Executive Summary

AFRI is addressing forestry research needs of the mandated areas of Rajasthan, Gujarat, Dadar & Nagar Haveli (UT) and taken up various research projects under different thrust areas and themes. Out of the 41 Projects executed, 5 projects were completed, 27 are ongoing and 9 new projects were initiated during 2012-13. Forestry research findings were disseminated to the end users/stake holders through three VVKs (Van Vigyan Kendras) established in Rajasthan, Gujarat & Dadra Nagar Haveli, Demovillege at Salawas Jodhpur and trainings and workshops.

Field surveys were conducted under various projects viz; reassigning forest types, carbon studies, bio-diversity of sacred groves and population density of guggal. The brief summary of the above surveys are as follows:

Survey conducted under the project entiltled, 'Reassigning Forest Types of India' to understand the impact of climate change on forest vegetation and to prepare a change matrix of forest types of India. Data recorded for the given coordinates, demonstrates that 40 forest sub types exist in mandated areas. In this, 19 forest sub types are in Rajasthan, 34 types in Gujarat, 3 types in D&NH, 3 in Diu and one in Daman. A study on under carbon sequestration conducted in 139 forest blocks in Jodhpur indicates large variations in soil organic carbon stock. Highest (229.6 tons/ ha) carbon stock was recorded in Luni and Osian ranges. Survey conducted in 11 sacred groves in Rajasthan revealed that high plant and animal diversities are available in these areas. In another Survey conducted in 33 districts of Rajasthan for assessing population density and sex ratio of plants, revealed that 99.9% guggal plants are female. In seven districts (Barmer, Jalore, Jhunjhunu, Karoli, Sawai Madhopur and Sikar) high density of guggal population (above 40 plants/ha) was recorded.

Luni river basin effluent water and soil samples were collected and analysed. Effluent sample collected from CETP Pali was having alkaline pH (8.67), whereas acidic pH (5.94) was found in water sample collected from Jasol. Highest (100.89 mS cm-1) electrical conductivity (EC) was found in effluent sample collected from Punayta, whereas lowest (0.83 mS cm^{-1}) was from Pali outskirts.

Socio-economic studies of forest fringe villages in 11 districts of Rajasthan revealed that people of tribes Mena, Ragor, Bheel, Rewari, Meghwal and Rawat etc. are mainly dwelling there and also almost every village have primary school, electricity and sufficient irrigation facility. They grow mainly peanuts, maize, soyabean and pulses as cash crops.

Survey and selection of Candidate Plus Trees of *Tecomella undulata* were carried out in seven districts viz. Sikar, Churu, Jaipur, Nagaur, Bikaner, Pali and Jalore of Rajasthan. Total of 41 CPT's were identified on the basis of quantitative traits (height, girth, clear bole and crown diameter) and qualitative traits (straightness and health). Phenological observations like flowers

initiation time and its color variation were also recorded from all the identified CPTs.

Apart from survey works, important research works/experiments were done during year2012-13.Under the coordinated project on integrated management of Khejri mortality for socio-economic upliftment in Rajasthan, infestation data was collected after six months of second treatment to evaluate the effectiveness of different treatments. It was observed that the treated trees exhibited significant improvement as compared to control. Rearing of *Acanthophorous serraticornis* larvae on artificial diets entered in the 5th instar of their life cycle in the laboratory. A few early instar larvae, collected from root stock of felled Khejri trees from Nagaur have been inserted in the young Khejri trees in the out-door wire mesh cages to study their life cycle. Pathogenecity test using *Ganoderma lucidum* as pathogen on Khejri as host has been successfully proved on one and half year old seedlings. The typical top drying symptom was observed after two months of inoculation of the pathogens.

Induction of Systemic Acquired Resistance in Rohida against stem canker**,** two chemicals viz., Jasmonic acid and Silicylic acid were injected into plants. The biochemicals studies at different intervals revealed that concentration of protein, phenolics and PAL increases as days passes from 30 to 60 to 90 days as compared to only pathogen infected seedlings.

