid MMS medium devoid of activated charcoal for different time durations after which the plating of cell clumps was done on hormone free MMS medium. It was observed that embryo synchronization was observed the best from plated cell clumps after one month in cell suspension cultures. Experiments were also carried out for optimizing maturation of somatic embryos. For this the effect of concentration of ABA (0.5, 2.5, 5.0, 7.5 and 10.0 mg/l) and sucrose (1%, 3%, 6%, 9%, 12% and 15%) were tested on somatic embryos (in late torpedo and early cotyledonary stage) harvested from long term maintained callus cultures and somatic embryos derived from suspension cultures. It was observed that large size matured white somatic embryos were obtained on 7.5 mg/l ABA supplemented medium and also on medium with 9% sucrose. Desiccation (drying) of media for 2 months also resulted in embryo maturation. The matured somatic embryos germinated within 7 days on hormone free MMS medium with a high germination percent (upto 90%). The germinated somatic embryos were passed through *in vitro* and *ex vitro* hardening cycle. Fifty hardened plants of *C. wightii* were obtained and growing well. Fifty more plants are at hardening stage.

## 2.7 Forest Protection

### 2.7.1 Overview

#### 2.7.1.1 Summary of the achievements under the Theme

- Severe infestation of pest (*Achaea janata*) and charcoal root rot disease, caused by *Rhizoctonia bataticola*, have been recorded on mehndi (*Lawsonia inermis*) in Pali and Sojat. Bio-ecology of the pest and pathogenicity of pathogen have been studied in detail.
- Yield of mehndi was high 2.47 kg/m<sup>2</sup> in treated with *Trichoderma* + Vermicompost + Phorate granules as compared to untreated plots (20.0 kg/m<sup>2</sup>).
- Yield of stover and monetary return was also worked out in treated and untreated plots of isabgol and yield was increased to 104.88 kg stover per 25 square meter area as compared to control (76.56 kg Stover/plot).
- Periodical and systematic surveys of *A. nilotica* have been conducted in 17 sites in Rajasthan state and 24 sites in Gujarat state at quarterly intervals. So far, 16 species of insects, 2 species of mites, 3 species of parasitic nematodes and 13 species of diseases have been documented. Severe rust infection was recorded at Tarapur (Ananad).
- Seedlings treated with monocrotophos (0.01%) and kept under canopy in exclusion trials, laid down at Rajasthan and Gujarat, exhibited the best average growth performance in almost all the parameters after a period of 48 weeks. The treatment was found the most

suitable at Gandhinagar and Nadiad sites.

- Host- specificity test for rust fungi, *Revenelia evansii* and two species of mites viz., *Tenuipalpus sp.* and *Olingonychus sp.* against different species of *Acacias* uses worked out. The cross- infectivity and host specificity tests using the seven species of *Acacias* including *A. nilotica var.indica* revealed that the rust as well as mites exhibited strong host specificity.
- Five AMF genera and 11 species of *Glomus* have been recorded in mehndi and ashwagandha.
- The distribution of 11 VAM species and their spore population was studied at 10 sites in Rajasthan.
- In mehndi, *G. fasciculatum* was found the best in plant growth and vigour as compared with other treatments, whereas, in case of ashwagandha indigenous mixed inoculums with dominance of *G. aggregatum* was found the best for all growth parameters.
- Mehndi and ashwagandha were found highly mycorrhizal in nature.

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

## 2.7.2 Insects pests, diseases and control

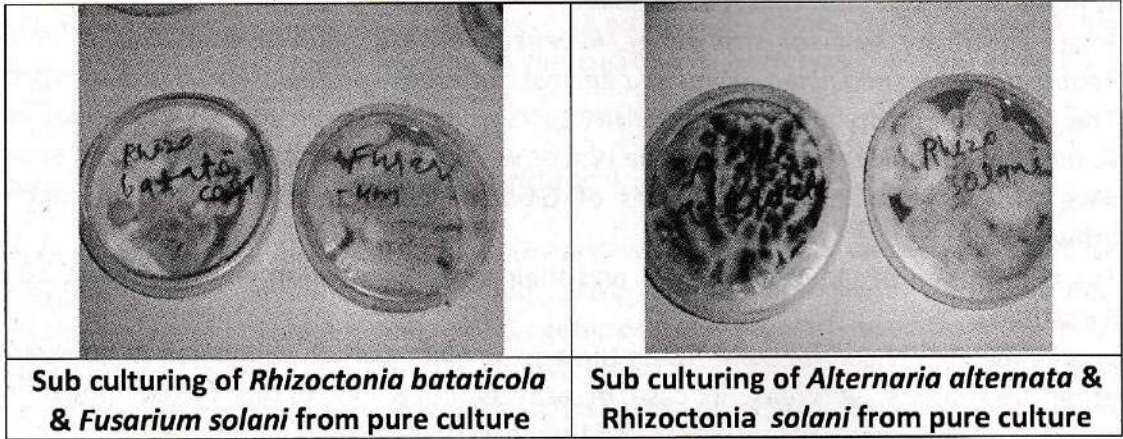
### NEW PROJECTS INITIATED DURING 2009-10 (PLAN)

**Project 1. Evaluation of antifungal potential and identification of broad spectrum antifungal compound from selected tree/shrubs/weeds of Indian arid region (93 AFRI/AFED/2009-14).**

*Principal Investigator : Mrs. Bhawana Sharma*

The samples of *Balanites aegyptica* (root, leaves and bark), *Tephrosia purpurea*(leaves, root, seed), *Citrus colocynthis* (leaves) were collected from vicinity of Jodhpur(Raj.).The samples were shade dried and prepared ethanol and water extract by adopting standard procedure. The extracts were used @50mg /ml/solvent for further studies.The pure culture of the fungal pathogens viz, *Rhizoctonia solani*, *R. bataticola*, *Fusarium solani* and *Alternaria alternata* were procured from Forest Pathology Division, FRI Dehradun. The fungal pathogens were re-cultured periodically in Potato Dextrose Agar (PDA) medium at 25 ± 1° C temperature in BOD incubators. The pure cultures of fungus were kept at 10° temperature C for further studies.

The ethanolic extracts of *Balanites aegyptica*, *Tephrosia purpurea* and *Citrus colocynthis* were tested against *Rhizoctonia solani*, *R. bataticola*, *Fusarium solani* and *Alternaria alternata*. The ethanolic extract of *Citrus colocynthis* (leaves) was found very effective and inhibiting growth of *Fusarium solani*.

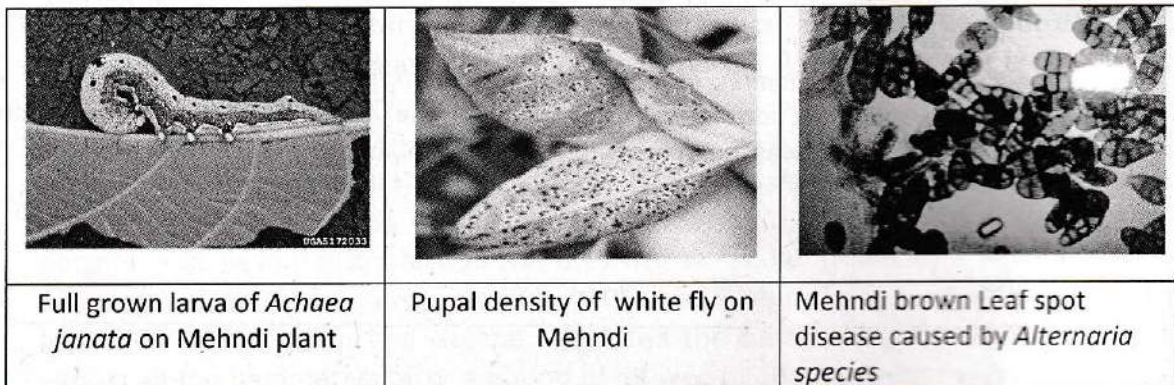


**PROJECTS COMPLETED DURING 2009-10 (PLAN)**

**Project 2. Management of potential insect pests and diseases of important medicinal plants grown in arid and semi-arid regions (AFRI- 72/FP/2010).**

*Principal Investigator: Dr. S. I. Ahmed*

A check-list of five species of insect pests and three species of diseases has been prepared. Severe infestation of *Achaea janata* (Noctuidae), a semilooper has been noticed on all mehndi (*Lawsonia inermis*) growing areas at Sojat road (Pali). Bio-ecology of the key pests viz *Achaea janata* and *Aphid gossypii* have been studied. Charcoal root rot disease caused by *Rhizoctonia bataticola* was found to cause severe damage to mehndi plants with an ultimate loss of mehndi yield at Sojat. Soil treatment (10 g *Trichoderma* + 5-0 kg Vermicompost + 15 g Phorate) and foliar Spray (0.02% Pratirodh) was found to be the best against mehndi defoliator (*Achaea janata*), aphid (*Aphid gossypii*) attack and leaf blight disease. The mean dry weight of the treated plot was recorded 2.47 kg with a net return of Rs.185 per metre<sup>2</sup> plot as compared to untreated control with mean dry weight 2.00 kg and net return of Rs.150/metre<sup>2</sup> plot. Seed treatment using *Trichoderma harzianum* @ 10g/kg seed + soil treatment with *Beauveria bassiana*-1 + Phorate granules was found to be the best against downy mildew and termites in Isabgol. The treated (5m x 5m) plot yielded 104.88 kg stover/plot as compared to untreated 76.56 kg stover/plot with net return of Rs. 3670.80/- and Rs. 2679.60/- per plot, respectively.