In the study of seed pest, wherein *Bruchidius bilineatopygus* was identified as major pest on *Prosopis cineraria* seeds. Three litter decomposing fungi, *Trichoderma viride*, *Aspergillus niger* and *Streptomyces* were selected for amendment for rapid composting process.Aerobic composting (heap method) by using indigenous strain of *Trichoderma viride* (500gm in 20 kg FYM) + PSB (250ml in 20 lit. of water) + dried leaves has taken 90 days, whereas in traditional process, it takes about 120 days . Twelve species of AM fungi of important five genera namely, *Glomus, Gygospora, Scutellospora Acaulospora & Sclerosystis* were isolated & identified in natural plantations of *A. nilotica var. cupressiformis* raised around Jodhpur & Pali districts.

Commiphora wightii (Arn.) commonly known as Guggal, is one of the threatened species. Two major projects are being executed for this plant species**.** Germplasm of *Commiphora wightii* a medicinal plant collected for ex-situ conservation from identified 117 CPPs. About 1428 vegetative cuttings with source details (GPS locations) were collected and raised in vegetative propagation area for rooting. Progenies of 10 CPPs are evaluated for apomixes. DNA and Isozyme marker studies revealed that many of these CPPs produces genetically different progenies. Guidelines for seed germination in nursery beds and vegetative propagation have been developed.

AFRI has two research projects on *Jatropha curcas*. In the present study, a total of 161 sources of *J. curcas* representing the promising Jatropha-growing belt of India, were screened and evaluated. Maintained, monitored and evaluated Seedling Seed Orchards and various trials on performance, pollarding, spacing, agro-technology of *J. curcas* for desired parameters. Protocols for seed germination and micro-cuttings were standardized.

Tree improvement project are on *Ailanthus excelsa*, *Azadirachta indica*, *D.sissoo*, *E.camaldulensis*, *P. cineraria, Salvadora persica, Tecomella undulata* and *Tectona grandis.* On Teak (*Tectona grandis*) studies were conducted on the evaluation of progeny trials to asserting the genetic worth of the selected trees besides understanding the inheritance pattern of different economically important traits of Western Indian teak. Demonstration trial of male and female plants of *A. excelsa* revealed that female plants are taking lead in growth and difference is also increasing gradually. Selected Candidate Plus Trees of *P. cineraria* and *T. undulata* from Rajasthan based on the quantitative and qualitative traits. *For cloning of CPT of P. cineraria*, shoot multiplication has been achieved from mature stem nodal segments from auxiliary buds and *in vitro* rooting was achieved on MS medium supplemented with 3mg/l IBA.Under the study of salt tolerance through gene expression pattern analysis, nine putative salt tolerance genes have been identified.

The development of the web application of the plants database was completed and bilingual web application has been developed in Hindi and English so that a common user may easily use it by reading the content in Hindi.

In addition to these, 19 trainings were arranged at the institute for integrated watershed management members, two trainings under Direct To Consumer scheme, three trainings on Jatropha cultivation and one training under HRD programme of the ICFRE.

Summary of projects

Projects	**Completed Projects**	**Ongoing Projects**	**New Projects Initiated During the Year**
Plan	2	22	4
Externally Aided	3	5	5
Total	5	27	9

	Contents
1.	**Introduction:** **Institute- At a Glance** Arid Forest Research Institute, Jodhpur (Rajasthan), is one of the nine 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 Havelli. The main emphasis in areas of research of the institute are soil, water & nutrient management, technologies for afforestation of stress sites, management of plantations, growth and yield modeling, planting stock improvement and biotechnology, bio-fertilizers and bio-pesticides, Agroforestry, JFM & extension, phytochemistry & non-timber forest products, integrated pest & disease management and forestry education and extension. During 2012-13, forty one projects were executed including ten externally funded projects from the Rajasthan Forest Department, Gujarat Forest Department, Department of Biotechnology, Government of India, New Delhi, National Medicinal Plant Board, New Delhi, CSIR, New Delhi and IIT Rajasthan.  **Mandated states of AFRI, Jodhpur**

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

AICP Project: Tree crop interaction study of exiting MPTs based silvi-agri system in arid and semi-arid region of India

Project-1: Managing resources to enhance productivity of Agroforestry system in dry areas of Rajasthan (AFRI-01/AFED/Int(ICFRE)AICP/2012-17).

Principal Investigator: Dr. Bilas Singh, RO

Agroforestry trial established in Forest Ecology experimental field, AFRI, Jodhpur field comprising 17 years old *Hardwikia binata* and *Colophospermum mopane* trees at a spacing of 5 m x 10 m.The four treatment comprises for each species viz; Intact tree (T_1), Tree branch removal only (70% of total tree height) (T_3), root barrier treatment (T_3) and both tree branched removal and root barrier treatment (T_4). The sole crop and grass plots were as control. Trial conducted in Randomize Block Design with three replications for each species. The area of agroforestry trial is 0.90 ha. *Cymopsis tetragonoloba* crop integrated with *H. binata* and *Cenchrus ciliaris* grass integrated with *C. mopane* trees. The grain production of *C. tetragonoloba* crop was significantly high in sole crop as compared to the treatments. The grain production of *C. tetragonoloba* was higher in both tree branched removal and root barrier treatment (T_4) than root barrier treatment (T_3). The grain production of *C. tetragonoloba* was high in 5 m distance as compared to 0.5 m and 2.5 m distance from tree trunk. The tiller number, clump size and production of *C. ciliaris* grass were not differed among the treatment and distances. Photo active radiation (PAR) was significantly high in sole crop and grass plots as compared to different treatments. PAR varied between 544 to 1391 µmol m^{-2} s^{-1} in July to October, 2012. PAR was the lowest in T_1 treatment *which* was differed significant with T_4 treatment in *H. binata* tree. Soil water content was not differed among the treatments, but it was higher in 2.5 m and 5 m distances as compared to 0.5 m distance from the trunk. Tree root density was not differed among the treatment. pH, EC and organic carbon of soil were not differed among the treatments.

Project-2: Enhancing fodder productivity through silvipastoral system on degraded land of India (AFRI-02/NWFP/Int/IICFRE)AICP/20012-2017).

Principal Investigator: Dr. Ranjana Arya, Scientist F

Silvipastoral trials are planned to be laid with the existing plantations of *Colophospermum mopane* and *Sweda nudiflora* trials with *Cenchrus ciliaris* as grass species. In *C. m*opane trial, soil structures were made, 2 Kg seed of *C. ciliaris* was procured from CAZRI, but grass could not be sown due water logging in experimental site. Causality replacement was done and growth data recorded of tree species. Initial height with grass treatments was ranging from 80.0 cm – 143 cm, crown diameter 95.3 – 227 .5 cm and collar diameter from 25.1 -49.6 mm. While the data for control was; height 115-137 cm, crown dia 183.3-212.0 cm of *C. mopane*. Trial could not be laid with *Sweda nudiflora* due to localized storm and as a result trees were uprooted. Total dry ground

above biomass was ranging from 17.2 kg to 57.3 kg/tree. Since sufficient trees were not left for laying a trial field preparation was done for planting new trial.

Project-3: Network project on guggul (AFRI-76/Silvi/NMPB/2008-13).

Principal Investigator : Dr. D.K. Mishra, Scientist F

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

A non destructive Ethephon (a plant growth regulator) injection based method was worked upon in arid conditions for the tapping of oleogum resins from *Commiphora wightii* and results of this method was very encouraging and Guggul plants are surviving even after three time gum exudations. Application of FYM has helped in plant survival. Application of higher dose of Ethophon (200 mg and above) adversely influenced the plant growth for two years, but its effect diminishes afterwards.

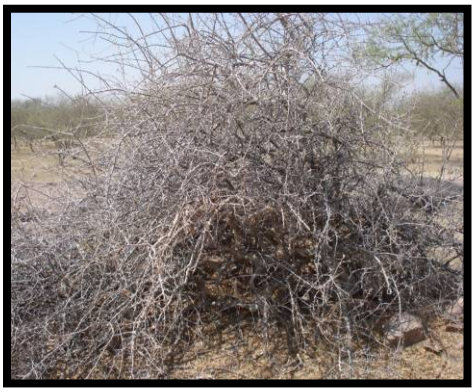

Fig 1. *Commiphora wightii* in summer (without foliage)

Fig 2. *Commiphora wightii* after rain (with foliage)