### 2.7.3 Mycorrhizae, rhizobia and other useful microbes

#### ONGOING EXTERNALLY AIDED PROJECT

**Project 3. New biocontrol opportunities for prickly acacia: exploration in India (AFRI/FPD/2008-2011).**

*Principal Investigator: Dr. S.I. Ahmed*

The study sites were selected for survey and laying out of exclusion trials in Rajasthan (Jodhpur, Hanumangarh, Bharatpur and Pali) and in Gujarat (Bhuj, Nadiad, Junagarh and Gandhinagar). Regular and random samplings were carried out in different survey sites. Data on temperature, humidity, light intensity, longitude & altitude were recorded in each site. The samples collected during survey were identified. The rust fungus sample collected during survey from Verawal, Tarapur, and Nadiad in Gujarat was identified as *Revenelia evansii*. Two species of mites viz., *Amblyseius alstoniae* and *Pronematus* sp. were collected from Gujarat, while three species of mites pests viz., *Amblyseius alstoniae*, *Tenuipalpus* sp. and *Oligonychus* sp. were collected from Rajasthan. Rust and mites have been prioritised for host-specificity tests for *acacia* seedlings. Data of exclusion trials on plant height, number of shoots, number of leaves per plant, basal stem diameter, root length and total wet weight of seedlings (above ground and below ground) of 12 weeks, 24, 36 and 48 weeks old seedlings of *A. nilotica*, kept under observation for exclusion trials at Jodhpur, Pali, Hanumangarh and Bharatpur (Rajasthan) and Gandhinagar, Nadiad, Junagarh and Bhuj (Gujarat), has been analyzed. Plant parasitic nematode species isolated from dead and dried trees of *A. nilotica* from Ratipar Forest Reserve in Gujarat were identified as *Hoplolaimus indicus*, *Aphelenchus avenae* and *Helicotylenchus* sp. These nematodes were isolated and separated out from the soil samples collected from dried and diseased trees of *A. nilotica* at Ratipar and Bhuj (Gujarat). All the three species were found ecto- semiendo- and endoparasitic in nature, which feed mainly on cortical tissues. In seedlings, neither necrosis nor stunting of root has been observed at Bhuj (Gujarat).

#### PROJECTS COMPLETED DURING 2009-10 (PLAN)

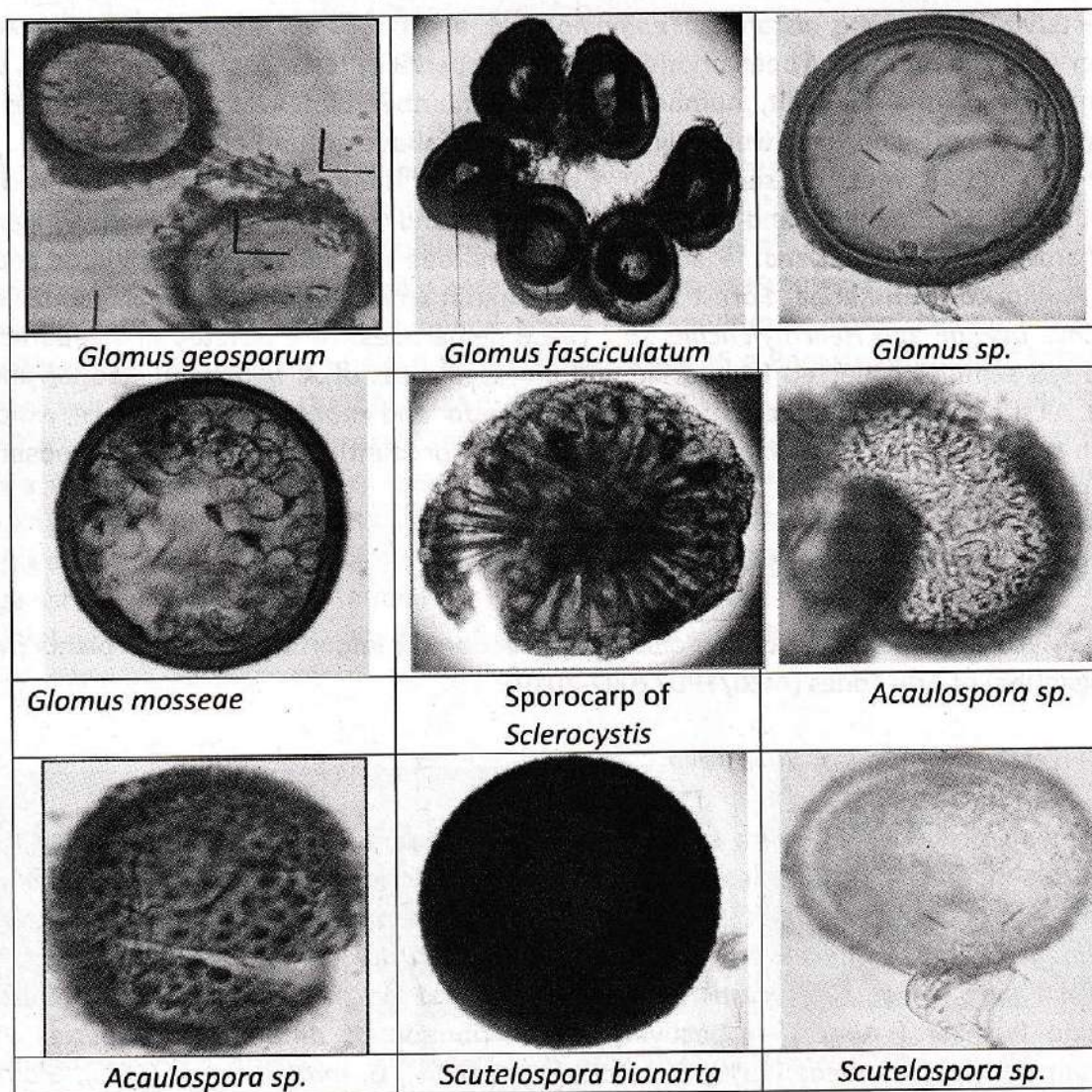
**Project 4. Mycorrhizal dependency & productivity of economic important medicinal plants (Mehndi & Ashwagandha) of Arid Zones (AFRI/FPD/2007-2010).**

*Principal Investigator : Dr. K.K. Srivastava*

In mehndi, five AMF genera such as *Glomus*, *Gigaspora*, *Scutellospora*, *Sclerocystis* and *Acaulospora* and among the species of *Glomus* viz., *G. fasciculatum*, *G. aggregatum*, *G. mosseae*, *G. macrocarpum*, *G. microcarpum*, *G. intraradices*, *G. reticulatum*, *G. constrictum*, *G. multicaulae*, *G. geosporum* and *G. convolvulus* were recorded. *Glomus multicaulae*, first time reported on mehndi from Pushkar and Ajmer. *Sclerocystis indica* was recorded on mehndi and ashwagandha from Nagaur and Pushkar (Ajmer), respectively. The distribution of different AM species viz., *G. aggregatum* (35%), *G. mosseae* (15%), *G. fasciculatum* (20%), *G. macrocarpum* (10%), *Glomus* sp. (15%), *Scutellospora* (3%) and *Acaulospora* (2%) were recorded in ashwagandha, whereas, in mehndi, distribution of AM fungi recorded as *G. fasciculatum* (55%), *G. aggregatum* (20%), *G.*

*macrocarpum* (12%), *Glomus* sp. (8%), *Acaulospora* (5%), *Scutellospora* (3%) and *Sclerocystis* (2%) with the dominance of *G. fasciculatum*. The maximum root infection was recorded (85%) from Sojat (Pali) and minimum (46%) from Pushkar, Ajmer. While in, ashwagandha maximum root colonization (78%) was recorded from Harima Krihifarm (Nagaur) and minimum (34%) from Ajmer. Root infection was recorded 54 per cent, while, AM spores were found 210/100 gm soil. Both the species viz mehndi and ashwagandha were found highly mycorrhizal in nature. The root infection was found in the form of intercellular, intracellular hyphae, vesicles and arbuscular structures in the roots. In VAM inoculation experiments, the maximum (53.6cms) shoot length was recorded in seedlings inoculated with pure culture of *G. fasciculatum*. However, all the treatments were found effective in all parameters i.e., enhancing shoot height, basal stem diameter, number of spores/10gm of soil and percentage of infection in mehndi, whereas, in case of ashwagandha, the maximum shoot height, basal stem diameter was 70.5 cms and 10.5 mm, respectively in seedlings inoculated with consortium inoculums with dominance of *G. aggregatum*. No. of spores/10gm of soil and percentage of infection were also recorded high as compare to other treatments.

#### AM Spores collected from Mehndi & Ashwagandha





### 3. Education Visits / Activities

1. Dr. Neelam Verma attended training on "*Identification and uses of Mycorrhiza in Forestry*", from 26<sup>th</sup> May to 05<sup>th</sup> June, 2009 at Dept. of Microbiology, Tamil Nadu Agriculture University, Coimbatore (Sponsored by ICFRE).
2. Dr. K.K.Srivastava imparted training on VAM technology from 7/09/09 to 9/09/09 to forest officials, progressive farmers under VVK project at Gandhinagar, Gujarat
3. Faculty and IX standard students of St. Austen's Sr. Secondary School, Jodhpur, Rajasthan visited AFRI on 3rd November 2009 and were shown different laboratories and the experimental fields.
4. Faculty & Deputy Rangers from Forest Training Institute Sundernagar, Himachal Pradesh visited AFRI on 12.11.2009. They were taken to the laboratories, experimental fields and explained about the research activities carried out by AFRI.
5. Faculty and M.Sc. students from Department of Geology, Mohanlal Sukhadia University, Udaipur, Rajasthan visited AFRI on 19.11.2009. They were explained about research activities of AFRI.
6. Dr. Neelam Verma attended specialized training on "*Isolation, Identification and Preservation of fungi*" at Forest Pathology Division, FRI, Dehradun from 18-23 January, 2010 (Sponsored by ICFRE).
7. B.Sc. Forestry students from G.B. Pant University of Agriculture & Technology, Hill Campus, Ranichauri, Teri Garwal, Uttaranchal visited AFRI on 20.1.2010 and were explained about the research activities of AFRI.
8. A team of 160 students and 20 members of Air Force Wives Welfare Association (AFWWA), Jodhpur, Rajasthan visited AFRI on 27.1.2010. A lecture on the research activities of AFRI was given and also visited to nursery and research fields.
9. A team of 30 District Development Managers, National Bank for Agriculture and Rural Development (NABARD), Rajasthan visited AFRI on 11.2.2010 and a lecture on research activities of AFRI was delivered .
10. 50 students of final semester along with four lecturers from Ashok & Rita Patel Institute of Integrated Study & Research in Biotechnology and Allied Sciences, Anand, Gujarat visited AFRI on 23.2.2010. A lecture on forestry research carried out by AFRI was given and visited biotechnology labs and experimental fields.
11. A group of 10 students (M.Sc. & M.Phil) from School of studies in Botany, Vikram University, Ujjain, Madhya Pradesh visited on 31.3.2010. They visited various research laboratories, experimental fields and they were explained about the research activities carried out by AFRI.

### 3.1 FRI University (Applicable for FRI, Dehradun only )

### 3.2 Trainings Organized

- One week training course was organized for farmers and Field functionaries on Bamboo at Rajpipla, Gujarat under National Bamboo Mission from 5-10-09 to 09-10-09. Total 23 nos of trainees (07 farmers and 16 Forest Field staff) attended the training programme. They visited bamboo plantation of Zankhavav Central Nursery, Wankol range, bamboo plantation raised through JFM in Bistalia village, Mandvi North Range, Rajpipla (W) division, Bambusetum, Singalkhanch, Ukai range, Silva division, Rajpipla and JK Paper Mill, Songarh, Bayara forest division, bamboo plantation on progressive farmer field at Piplod village, Piplod range and Interpretation Centre of Shoolpaneshwar Sanctuary, Rajpipla (E) division, Kavadia colony, Rajpipla. The technical lecture sessions were also arranged at GFRC, Rajpipla for participants.
- One week training course was organized for farmers and field functionaries on Bamboo at Kota, Rajasthan under National Bamboo Mission from 26-10-09 to 29-10-09. Total thirty two trainees (13 farmers and 19 Forest Field staff) attended the training programme. They also were taken to Jawahar Sagar natural bamboo growing Forest area around Chambal river, Darra N P, Kota, to field nurseries (Jhir) and bamboo plantations in Jhalawar District. The technical lecture sessions were also arranged for participants.
- Forty two farmers and field functionaries trained under VVK during 27-29<sup>th</sup> Nov, 2009 by a training organized at Gujarat Forest Research Institute, Gandhinagar.
- One week compulsory training of IFS Officers on "Integrated Approach for sustainable Development of Fragile Desert Ecosystem" sponsored by Ministry of Environment & Forests, Govt. of India, New Delhi, was organized by this Institute from 14-18, December, 2009 in which 31 IFS officers attended the course.
- Three day training for farmers and field functionaries was conducted from 13 to 15 Feb. 2010 under VVK (Rajasthan) at Kisan Bhawan Bikaner, Rajasthan. Total 82 participants (36 Farmers and 46 Forest Field Staff) from various villages/ranges/division attended this training programme. Both class room lectures and field visit were arranged in this training programme.

### 3.3 Visits Abroad

Dr. N.K. Bohra visited Copenhagen, Denmark to attend "The Copenhagen Climate Exchange 2009" conference and presented paper "Climate change and its effect in arid zone of Rajasthan" in 3rd-6th December 2009.

### 3.4 Participation in Seminars/Symposia/ Workshops/Trainings

1. Bhawana Sharma and Dr. Neelam Verma, attended ten days Specialized training on Identification and use of mycorrhizal fungi in forestry organized by TAN University at

Coimbatore during 26.5.2009 to 4.6.2009.

2. Dr. Bilas Singh, Research Officer, attended "Two days Sensitization workshop on common guidelines" on 25-26th June 2009, Jodhpur and discussed about Role of Research organization/SAUs/NGO in watershed implementation with innovations, Govt of Rajasthan
3. Dr. T.S. Rathore attended and participated in consultative workshop on "Development of Criteria and Indicators for Sustainable NTFP Management", jointly organized by the AFRI, Jodhpur and IIFM, Bhopal on 29th August, 2009.
4. Dr U.K. Tomar, Scientist E attended and participated in the Workshop for preparation of a Definition Directory of Hindi Terminology Held at Udaipur from September 22 to 26, 2009.
5. Dr. Tarun Kant, Scientist D attended and participated in National Seminar on Emerging Trends in Biotechnology organized by Jodhpur National University on 1st October 2009.
6. Dr. G. Singh, Scientist E attended one week training on 'Carbon sequestration' at ICFRE, Dehradun, 5-9 October 2009.
7. Dr. T.S. Rathore attended and participated in workshop for the preparation of state environment policy for Rajasthan at Jodhpur on 27th October 2009.
8. Dr U.K. Tomar, Scientist E attended and participated in Workshop on Statistical Application in Biotechnology at Dayalbagh Educational Institute Agra from October 30-31, 2009.
9. Dr. G. Singh, Scientist E attended one Capacity building programme on 'Technology Diplomacy' organized by Consumer Unity and Trust Society (CUTS) at Jaipur, 2-6 November 2009.
10. Dr. Tarun Kant and Shri A. K. Sinha attended E-campions workshop held at ICFRE, Dehradun from 2 to 7 November, 2009.
11. Dr. N.K.Bohra participated in International Conference on Nurturing Arid Zones for People and the Environment: Issue and Agenda for the 21<sup>st</sup> century held at CAZRI from 24-28 November 2009.
12. Dr. Neelam Verma attended and participated in International Conference on Nurturing arid zones for people and the environment: Issues and Agenda for the 21st Century held at CAZRI, Jodhpur on 24-28 November, 09.
13. Dr. Meeta Sharma attended and participated in International conference on Nurturing Arid Zones for people and the Environment Issues and Agenda for the 21st Century at CAZRI, Jodhpur, from 24-28 November, 09.
14. Dr. T.S. Rathore attended and participated in National Conference on "Renewable energy and trade show" on November 6th, 2009 at Vyas Institute of Engineers and Technology, Jodhpur.
15. Dr.T.S. Rathore attended and participated in the International Conference on "Nurturing Arid Zone for People and the Environment: Issues and Agenda for the 21st Century" held at CAZRI, Jodhpur from November 24-28th, 2009.
16. Dr. Abha Rani and Dr. Mala Rathore attended and participated in 24th Carbohydrate conference, industrial polysaccharides & biological significance of carbohydrates from 7-9 December, 2009 at Lachoo Memorial College of Science & Technology, Jodhpur organized by ACC&T(India) and IGGMA, Jodhpur.
17. Dr. G. Singh, Scientist E attended a six days training programme on 'Dendroclimatology' from 7-17 December 2009, at IITM, Pune.
18. Dr U.K. Tomar, Scientist E attended and participated two days workshop on "Designing green landscape to provide multiple services" at IWST Bangalore from January 4-8, 2010.
19. Mrs. Bhawana Sharma and Dr. Neelam Verma attended a training on "Isolation,

Identification and Preservation of Fungi" at Forest Pathology Division, FRI, Dehradun from 18-23 January 2010.

20. डा. नीलम वर्मा ने वन पौधशालाओं में लगने वाले रोग तथा उनके उपचार, राजभाषा वैज्ञानिक संगोष्ठी, रक्षा प्रयोगशाला, जोधपुर में 18-19 फरवरी 2010 को आयोजित कार्यक्रम में भाग लिया।
21. T.S. Rathore attended and participated in workshop on "Environment protection and concern laws" on 6th March, 2010 at Jodhpur.
22. Dr U.K. Tomar, Scientist E attended national seminar on "Productivity enhancement & value edition of bamboos" held on March 9-10, 2010 at Institute of Forest Productivity, Ranchi.
23. Dr. T.S. Rathore attended and participated in seminar on "Water quality management" organized by the Marwar Engineering College and Research Centre, Jodhpur on 21st March 2010.

#### 4. Extension Panorama/Activities

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

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

##### VVK Bikaner, Rajasthan

A couple of the meetings held by AFRI officials with PCCF, RFD, Jaipur, CCF (IGNP), Bikaner, DCF, Division-I, IGNP area Bikaner and DCF, Mohangarh, IGNP area, Jaisalmer and CF, Jodhpur, Rajasthan Forest Department (Rajasthan). Hi-tech nursery upgradation/ renovation works were taken up at Bichhawal, Bikaner & satellite nursery, Mohangarh, Jaisalmer. Old Agroshed house renewed at Bichhawal nursery, Bikaner (02 Nos) and satellite nursery Mohangarh, Jaisalmer (02 Nos). Poly house (mist chamber) renewed at the nursery of Bichhawal, Bikaner (01Set) and Mohangarh, Jaisalmer (01 set). Old root trainer stands (1200 nos) were repaired (cleaning, welding and painting). One compost chamber (permanent structure) was constructed at Bichhawal, Bikaner.

Farmers and field functionaries (82 nos) training was organized during 13-15th Feb., 2010 at Kishan Bhawan, Bikaner. Display photo panels in both Hindi & English languages prepared. High quality seedlings (10000 nos) of *Prosopis cineraria* (khejri) were raised at Hi-Tech nursery, Bichhawal, Bikaner for farmers/stakeholders.



Training of Farmers & field functionaries at Kisan Bhawan, Bikaner



Renovated Polyhouse at Hi-Tech nursery Bikaner

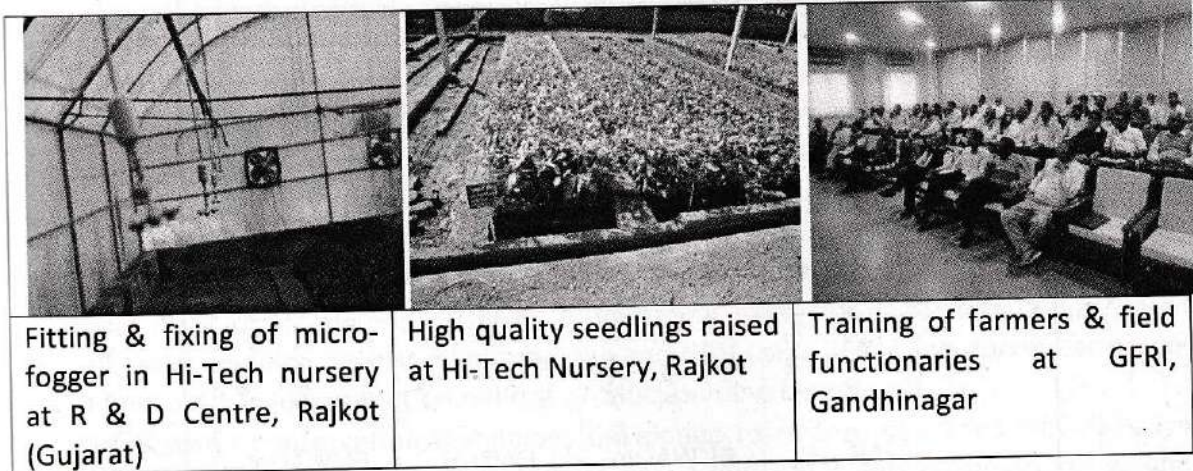


Agronet house after renovation at VVK Satellite nursery, Mohangarh

### VVK Rajkot, Gujarat

Meetings were also organized with CCF (Research) and DCF (Research) and Nodal Officer (VVK) Gujarat Forest Department for research demonstration, renovation of Hi-Tech nursery, raising high quality seedlings and training programme. Hi-Tech nursery upgradation/ renovation works under VVK were taken up at R & D Centre of GFD, Gujarat, Rajkot. Complete sprinkler system set, four way fogger (24 Nos) etc were fixed and the Agroshed house and mist chamber strengthen. UV Film of germination chamber was replaced and green net cover (300 sq meters) also provided for repairing/strengthening. Root trainer, micro fogger, iron root trainer stands and germination chamber stand, garden nylon pipe, nursery tools kit etc procured & supplied to strengthen the Hi-Tech nursery, VVK Rajkot.