Fig 3. Increment borer and its parts

Fig 4. Making holes with the increment borer

Fig 5. Gum oozing (first time) from *Commiphora wightii*

Fig 6. Gum oozing in healed plant (third time) of *Commiphora wightii*

Yield of Guggulsterone can be enhanced by ethyl acetate extraction of small twigs of ethephon treated plants. It was also observed that yield of guggulsterone will go up with increased number of tappings. Use of simple borer has created relatively large hole which resulted in some causalities in higher ethephon doses. However, branch cuttings (1.5 cm to 3.5 cm diameter) from plants were taken after gum exudation and planted. Nearly 85% sprouting was observed. Using an increment borer, conservative holes (with minimum injury based on the thickness of the stem) were made. The holes were angled towards the base of the plant to prevent the backflow of the introduced solutions. This methodology enhanced plant survival; the cuts were healed within a month and hole was healed after 4-6 months. Fungicide (Bavistin and Blitox 0.2% twice) application, once after cessation of gum exudation and second after monsoon withdrawal (October), helped to avoid infection The optimum ethephon concentration to induce average production of gum with minimum injury to the tapped plants is between 150 to 300 mg under arid conditions as no casualty took place despite being tapped for three times in four years. Yield was ranging from 50.0 to 80.0 g per plant and plants were surviving. This method will encourage the farmers to cultivate Guggul on field bunds as fencing this will give them additional income from tapping the Guggul plants. On the farm bund, we can plant the shrubs at a distance of 3x3 ^{m2} it will lead to 1111.0 plants /ha. Assuming 50 g/shrub/year as gum yield, it will provide nearly 56 kg gum yield /ha. Taking the market cost as Rs. 800/kg it will provide approx. Rs. 44,000/year to the farmers. However, it is advisable to give break after two tapping.

Project-4: Quantification, value addition of NTFP and improved agricultural productivity in the tribal belt of Sirohi district of Rajasthan (AFRI-03/NWFP/Int(ICFRE)AICP/2012-2017).

Principal Investigator : Smt. Sangeeta Tripathi, RO

This project was initiated in June, 2012 to document the extent of NTFP collection, processing, storage and marketing in selected villages of Mount Abu Block (Bhakhar area) of Sirohi District in Rajasthan. Collected secondary data from State Forest Department, Sirohi, Zila Parishad and DSO, Sirohi and Revenue Department, Abu Road on population, land statistics: Agriculture land including irrigated, unirrigated, wasteland, populated and community land, hillocks, size of land

holding, food security, livestock population, rural artisan & type of rural artisan , literacy status, means of livelihood, collection, consumption and selling of NTFP, sources of fuelwood, collection of fodder from forest/agriculture field, average monthly income, drinking water facility, social group, other NGO's, Govt. Dept. visiting village etc.

On the basis of quantity of NTFPs collected by tribals, six study villages-Siyawa, Jamboori, Uplakhejra, Meen, Taleti and Paba were selected for baseline socio-economic survey to analyze the role of NTFP collection in tribal livelihood. Questionnaire for socio-economic survey and market price spread has been prepared and field tested. Collected samples of key NTFPs available in the study area and also in the market. Quantified green fodder available from agriculture field.

Fig 7. *Momordica diocia*

Fig 8. *Cassia tora*

Fig 9. NTFP Selling in local market

Project-5: Tapping the potential of some selected indigenous lesser known wild edible plants for food and nutrition in arid and semi arid regions (AFRI-110/NWFP)/ICFRE/2011-2016).

Principal Investigator : Dr. Mala Rathore, Scientist D

Survey was carried out and each sample was collected from 2-3 regions in Rajasthan. Morphological data was taken and samples were analysed for their nutrient content. High ash content was observed in case of *Cassia tora* (13.55-14.96 %) and *Haloxylon salicornicum* (25.01%). Protein content was high in *Cordia gharaf* (3.86), *Grewia tenax* (5.3) and *Cassia tora* leaves (1.09-4.47). Fat content ranged from 1.5% to 4.53 %.

Dietary fiber was high ranging from 27.43-50.99 %, in *Cassia tora, 39.58 % in Grewia tenax* and *66.1 % in Haloxylon salicornicum.*