Forty two farmers and field functionaries trained under VVK during 27-29<sup>th</sup> Nov, 2009 by a training organized at Gujarat Forest Research Institute, Gandhinagar. Audio-visual instrument i.e. Digital Camera and training material procured. Photo panel material in both Hindi and English languages prepared and supplied for display at VVK site, Rajkot. High quality of 5000 seedling of ten tree species raised at the Hi-Tech nursery, VVK Rajkot for stakeholders.



Fitting & fixing of micro-fogger in Hi-Tech nursery at R & D Centre, Rajkot (Gujarat)

High quality seedlings raised at Hi-Tech Nursery, Rajkot

Training of farmers & field functionaries at GFRI, Gandhinagar

### VVK Khanwel, Silvassa (Dadra & Nagar Haveli, UT)

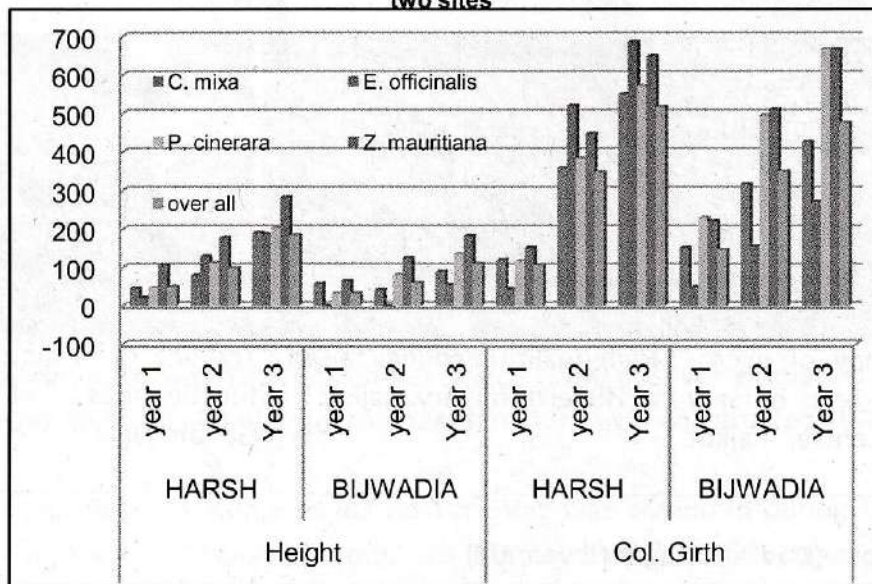
Meetings were also organized with Dadra & Nagar Haveli FD for establishment of a VVK at Silvassa. Display boards (20 Nos) in both Gujarati & English languages prepared for VVK Silvassa. Training material procured for the VVK training. Draft MOU of VVK, Khanwell, Silvassa has not been approved till date by the Law Department of DNH. Therefore, FD, DNH has not permitted AFRI to take up any activities of VVK at Khanwel, Silvassa. Matter of signing of MOU with DNH Authority is still under process.

### STATUS OF DEMO VILLAGE

During 2007 two farmers namely Mrs. Sita Chaudhary, Bijwadia village and Mr. Rajendra Singh Chaudhary, Harsh village were identified and their fields were selected to establish agro-horti-silvi model experiments. Farmers were asked for their preference of the species to be planted on their farmlands.

Accordingly MOUs were signed and preparation of land for plantation and other formalities were initiated. Trials were established in August, 2007. Four tree species namely; *Prosopis cineraria*, *Emblica officinalis*, *Zizyphus mauritiana* and *Cordia mixa* were planted individually and in combination with each other. The demonstration was laid in randomized block design in three replications. There were ten treatment combinations and one plot for crop alone as control. Trees were planted at 6 m x 6 m spacing. Trials were maintained by farmers with technical and financial help of AFRI. In Mrs. Sita Chaudhary's field total 900 seedlings were planted covering an area of 3.24 ha, whereas in Mr. Rajendra Singh Chaudhary's field a total of 1080 seedlings were planted covering an area of 3.24 ha. Initial irrigation and annual weedings were done by the Institute. Data on survival and growth were recorded every six month interval. Crop yield was also recorded. Initial survival at both the sites at three month was 90%. After one year the survival was 55 and 58%, respectively, but it was 30 and 41 percent at second year. In both the trials, *Zizyphus mauritiana* and *Prosopis cineraria* showed better growth as indicated by percent increase in height and collar diameter over initial level (Fig 1). *Zizyphus mauritiana* and *Prosopis cineraria* maintained better growth. The overall survival was 40% and 30%, respectively followed by *Cordia mixa* and *Emblica officinalis*. *Emblica officinalis* also exhibited poorest survival.





Fig 1. Growth of different species in percent over initial growth at two sites



Overview of model plantation after planting



Overview of model plantation after one year showing cultivation of crop

	
Overview of plantation at Smt. Sitadevi Chaudhary's field (2009)	Overview of plantation at Shri R. Chaudhary's field (2009)
	
Director AFRI and other officers in discussion with farmer Shri R. Chaudhary	<i>Prosopis cineraria</i> in model plantation (3 years old)

#### 4.2 Technology developed

- Annual litter production in *Eucalyptus* plantation along Indira Gandhi Nahar Pariyojana (IGNP) was modeled against plantation age and GBH using linear and non linear procedures and best models for estimation of litter production developed.
- Soil and water conservation technology developed to restore degraded hills of Aravalli by adapting and evaluating different gradient based rain water harvesting structures and tree plantation.

#### 4.3 Research Publications

##### A. Research Papers in Scientific Journals

1. Abha Rani, P. H. Chawhaan and Mala Rathore (2009). Availability, physical characteristics, harvesting and processing of bael (*Aegle marmelose*) fruit in Chhattisgarh forest. *Green Farming* 2(7): 465-468.
2. Abha Rani, P.H.Chawhan and Mala Rathore (2009). Sustainable harvesting of Nagarmotha (*Cyprus scariosus* R.Br.). *Indian Forester* 135 (11): 1579-1584.
3. D. Kumar and D. K. Mishra (2009). Influence of chemicals pre-treatment on germination and seedlings performance of fresh and stored Neem (*Azadirachta indica* A. Juss.) seed. *Annals of Forestry* 17 (2): 168-176.
4. D. Annapurna and T.S. Rathore (2010). Micropropagation of *Embilica ribes* Burn F.

- through proliferation of adult plant through axillary shoots. *In Vitro Cell. Dev. Biol. – Plant* 46: 180-189.
5. D. Annapurna and T.S. Rathore (2010). Direct adventitious shoot induction and plant regeneration of *Embilica ribes* Burn F. *Plant Cell Tissue and Organ Culture* 101:269-277.
  6. G. Singh (2009). Comparative productivity of *Prosopis cineraria* and *Tecomella undulata* based agroforestry systems in degraded lands of Indian Desert. *Journal of Forestry Research* 20(2): 144-150.
  7. G. Singh (2009). Performance of seed sown seedlings in rehabilitation of degraded hills of Aravalli under resource management. *Wasteland News* 24(1): 48-51.
  8. G. Singh (2009). Soil water dynamics, growth of *Dendrocalamus strictus* and herbage productivity influenced by rainwater harvesting in Aravalli hills of Rajasthan. *Forest Ecology and Management* 258: 2519-2528.
  9. G. Singh and B. Singh (2009). Effect of varying soil water stress regimes on nutrient uptake and biomass production in *Dalbergia sissoo* seedlings in Indian desert. *Journal of Forestry Research* 20(4): 307-313.
  10. G. Singh, N. Bala and Thanaram Rathod (2009). Utilization of industrial effluent for raising *Azadirachta indica* A. Juss seedlings in Indian Desert. *Journal of Environmental Engineering and Landscape Management* 17(3): 171-180.
  11. G. Singh (2010). Rainfall dependent competition affected productivity of *V. radiata* in *Hardwickia binata* agroforestry in Indian desert. *Indian Forester*, 136(3): 301-315.
  12. I. D. Arya, S. Sharma, S. Chauhan and S. Arya (2009). Micropropagation of superior eucalyptus hybrids FRI-5 (*Eucalyptus camaldulensis* Dehn x *E. tereticornis* Sm) and FRI-14 (*Eucalyptus torelliana* F.V. Muell x *E. Citrodera* hook): A commercial multiplication and field evaluation. *African Journal of Biotechnology* 8 (21): 5718-5726.
  13. D. K. Mishra (2009). Selection of candidate plus phenotypes of *Jatropha curcas* L. using method of pair comparisons. *Biomass & Bioenergy* 33: 542-544.
  14. D. K. Mishra and D. Kumar (2009). Development of suitable agronomic practices for important medicinal plants under irrigated and rainfed conditions in Rajasthan. *Indian Forester* 135(8): 1088-1098.
  15. D. Kumar and D. K. Mishra (2009). Influence of morphologically superior and inferior trees on germination, storability and seedling performance of neem (*Azadirachta indica* A. Juss.) seed. *Indian Forester* 135(5): 697-706.
  16. Mala Rathore (2009). Nutrient content of important fruit trees from arid zone of Rajasthan. *Journal of Horticulture and Forestry* 1(7): 103-108.
  17. N. Bala, Pramod Kumar, N. K. Bohra, N. K. Limba, S. R. Baloch and G. Singh (2009). Production and decomposition of litter in plantation forests of *Eucalyptus camaldulensis* along canal command area in Indian desert. *Indian Forester* 136(2): 163-172.
  18. Narayanan, P. H. Chawhaan and A. K. Mandal (2009). Inheritance pattern of growth and wood traits in teak (*Tectona grandis* L.f.). *Silvae Genetica* 58 (3): 97-101.
  19. Neelam Verma, J.C. Tarafdar and K.K. Srivastava (2010). Periodic changes in *Prosopis cineraria* associated AM population at different soil depth and its relationship with



- organic carbon and soil moisture. *African Journal of Microbiology Research* 4 (1): 115-121.
20. Neelam Verma, J.C. Tarafdar and K.K. Srivastava (2010). Role of Arbuscular Mycorrhiza strains on biomass production and P, Cu, Zn uptake in *Prosopis cineraria*. *Indian Forester* 136 (2): 205-214.
  21. P. Chaudhry and V.P.Tewari (2010). Environmental education using Nek Chand's rock garden in the city of Chandigarh. *International Journal of Environment and Sustainable Development* 9(1/2/3): 30-36.
  22. P. Chaudhry and V.P.Tewari (2010). Managing urban parks and gardens in developing countries: a case from an Indian city. *International journal of Leisure and Tourism Marketing* 1(3): 248-256.
  23. P. Chaudhry and V.P.Tewari (2010). Role of public parks/gardens in attracting domestic tourists: an example from CITY BEAUTIFUL of India. *Tourismos* 5(1): 101-109.
  24. Parveen and U. K. Tomar (2009). *In vitro* high frequency of adventitious shoot regeneration from hypocotyls segment of *Ailanthus excelsa* Roxb. *Annals of Forestry* 17: 21-26.
  25. Ranjana Arya (2009). Performance of *Atriplex spp* on various soil structures on arid salt affected soil in Rajasthan. *Current Agriculture*: 33, 1-7.
  26. S. Arya, N. Rathi and I. D. Arya (2009). Micropropagation protocol for *Glycyrrhiza glabra* L. *Phytomorphology* 59 (1&2): 71-76.
  27. S. Sharma, I. D. Arya and S. Arya (2009). Field evaluation of multilocation trials of micropropagated interspecific F1 *Eucalyptus hybrids* FRI-5 and FRI-14 in Uttarakhand state. *Ind. J. Bot. Soc.* 88(1&2): 128-133.
  28. S.K. Sharma, S. Chauhan, B. Kaur and I.D. Arya (2009). Opportunities and major constraints in Agroforestry systems of Western U.P: A vital role of Star Paper Mills, Saharanpur (UP) *Agriculture and Biology Journal of North America* 1(3): 343-349.
  29. Sharma, S., Rathi, N. Nautiyal, S. and Arya, I.D. (2010). Micropropagation studies on important forest trees of high importance: an effort for large scale commercial multiplication and their field plantation. In: *Acta Hort. (ISHS)* 865: 255-264.
  30. S. Viswanath, Dhaniya, B. and T. S. Rathore (2009). Domestication of sandal (*Santalum album* L.) in India : Constraints and prospects. *Asia-Pacific Agforestry News Letter* 30:9-12.
  31. V.S. Gour and Tarun Kant (2010). *In vitro* regeneration in *Embllica officinalis* from juvenile root-derived callus. *J. Indian Bot. Soc.* 89(1&2): 1-3.
  32. Vineeta Shrivastava and Tarun Kant (2010). Micropropagation of *Pongamia pinnata* (L.) Pierre - A native Indian biodiesel tree from cotyledonary node. *Int. J. Biotech. Biochem.* 6(4): 555-560.
  33. Y. Mishra, G. Usmani and P. H. Chawhan (2010). Propagation of *Tinospora cordifolia* (willd) Miers Ex.Hook. F. and Thoms through mature vine cuttings and their field performance. *Indian Forester* 136(1): 88-94.

**B. Book/Chapters in Books:**

1. Dantu P. Kumar and U. K. Tomar (2010). Somatic Embryogenesis. In: Cellular and Biochemical Science, G. Tripathi (ed.), pp. 892-908.
2. G. Singh and N.Bala (2010). Eucalyptus and the environmental impacts: realities behind controversy. In: Eucalyptus and water consumption, ICFRE, Dehradun, S. Tripathi, M.P. Singh, S. Nautiyal, B.M. Dimri and D. Kumar (eds.), pp 61-79.
3. G. Tripathi, B. M. Sharma, J. Shasmal and U. K. Tomar (2010). Transposable elements. In: Cellular and Biochemical Science, G. Tripathi (ed.), pp. 455-475.
4. I. D. Arya, R. Sharma, S. Chauhan and S. Arya (2009). Tissue culture studies on Bamboos. In: Plant tissue culture and Molecular marker, I.K.International publishing House Pvt. Ltd. New Delhi, Kumar, A. and Shekhawat, N.S. (eds.), pp 187-210.
5. M.P. Singh, Satya Vir, Nisha Patel, S.Lodha, R.R. Bhansali, Arun Kumar, R.S.Tripathi, B.K. Soni, R.K. Kaul, Raj Singh, T.S. Rajpurohit, B.S. Rathore, S.I. Ahmed, K.K. Srivastava, Meeta Sharma, Neelam Verma and Sangeeta Singh (2009). Management of pests, diseases and weeds in arid production systems. In Trends in Arid Zone Research in India, Amal Kar, B.K. Garg, M.P. Singh and S. Kathju (eds.), Central Arid Zone Research Institute, Jodhpur, pp. 411-457.
6. S. Arya, R. Satsangi, A. Kant, R. N. Pandey, S. K. S. Chauhan, S. Sharma, and I. D. Arya (2009). Micropropagation and large scale plant regeneration of edible bamboo *Dendrocalamus asper* through somatic embryogenesis. In: Plant tissue culture and molecule markers: Their role in imporving crop productivity. Kumar, A. and Shekhawat, N.S. (eds.), I.K. International Publishing House Pvt.Ltd. New Delhi, pp.233-246.
7. S. Kumar, G. Singh, P.J. Parmar, R.P. Pandey, S.C. Sharma, S. Surndermoorthy, J.P. Singh, Pawan Kasera, Chandan Singh Purohit and D.N. Sen (2009). Plant diversity conservation for sustainability. In Trends in arid zone research in Indi. Amal Kar, B.K. Garg, M.P. Singh and S. Kathju (eds.), Central Arid Zone Research Institute, Jodhpur, pp. 151-179.
8. S.I. Ahmed and K.K. Srivastava (2009). Role of forest protection research in the extension activities. In: Forestry research extension & strategies, C.S. Dange and Seema Kumar (eds.), Published by Scientific Publisher, Jodhpur, pp 220-233.
9. Tarun Kant (2009). Genetic Engineering: An Overview. In: Biotechnological techniques and its application. P.C. Trivedi (ed.), Pointer Publishers, India. pp. 14 – 33.
10. U. K. Tomar and Dantu P. Kumar (2010). Protoplast culture and somatic hybridization. In: Cellular and Biochemical Science, G. Tripathi (ed.), pp 876-891.

### C. Papers Published in Proceedings

1. A. Kant, S. Arya, and I. D. Arya (2009). Micropropagation protocol for *Melocanna baccifera* using nodal explants from mature clump. In: 8<sup>th</sup> World Bamboo Congress Proceedings. 6: 2-12.
2. I. D. Arya and S. Arya (2009). Propagation of Bamboos through tissue culture technology and field plantation. In: 8<sup>th</sup> World Bamboo Congress Proceedings 6: 131-143.
3. S. Arya, B. Kaur and I. D. Arya (2009). Micropropagation of economically important bamboo *Dendrocalamus hamiltonii* through axillary bud and seed culture. In: 8<sup>th</sup> World Bamboo Congress Proceedings 6: 122-130.
4. T. S. Rathore, U. Kabade, M.R. Jagdish, P.V. Somashekhar and S.Vishwanath (2009). Micropropagation and evaluation of growth performance of the selected industrially important bamboo species in Southern India. In: 8th World Bamboo Congress Proceeding, 16-19 Sept. 6: 41-55.

### D. Abstract in Seminar/Symposia

1. Abha Rani and P. H. Chawhaan (2009). Sustainable harvesting of medicinal plants *Curcuma angustifolia* Roxb. In: IV National Forestry Conference held at FRI, Dehradun 9-11 November, p 108.
2. Abha Rani and P. H. Chawhan (2009). Sustainable harvesting of medicinal plant- *Curcuma angustifolia* Roxb. In: IV National Forestry Conference, 9th to 11th November, Forest Research Institute Dehradun, p 108.
3. Abha Rani, Mala Rathore and P. H. Chawhan (2009 ). X-ray diffraction studies on starches of forest origin. In: CARBO-XXIV, 24th Carbohydrate Conference, Industrial Polysacharides & Biological Significance of Carbohydrates, 7-9 December, 2009, held at Lachoo Memorial College of Science & Technology, Jodhpur; ACC&T(India) and IGGMA, Jodhpur, pp 11-12.
4. Abha Rani, Mala Rathore and P. H. Chawhaan (2010). Nutritional value of shoots of *Dendrocalamus strictus*. In: National Seminar on productivity enhancement and value addition of bamboos, at IFP, Ranchi, 9-10 March. p 67.
5. Bhawana Sharma, K. K. Srivastva, Neelam Verma (2009). Mycorrhizal fungi : An important tool for degraded land reclamation In Abstract book on National workshop on Rehabilitation of Degraded lands, sponsored by ICFRE, Dehradun and DST (Department of Science and Technology), New Delhi Organized by Centre for Social Forestry and Eco-Rehabilitation, Allahabad on 6-7 October, 2009, p.46.
6. D. K. Mishra and N. K. Bohra (2009) Establishment of seed production areas (SPA) of *Acacia nilotica* var. *indica* in Rajasthan. In: International conference on Nurturing Arid Zones for People and the Environment: Issue and Agenda for the 21<sup>st</sup> century held at CAZRI from 24-28 November, p 152.
7. D. K. Mishra, A. Tripathi, and A. Ram (2009). Performance of *Commiphora wightii* (Arn.) Bhandari under arid environment. In: IV National Forestry Conference held at FRI, Dehradun, 9-11 December, p 31.