Mineral analysis: *Cassia tora* leaves (1.4 to 3.75 g/100g) and *Haloxylon salicornicum* seeds (1.165 to 4.112 g/100gm) were rich sources of Calcium. Ce*ropegia bulbosa* (172.2 to 270 mg/100gm) and *Haloxylon salicornicum* seeds (406.5 to 462.5mg/100gm) are rich sources of Magnesium whereas, *Haloxylon salicornicum* seeds (2.5 to 7.5 mg/100gm) are especially rich in Zinc. *Cassia tora* leaves (4.5 to 17.65 mg/100gm) , *Ceropegia bulbosa* tubers (11.85 to 42.33 mg/100gm), *Haloxylon salicornicum* seeds containing 38.4-40.75 mg/100gm Iron were found to

be rich source. *Haloxylon salicornicum* seeds contained maximum 1165 to 4112 mg/gm of potassium.*Cassia tora* leaves contain 0.2 to 3.25 mg/100gm, *Grewia tenax* fruits contain 0.3-7.5 mg/100gm, *Ceropegia* tubers contain 0.65 to 1.33 mg/100gm. *Haloxylon salicornicum* contains 2.5 to7.25 mg/100gm and *Cordia gharaf* contain 1.3 – 1.6 mg/100gm of Copper and *Ceropegia bulbosa* contained 172.2 to 270 mg/100gm. *Haloxylon salicornicum* seeds contained 406.5 to 462.5mg/100gm and *Calligonum polygonoides* flower buds contained 224.25mg/100gm of Magnesium.

These species can thus be important biosources of protein, fibre, vitamins alongwith providing essential micronutrients. The results have shown significance of wild edible species as important source of nutrient for rural poor.

Table 1. Mineral content in some selected mild edible plants

Elements→ Plant species ↓	Cu (mg/100gm)	Zn (mg/100gm)	Fe (mg/100gm)	Mn (mg/100gm)	Mg (mg/100gm)	P (mg/100gm)	K (mg/100gm)	Ca (g/100gm)	Na (g/100gm)
Cassia tora leaves	0.2 to 3.25	**1.9 to 3.2**	4.5 to 17.65	1.85 to 3.4	106 to 185.75	0.425 to 1.96	827-1488	1.4 to 3.75	0.003-0.121
Grewia tenax	0.3-7.5	1.55-1.6	6.1 to 9.45	0.6	61-78.75	0.77-1.305	963 to 2950	0.277-0.385	1-2.12
Ceropegia bulbosa	0.65 to 1.33	1.5 to 5.33	11.85 to 42.33	1.15 to 5.5	172.2 to 270	0.165 to 0.375	0.65 to 1.33	1.165 to 4.112	0.305 to 0.387
Haloxylon salicornicum	2.5 to7.25	2.5 to 7.5	38.4-40.75	5 to7.25	406.5 to 462.5	0.355 to 0.385	1165 to4112	0.416-1.406	0.8 to 3.315g
Calligonum polygonoides	0.25	1.75	15.6	5.25	224.25	1.05	1157	0.195	0.023
Cordia gharaf	1.3 – 1.6	2.3-2.75	11.8	1.00	63.75-86.5	1.925	1123to 1468	0.027-0.076	0.112 – 0.198
Leptadenia reticulata	0.55	1.55	6.8	1.00	106	1.225	1612	0.07	0.025

Project-6: Establishment of multilocational clonal trial and seedling seed orchard of *Jatropha curcas* (AFRI-81/JU/SILV/DBT/2007-13).

Principal Investigator : Dr. D.K. Mishra, Scientist F

Two multilocational clonal field trials have been established at Haldughati, Udaipur. The first trial was established in the month of November, 2007, with 12 accessions and the second clonal trial was established with 8 accessions in the month of September, 2008 in RBD with four replications. Seedling seed orchards in Randomized Block Design (RBD) with 5 replications at Arid Forest Research Institute, Jodhpur and 15 replications at Haldughati, Udaipur were established.

Highest value of mean plant height, number of branches and collar diameter was observed 137.22cm, 5.24 and 5.31cm in (TERI/DBT/Jat/04-05) and crown dia 98.33cm maximum in SDHQ4N2. While lowest value of mean plant height 112.11cm **(**BTP-K**)**, number of branches 3.67 (SDHQ4N2), collar diameter 2.67 cm (SDHQ4N1) and crown dia was observed 55.00cm (SDHQ4N1), respectively after 56 month of growth period. Data were non- significant for all plant parameters. Growth performance of 2nd -multi-locational trial of *Jatropha* after 46 months of plantation at Haldughati, Udaipur. Percent survival varied from 0 to 13.89 percent. Maximum value of mean plant height, collar diameter and crown dia. was noticed 118.75cm, 4.66cm and 73.75 in (NBRI-JA-9), whereas maximum number of branches was 5.50 in J-2, Hisar. However, minimum value of plant height, number of branches, collar diameter and crown dia. was noticed 55.00cm,3.33, 2.44cm and 38.33cm in HS-44. Data were non-significant for all the four parameters.