8. D. K. Mishra, J. K. Shukla and R.L. Suara (2009). Growth performance of *Jatropha curcas* under arid environment. In: IV National Forestry Conference held at FRI, Dehradun 9-11 December, p 32.
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#### 4.4 Seminar/Symposia/Workshop Organized

1. A one day Consultative Workshop on 'Development of criteria & indicators for sustainable NTFP management was jointly organized by AFRI and Indian Institute of Forest Management, Bhopal on 29<sup>th</sup> August, 2009, at AFRI, Jodhpur. The main objective of the workshop was to provide a forum for linking various agencies, institutions and stakeholders dealing with dry and arid NTFP species and their ecological systems and to share experiences and knowledge, related to the development of C & I. The meeting was presided by the chief guest Mr. A.K. Singh, PCCF, MD, CGMFP Federation, Raipur, Chattisgarh, and the distinguished guest, Dr. Ram Prasad, Chairman of steering committee and former PCCF, M.P. Dr T.S. Rathore, Director, AFRI, welcomed the delegates and gave his introductory remarks. Dr H. S. Singh, CCF & MD GSFDC, Vadodara, Gujarat, gave overview of NTFP in Gujarat. Objectives and the relevance of the workshop were highlighted by Prof. P. Bhattacharya, workshop Convener & Member Secretary, IIFM, Bhopal. The representatives of AFRI, CAZRI, JNV University, National Ayurveda University, Botanical Survey of India, State forest department, Scientists from Jodhpur, progressive farmers, NGO's- Taal Chhappar Livelihood Project, Churu, Seva- Ahemdabad, Mehsana, Patan, GEER Foundation, Gujarat, Seva Mandir, Udaipur, Samarthak Samiti, Udaipur. Actively participated in the workshop. In the first session presentations on dry zone NTFP's their characteristics, ecological dimensions and prioritized species, sustainable management of NTFP's, etc. were discussed. During second session group discussions were held on C & I framework for NTFP's with special emphasis for their development for dry zone on Ecological and biological aspect, Meeting ended with concluding remarks by the chairperson.
2. A one day Brain storming workshop on Khejari (*Prosopis cineraria*) mortality was organized at AFRI, Jodhpur on 16<sup>th</sup> Nov, 2009. Dr A.S.Faroda, Ex Vice Chancellor Maharana Pratap Agriculture and Technical University, Udaipur chaired the one day workshop. Scientists/officers from scientific institutes like ; AFRI, CAZRI, Jodhpur, Agricultural research stations at Mandore, Fatehpur and Jalore, ZSI, Jodhpur, Ground water board, Jodhpur. Forest Department, Jodhpur and progressive farmers Sikar, nagure and Barmer attended the workshop. A coordinated research project on integrated approach to tackle the problem of Khejari mortality in Rajasthan was prepared based on inputs received from this workshop.

#### 4.5 Consultancies

Under the consultancy project entitled "Identification of mycorrhizal and rhizobial association, establishing gene bank and technology transfer to farmers in field" supported by the SFD Gujarat, imparted training to SFD Gujarat, established biofertilizer laboratory and trained manpower for isolation, multiplication and identification of biofertilizer strains.

#### 4.6 Technical Services

- Seed Certification and Testing.
- Soil and Water analysis.
- Advisory services to stakeholders
- Urban greening and landscaping.

#### 4.7 Activities of Rajbhasha

- Organized quarterly meetings
- Organized Hindi week
- Organized annual workshop.
- Invited lectures

#### 4.8 Awards and Honours

Dr. D.K.Mishra was awarded Brandis Prize for his best paper published in Indian Forester.

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

- Biological Diversity Day also known as world Biodiversity Day was celebrated on 22<sup>nd</sup> May 2009 by the Arid Forest Research Institute, Jodhpur. Neem trees were planted by Director, AFRI followed by Officer, Scientists & employees near AFRI main gate area. Director AFRI delivered the presidential address stress upon judicious utilization of fauna and flora by generating awareness. A lecture on "Importance of Biological Diversity emphasizing the role of invasive alien species in our environment was delivered. A brochure on *Prosopis juliflora* an important invasive alien species of arid and semi-arid regions was prepared which highlights the introduction of the species, threat invasive alien species pose to biodiversity, awareness and tackling the problem by people participation.
- World Environment Day was celebrated on June 5<sup>th</sup>, 2009 in the institute. Plantation activity of Neem (*Azadirachta indica*) was undertaken on the occasion by the staff of the institute. A leaflet containing research highlights of the institute in Hindi was released on the occasion by the Director, AFRI. A lecture on Climate Change was delivered by Dr. G.Singh, Scientist-E and Head, Forest Ecology Division on the occasion.
- World Day to combat Desertification was celebrated on June 17<sup>th</sup>, 2009 in the institute. Plantation of *Commiphora wightii* (Guggul) was undertaken in the institute. Sh. Malkhan Singh, MLA, Luni constituency was the chief guest and Sh.Rahul Parashar, Councillor, Sardarpura, Jodhpur was the Guest of the Honour on the occasion. Leaflets and pamphlets on "Desertification: Challenges and Strategies for Control" were released by the dignitaries on the occasion. A presentation on Draught and Desertification was done by Dr. G.Singh, Scientist-E and Head, Forest Ecology Division on the occasion.





- A stakeholders meet of AFRI, Jodhpur was organized at Jaipur under Chairmanship of Shri Abhijit Ghose, PCCF, Rajasthan on 28<sup>th</sup> July 2009.
- 60<sup>th</sup> Van Mahotsava was celebrated on 30<sup>th</sup> July, 2009 in the Institute. On this occasion, Neem trees were planted in the campus. All scientists, officers and staff of the institute participated actively in the function.
- A second stakeholder meet of AFRI, Jodhpur was held at Forest Training Institute, Gandhinagar under Chairmanship of PCCF, Gujarat on 8<sup>th</sup> Sept. 2009.
- A Hindi fortnight was celebrated in the institute from 14<sup>th</sup>-29<sup>th</sup> Sept., 2009 incorporating eight competitions for ministerial and scientific/ technical staff, invited talk for promotion hindi by Dr. Kalu Ram Parihar, Programme Executive from Akaswani, Jodhpur.
- RAG Meeting of AFRI was held on December, 21<sup>st</sup>, 2009. New Project proposals (10 Nos.) of various divisions were presented by the Pls. RAG Meeting was chaired by Shri U.M. Sahai, PCCF (TREE), Rajasthan.
- Participated in the western Rajasthan Hastshilp Utsav, held at Rawan Ka Chabootra, Jodhpur from 2<sup>nd</sup>-11<sup>th</sup> January, 2010 for dissemination of research results and developed technologies of various research activities of the Institute to the stakeholders by way of display and through various brochures/leaflets/Information booklet and one to one interaction.
- AFRI, Jodhpur participated in one day Kisan mela organized by Agricultural Technology Management Authority (ATMA), Jodhpur in colloberation of Shri Marudhar Bagwani Krishi Utpadan Vikas Samiti on 22<sup>nd</sup> Feb. 2010 at Beraie, Bhopalgarh Rajasthan. The information of research Activities of AFRI, Jodhpur were displayed in a stall in the Mela. The informative literature of AFRI comprising of published information booklet, leaflets, pamphlets were placed in a stall at the Kissan Mela. About-3000-4000 farmers visited the stall. The chief guest of the occasion was Professor M.S. Swaminathan from M.S. Swaminathan Foundation, Chennai.

#### **Distinguished Visitors**

- Dr. K. Dhileepan, Principal Entomologist, Alan Fletcher Research Station, Univ. of

Queensland, Australia PI of the research project "New bio-control opportunities for prickly acacia: exploration in India" visited India from 5<sup>th</sup>-12<sup>th</sup> July 2009. Dr. Dhileepan also visited the survey sites of Gujarat for exploration of Biological control agents specially Galls and Rust.

- Dr. K. Dhileepan, Principal Entomologist, Alan Fletcher Research Station, Univ. of Queensland, Australia and Dr. Roger Shivas, Principal Plant Pathologist, Agri-Science, Dept. of Employment, Economic Development & Innovation, Indooroopilly 4075, visited Institute from 12-13<sup>th</sup> January, 2010. They examined the different experiments being carried out of the *Acacia nilotica* project entitled "New biocontrol opportunities for prickly acacia: exploration in India" at forest protection experimental field and poly house. Both of them also visited *Acacia* sites in Rajasthan and Gujarat.
- Dr Prem P. Jauhar, Professor of Cytogenetic, United States Deptment of Agriculture, Agricultural Research Service, Northern Crop Science Laboratory, Fargo, North Dakota, USA; delivered lectures on 3<sup>rd</sup> and 4<sup>th</sup> Nov 2009 at AFRI, Jodhpur on topics related to 'India's glorious past, present struggle and future directions' and 'Biotechnological interventions on Wheat'.
- Director General ICFRE, Dehradun, Dr. G.S. Rawat, IFS, visited AFRI from 13<sup>th</sup> to 15<sup>th</sup> January 2010. He visited the Labs and experimental areas of the Institute. The Director General also inaugurated the Bio-control laboratory cum culture room of the Forest Protection Division on 13<sup>th</sup> January 2010.



Inauguration of Biocontrol-cum-culture laboratory by Dr. G.S. Rawat, IFS, D.G. (ICFRE)

## 5. Administration and Information Technology

### Introduction

#### 3.5 Information Technology

- **Go-Live of IFRIS at the Institute**

IFRIS was made Go-Live at AFRI in the month of April 2009. The work on the Financial Accounting System (FAS) module, Payroll Management System (PMS) module and Research Management Information System (RIMS) module was started in the Institute. The data of all the ongoing projects were uploaded in the RIMS and the workflow of the ongoing as well as the new projects were properly executed for all the projects by the PI's with the help of E-Champions. The salary was prepared regularly every month through PMS throughout the year. The budget for the ongoing projects was uploaded in the system and the voucher entry was carried out through the year in the

Financial Accounting System. The Employee data, the leave data of all the employees and the approver details were entered in the Personnel Information Management System (PIMS). Several rounds of trainings and handholding of users were conducted on these modules and constant monitoring was made throughout the year before these modules were made functional in the Institute. The master data for the Estate Management System and the Procurement and Inventory Module was prepared and sent to the ICFRE for uploading in the IFRIS.

- **Construction of web page for all the Officers / Scientists/RO's in the website of AFRI**  
The web page for all the Officers/Scientists was constructed and uploaded to the website of the Institute containing the list of papers in International Journals/National Journals/Papers presented in Seminars/ Chapters in Books by the Scientist. The data of the publications for all the scientists were collected and arranged on their individual webpage.
- **Preparation of the Project Data of the Institute for the Project Database**  
The data for all the projects completed in the Institute since inception of the Institute was collected , validated and sent to ICFRE for inclusion in the project database.
- **Switching over of E-mail Server**  
The ICFRE mail server was shifted to new Email server. The list of users of the institute was prepared, validated and sent to ICFRE for making their E-mail Id's. The E-mail Id's of all the users of the Institute was made on new ICFRE mail server. Training was imparted on using the new Mail-Server for the users of AFRI.
- **Network extension to Accounts, Establishment and CO(F)**  
For the smooth working of the IFRIS, some more network points were extended in the Accounts Section, Establishment Section and Coordinator (Facilities) section of the Institute where the number of network points were less than required.
- **Preparation of estimate for GIS Lab**  
The specifications and estimate for making the GIS laboratory at the Institute was prepared for inclusion in the estimate of the onetime grant.

In addition to these works the regular works of the IT-Cell like maintenance of network and computing equipments, regular updation of the website of AFRI, documentation work and the other IT related works were carried out time to time.

5.2 Sevottam: Activities relating to the Citizens/Clients Charter as detailed below has to be included in the Annual Report 2009-2010.

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

The charter has been prepared based on the seven steps mentioned in Sevottam. As ICFRE has already mandated its mission "To generate, preserve, disseminate and advance knowledge, technologies and solutions for addressing issues related to forests and promote linkages arising out of interactions between people, forests and environment on a sustained basis through research, education and extension". Under the auspices, AFRI is enduring its Forestry research for conservation of biodiversity and enhancement of bio-productivity in Rajasthan, Gujarat and Dadra

& Nagar Haveli with special emphasis on arid and semi-arid regions. Keeping the National Forestry Research Plan (NFRP) in view the AFRI has identified its thrust areas based on the inputs and active participation of populace represented by different stake holders. Under these thrust areas Institute is implementing its research endeavors after duly recognizing the users need. The thrust areas includes

1. Soil, Water and Nutrient Management: Technologies for Afforestation of Stress Sites,
2. Management of Plantations,
3. Planting Stock Improvement and Nursery and Plantation Techniques,
4. Biofertilizers and Biopesticides,
5. Agroforestry, JFM & Extension,
6. Phytochemistry; Non-Wood Forest Products,
7. Biodiversity conservation and climate change &
8. Forestry Education & Training.

#### 5.2.2 Action taken to implement the Charter

To fulfill the Charter, research projects have been prepared in consultation with the stakeholders in Rajasthan and Gujarat, vetted by outside experts, RAG members and finally by RPC for internal funding and implementation. Projects have also been submitted for various donor agencies for implementing the Charter. A stakeholders meet of AFRI, Jodhpur was organized at Jaipur under Chairmanship of Shri Abhijit Ghose, PCCF, Rajasthan on 28<sup>th</sup> July 2009. A second stakeholder meet was held at Forest Training Institute, Gandhinagar under Chairmanship of Shri Pradeep Khanna, PCCF, Gujarat on 8<sup>th</sup> Sept. 2009. RAG Meeting of AFRI was held on December, 21<sup>st</sup>, 2009. New Project proposals (10 Nos.) of various divisions were presented by the Pls. RAG Meeting was chaired by Shri U.M. Sahai, PCCF (TREE), Rajasthan. Projects approved by RAG were presented in RPC meeting held in February, 2010 at ICFRE, Dehradun by the Director, AFRI.

#### 5.2.3 Details of training programmes, workshops etc. held for proper implementation of Charter

- Two one week trainings were organized for farmers and Field functionaries on Bamboo at Rajpipla, Gujarat and Kota, Rajasthan under National Bamboo Mission.
- One week compulsory training of IFS Officers on "Integrated Approach for sustainable Development of Fragile Desert Ecosystem" sponsored by Ministry of Environment & Forests, Govt. of India, New Delhi, was organized by this Institute from 14-18, December, 2009 in which 31 IFS officers attended the course.
- Based on the request of stakeholders (Farmers, NGO's and Forest Department) one day brain storming seminar on Khejari mortality in Rajasthan was organized on 16th November 2009 to formulate a coordinated project to address problem of Khejri mortality, its genetic improvement and conservation. As a follow up of brainstorming session, coordinated project on Khejri on the above line were prepared and the same was approved by the RPC for the implement action.
- A workshop on Development of criteria & indicators for sustainable NTFP management was organized on 29th August 2009 at AFRI in collaboration of IIFM Bhopal.
- Based on the need and request from the M.Sc. students and facilities of the Biotechnology department organized summer training programmes on Plant Biotechnology for M.Sc., B.Sc., B.Tech. Students.

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

- Forty two farmers and field functionaries trained under VVK during 27-29<sup>th</sup> Nov, 2009 by a training organized at Gujarat Forest Research Institute, Gandhinagar.
- Three days training for farmers and field functionaries (SFD's) was conducted from 13 to 15 Feb. 2010 under VVK (Rajasthan) at Kisan Bhawan Bikaner, Rajasthan.
- Participated in the western Rajasthan Hastshilp Utsav, held at Rawan Ka Chabootra, Jodhpur from 2<sup>nd</sup>-11<sup>th</sup> January, 2010 for dissemination of research results and developed technologies under various research projects of the Institute to the stakeholders (Farmers, NGO's, wood based industries, Environmentalists and SFD's).
- AFRI, Jodhpur participated in one day Kisan mela organized by Agricultural Technology Management Authority (ATMA), Jodhpur in colloberation of Shri Marudhar Bagwani Krishi Utpadan Vikas Samiti on 22<sup>nd</sup> Feb. 2010 at Beraie, Bhopalgarh Rajasthan to disseminate research findings of projects for the field application by the farmers.
- Quarterly publication of AFRI, Darpan for extension and publicity of the research interim findings and technologies for the dissemination and absorption by the stake holders.
- Interpretation Centre has been established for public awareness and education in forestry for school and college students of forestry, agriculture and allied subject students, researchers, farmers, NGO's, SFD's etc.
- Celebration of Days like Van Mahotasava, Environment, Biodiversity and combating deserts and desertification to generate awareness in public.

#### 5.2.5 Details of internal and external evaluation of implementation of Charter in the Organization and assessment of the level of satisfaction among Citizens/Clients

Three research projects of AFRI have been evaluated by external experts, and AFRI has evaluated ten Forestry projects/ plantations in various districts of Rajasthan under Harayali Scheme of Rajasthan Forest Department.

#### 5.3 Welfare measures for the SC / ST / backward / minority communities

A SC/ST/backward/minority communities welfare committee has been constituted at the Institute. Dr. S.I.Ahmed, Scientist-F is the chairman of the committee with four other members. The committee looks after the welfare aspect and the grievances of the employees of the SC/ST/backward/minority communities, if any. It is pertinent to mention that no such grievance was reported in the year 2009 from the employees of these sections.

## 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

Headquarters / Institutes	Appellate Authorities	Public Information Officers	Subject matter(s) allocated
Arid Forest Research Institute	Dr. T.S. Rathore Director, AFRI 0291-2722764 Email: dir_afri@icfre.org Phone : 0291-2742549 FAX : 0291-2722764	Dr. Pradeep Chaudhary, IFS, Head Silviculture Division, AFRI Email: pradeep@icfre.org Phone : 0291-2729196 FAX : 0291-2722764	All matters related to AFRI, Jodhpur

## 2. Email and Postal addresses

**Arid Forest Research Institute,**  
P.O. Krishi Upaz Mandi,  
New Pali Road, Jodhpur, 342005  
Email : dir\_afri@icfre.org  
Phone : 0291-2742549  
FAX : 0291-2722764

Name of Officials	Designation	Phone	Email Address
Sh. T.S. Rathore, IFS	Director	2722549, 2729101	dir_afri@icfre.org
Sh. Ashok Kumar, IFS	Group Coordinator (Research)	2721594 2729108	groupco_afri@icfre.org ashokkumar@icfre.org
Sh. M.R. Baloch, IFS	Head, Agro Forestry & Extension Division and Silviculture Division	2729200	mrbaloch@icfre.org
Sh. Jabber Singh, IFS	Co-ordinator (Facilities)	2729111	jabbersingh@icfre.org
Dr. S .I. Ahmed	Scientist -F & Head, Forest Protection Division	2729170	siahmed@icfre.org
Dr. I.D. Arya	Scientist -F & Head, Forest Genetics & Tree Breeding Division	2729160	aryaid@icfre.org
Dr. G. Singh	Scientist - F & Head, Forest Ecology Division	2729130	gsingh@icfre.org

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### 3. Intellectual Property

#### 3.1 Patents Granted

Nil

#### 3.2 Others

Nil

**PROJECTS OF AFRI, JODHPUR AT A GLANCE (2009-2010)**

Project title	Status of the project	Raj.	Guj.
<b>Theme : 2.1 Ecosystem Conservation and Management</b>			
<b>Sub Theme : 2.1.2 &amp; 3 Climate Change/Ecology and Environment</b>			
<b>EXTERNALLY AIDED</b>			
Project 1. Vegetation carbon pool assessment in some districts in Northern Rajasthan (Funded by IIRS, Dehradun) (AFRI-97/FED/IIRS, D.dun/ 2009-11).	New		
<b>PLAN PROJECT</b>			
Project 2. Studies on carbon sequestration in different forest types of Rajasthan (AFRI-98/FED/ 2008-2012).	Contiuned		
<b>Sub Theme: 2.1.4 Biodiversity</b>			
<b>PLAN PROJECT</b>			
Project 3. Efficacy and economics of water harvesting devices in controlling run-off losses and enhancing biomass productivity in Aravalli ranges (Funded by the State Forest Department, Rajasthan and ICFRE) (AFRI-39/EED/ 2005-11).	Contiuned		
<b>Theme : 2.2 Forest Productivity</b>			
<b>Sub Theme : 2.2.2 Silviculture</b>			
<b>EXTERNALLY AIDED</b>			
Project 1. Enhancing productivity of saline wastelands in Kachchh- through improved tree planting techniques and silvipastoral study (Gujarat SFD sponsored project- 77/NWFP/SFD/AFRI-2006-11).	Contiuned		
<b>PLAN PROJECT</b>			
Project 2. Studies on seed traits of seeds collected from seed stands / SPAs / SSOs / CSOs of important species of Gujarat state (AFRI-80/Silvi/2007-12).	Contiuned		
<b>Sub Theme : 2.2.3 Social Forestry, Agro-forestry/ Farm Forestry</b>			
<b>PLAN PROJECT</b>			
Project 3. Development of economically viable and integrated Agroforestry models for arid region (AFRI-55/Silvi/2006-12).	Contiuned		
<b>Sub Theme 2.2.4 Forest Soils &amp; Land Reclamation</b>			



	Project title	Status of the project	Raj.	Guj.
<b>EXTERNALLY AIDED</b>				
	Project 5. Studies on characteristic features pertaining to biodrainage potential of some selected tree species (AFRI-38/FED/MOWR/2004-2010).	Concluded		
<b>PLAN PROJECT</b>				
	Project 4. Characterization and classification of forest soils of Rajasthan (AFRI-85/FED/2007-2012).	Contiuned		
<b>Sub Theme : 2.2.5 Watershed Management</b>				
<b>PLAN PROJECT</b>				
	Project (Already included in Theme 2.2). Efficacy and economics of rain water harvesting devices in controlling run off losses and enhancing biomass productivity in Arravali ranes (AFRI-39/FED/2008-2011).	Contiuned		
<b>Theme : 2.3 Genetic Improvement</b>				
<b>Sub Theme 2.3.3 Tree Improvement</b>				
<b>EXTERNALLY AIDED</b>				
	Project 1. Investigations on genetic variation and inheritance of western Indian teak ( <i>Tectona grandis</i> L.f) (AFRI-94 /Silvi/2009-2014).	New		
	Project 2. Development of tissue culture technology for multiplication of economically important desert plant - <i>Salvadora persica</i> (AFRI-92/FGTB/2009-2014).	New		
<b>PLAN PROJECT</b>				
	Project 3. Screening of high oil and <i>azadirachtin</i> in neem (AFRI-34/FGTB-8/2002-2011).	Contiuned		
	Project 4. Multilocational trial of <i>Eucalyptus camaldulensis</i> and <i>Dalbergia sissoo</i> clones in Gujarat state (AFRI-41/FGTB/2002-09).	Contiuned		
	Project 5. Genetic improvement of <i>Tecomella undulata</i> (AFRI-33/FGTB/7/2002-2011).	Contiuned		
<b>Sub Theme : 2.3.4 Vegetative Propagation</b>				
<b>PLAN PROJECT</b>				
	Project 6. Demonstration trial of male and female <i>Ailanthus excelsa</i> plants raised through grafting (AFRI-79/FGTB/2006-2009).	Contiuned		
<b>Sub Theme 2.3.5 Biotechnology</b>				
<b>PLAN PROJECT</b>				

	Project title	Status of the project	Raj.	Guj.
	Project 7. In vitro mass propagation of <i>Jatropha curcas</i> L. and optimization of low cost options for economizing the technology (AFRI-83/FGTB/7/2007-2011).	Continued		
<b>EXTERNALLY AIDED</b>				
	Project 8. Multiplication and field trial of bamboos through tissue culture in Rajasthan & Gujrat (AFRI-68/FGTB/DBT/2005-09).	Concluded		
<b>Theme 2.4 Forest management</b>				
<b>Sub Theme 2.4.4 Forest Biometrics</b>				
<b>EXTERNALLY AIDED</b>				
	Project 1. Productivity and biometrics studies on some important species in semi-arid regions of Rajasthan for their sustainable management (AFRI-95/Silvi/SFD/2009-12).	New		
	Project 2. Market survey on selected species in selected markets (AFRI-58/Silvi/1994 continued).	Continued		
	Project 2. Productivity study and modelling growth and yield in Teak Plantation in Gujarat state.	New		
	Project 3. Development of the web portal for forestry research extension.	Continued		
<b>Theme : 2.6 Non-wood and Forest Products (NWFPs)</b>				
<b>Sub Theme : 2.6.2 Resource Development of NWFPs</b>				
<b>PLAN PROJECT</b>				
	Project 1. Effect of fertilizer application on growth and yield of 10 years old <i>Salvadora persica</i> and <i>Acacia ampliceps</i> plantations under silvipastoral system on arid salt affected soil (AFRI-89/NWFPD/2008-11).	Continued		
<b>Sub Theme 2.6.5 Biofuels and Bioenergy</b>				
<b>PLAN PROJECT</b>				
	Project 2. Survey selection performance trial and estimation of yield potential of <i>Jatropha curcas</i> in Rajasthan and Gujarat (AFRI-88/Silvi/2007-12).	Continued		
<b>EXTERNALLY AIDED</b>				
	Project 3. Establishment of multilocational clonal trial and seedling seed	Continued		

	Project title	Status of the project	Raj.	Guj.
	orchard of <i>Jatropha curcas</i> (AFRI-81/Silvi/DBT/2007-12).			
	Project 4. Genetic improvement of <i>Jatropha curcas</i> for adaptability and oil yield (AFRI-66/Silvi/CSIR/2005-12).	Continued		
	Project 5. Network research project on guggal <i>Commiphora wightii</i> Arn. Bhandari (AFRI-76/Silvi/NMPB/2008-13).	Continued		
<b>Theme 2.7 Forest Protection</b>				
<b>Sub Theme 2.7.2 Insects pests, diseases and control</b>				
<b>PLAN PROJECT</b>				
	Project 1. Evaluation of antifungal potential and identification of broad spectrum antifungal compound from selected tree/shrubs/weeds of Indian arid region (93 AFRI/AFED/2009-14).	New		
	Project 2. Management of potential insect pests and diseases of important medicinal plants grown in arid and semi-arid regions (AFRI- 72/FP/2010).	Concluded		
<b>Sub Theme : 2.7.3 Mycorrhizae, rhizobia and other useful microbes</b>				
<b>EXTERNALLY AIDED</b>				
	Project 3. New biocontrol opportunities for prickly acacia: exploration in India (AFRI/FPD/2008-2011).	Continued		
<b>PLAN PROJECT</b>				
	Project 4. Mycorrhizal dependency & productivity of economic important medicinal plants (Mehndi & Ashwagandha) of Arid Zones (AFRI/FPD/2007-2010).	Concluded		

### List of Abbreviations

ABA	Abscisic Acid
ADG	Assistant Director General
AFED	Agroforestry and Extension Division
AFRI	Arid Forest Research Institute
AFWWA	Air Force Wives Welfare Association
AMF	Arbuscular Mycorrhizal Fungi
ANOVA	Analysis of Variance
ATMA	Agricultural Technology Management Authority
BAP	Benzlaminopurine
BOD	Biochemical Oxygen Demand
BT	Box trench
C & I	Criteria and Indicator
CAZRI	Central Arid Zone Research Institute
CBL	Clear Bole Length
CCF	Chief Conservator of Forests
CF	Conservator of Forests
CGMFP	Chhattisgarh Minor Forest Produce Co- Operative
CO(F)	Coordinator (Facilities)
CPTs	Candidate Plus Trees
CRAPTC	Centre for Research and Application in Plant Tissue Culture
CRIDA	Central Research Institute for Dryland Agriculture
CSIR	Council of Scientific and Industrial Research
CSMCRI	Central Salt & Marine Chemical Research Institute
CSOs	Clonal Seed Orchards
CT	Contour Trench
DBH	Diameter at Breast Height
DBT	Department of Biotechnology
DCF	Deputy Conservator of Forests
DEMO	Demonstration
DNH	Dadra & Nagar Haveli
DV	Demo Village
EC	Electrical Conductivity
ENVIS	Environmental Information System
FAS	Financial Accounting System
FED	Forest Ecology Division
FGTB	Forest Genetics and Tree Breeding
FPD	Forest Protection Division
FRI	Forest Research Institute
FYM	Farmyard Manure
G	Gradonie
GBH	Girth at Breast Height

GCA	General Combining Ability
GCV	Genotypic Coefficient of Variation
GEER	Gujarat Ecological Education & Research
GFD	Gujarat Forest Department
GFRC	Gujarat Forest Rangers College
GIS	Geographic Information System
GSFD	Gujarat State Forest Department
GSFDC	Gujarat State Forest Development Corporation
HSCST	Haryana State Council for Science and Technology
ICFRE	Indian Council of Forestry Research & Education
ICT	Information and Communication Technology
IFRIS	Indian Forestry Research Information System
IGGMA	
IGNP	Indira Gandhi Nahar Pariyojana
IIRS	Indian Institute of Remote Sensing
IT	Information Technology
IWST	Institute of Wood Science & Technology
JFM	Joint Forest Management
MD	Managing Director
Mg	Mega Gram( $10^6$ g)
MKU	Madurai Kamaraj University
MLA	Member of Legislative Assembly
MMS	Modified Murashige and Skoog
MOU	Memorandum of Understanding
MOWR	Ministry of Water Resources
MS	Murashige and Skoog
NAA	Napthal Acetic Acid
NABARD	National Bank for Agriculture and Rural Development
NBPGR	National Bureau of Plant Genetic Research
NBRI	National Botanical Research Institute
NFLIC	National Forest Library and Information Centre
NGO	Non Governmental Organization
NMPB	National Medicinal Plant Board
NPK	Nitrogen-Phosphorus-Potassium
NTFP	Non Timber Forest Product
NWFP	Non Wood Forest Product
OBC	Other Backward Class
PCCF	Principal Chief Conservator of Forests
PCV	Phenotypic Coefficient of Variation
PDA	Potato Dextrose Agar
PDKV	Dr Panjabrao Deshmukh Krishi Vidyapeeth
PIMS	Personnel Information Management System

PMS	Payroll Management System
R/S	Root/Shoot
RBD	Randomized Block Design
RFD	Rajasthan Forest Department
RIMS	Research Management Information System
RSFD	Rajasthan State Forest Department
RTI	Right To Information
SAUs	State Agriculture Universities
SC	Schedule caste
SE	Somatic Embryo
SFD	State Forest Department
SIC	Soil Inorganic Carbon
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
SPAs	Seed Production Areas
SSOs	Seedling Seed Orchards
ST	Scheduled Tribe
SWC	Soil water Content
TANU University	Tamilnadu Agriculture University
TDZ	Thidiazuron
TERI	The Energy & Resources Institute
TOF	Tree Outside Forest
TREE	Training Research Extension & Education
USDA	United States Department of Agriculture
UT	Union Territory
UV	Ultra Violet
VAM	Vesicular Arbuscular Mycorrhiza
VD	V-ditch
VVK	Van Vigyan Kendra
WAS	Wild Ass Sanctuary
ZSI	Zoological Survey of India