Data were measured after 48 months of growth period. At AFRI, Jodhpur site, percent survival varied from 0 to 100 percent. The accession TERI/DBT-JATROPHA/07/05-06/14 showed maximum plant height 350.00, numbers of branches 12.00, collar diameter 12.50cm and crown dia. was also observed (225.00cm). Minimum plant height 155.00cm in TERI/DBT-JATROPHA/05/32, collar diameter 4.59cm was observed in accession (TERI/DBT-JATROPHA/04/03); and crown dia.95.00cm was observed in accessions(TERI/DBT-JATROPHA/04/11, TERI/DBT-JATROPHA/04/18, TERI/DBT-JATROPHA/05/32), whereas minimum number of branches was 5.5 in three accessions (TERI/DBT-JATROPHA/04/03 TERI/DBT-JATROPHA/04/18 and TERI/DBT-JATROPHA/05/20). Mean number of branches varied from 5.5 to 12.0.

At Haldughati, Udaipur site, percent age survival varied from 0 to 100%. Maximum plant height and crown dia. were observed 223.33cm, 126.67cm in accession (TERI/DBT-JATROPHA/04/16), whereas number of branches and collar diameter were observed, 7.50 and 7.06 cm in accession (TERI/DBT-JATROPHA/07/05-06/38), respectively. Minimum plant height, number of branches, collar dia. and crown dia. were observed in accession TERI/DBT-JATROPHA/04/31 (80.00cm, 3.00, 3.09cm and 43.33cm), respectively. The data table showed that plantation at AFRI, Jodhpur site perform better than at Haldughati, Udaipur in term of growth parameter however, accessions planted at Udaipur site showed better survival than Jodhpur site Data were non- significant.

Project 6. Genetic improvement of *Jatropha curcas* for adaptability and oil yield (AFRI-66/JU/Silvi/ CSIR/2005-13).

Principal Investigator : Dr. D.K. Mishra, Scientist F

Project has been completed during 2012-13. Survival varied from 6.25 to 75.00 percent. Overall mean plant height, number of branches and collar diameter varied from 165.00 to 250.00cm, 3.00 to 5.50 and 4.68 to 9.48 cm, respectively. Seed yield ranged from no seed to 740.00g per plant. In another trial, percentage survival varied from 33.33 to 100 %, whereas, average plant height, number of branches and collar diameter from 655.0 to 305.0cm, 2.00 to 5.00 and 3.77 to 12.68cm, respectively. Seed production varied from 0.00 to 340.0g per plant.

Table 2. Field performance of various native accessions of *Jatropha curcas* after 65-months of plantation under arid conditions at AFRI, Jodhpur.

Partner Institutes	Accessions Provided	Range				
		Percent Survival (%)	Mean			
			Height (cm)	No. of Branches	Collar Dia. (cm)	Seeds/Plant (g)
AFRI	12	33.33-100.0	196.00-285.00	3.00-5.00	6.84-12.68	0.00-66.00
CRIDA	13	33.33-66.67	165.00-275.00	2.00-5.00	4.82-10.44	0.00-25.00
CSMCRI	7	33.33-66.67	200.00-252.50	2.00-4.00	6.87-9.29	0.00-86.00
FRI	8	33.33-66.67	185.00-305.00	2.50-5.00	5.48-11.73	0.00-36.00
NBPGR	17	33.33-66.67	180.00-275.00	3.00-5.00	3.77-10.86	0.00-53.00
RRL	6	33.33-100.0	180.00-242.50	2.50-4.00	7.16-9.18	0.00-340.00
Total	63					
	CD		**NS**	**NS**	**NS**	

On the basis of across site performance, 14 accessions have been selected. The percent survival varied from 12.50 to 50.00 percent in elite accessions and 33 to 66 percent in native accessions. Mean plant height, number of branches and collar diameter ranged from 150.0 cm to 230.0 cm, 32.0 to 86.00 and 5.25 cm to 7.60 cm, respectively in elite accessions. In native accessions, mean plant height, number of branches and collar diameter ranged from 177.50cm to 290.0cm, 37.50 to 165.0 and 6.96cm to 10.63cm, respectively. No fruiting was observed in elite and native accessions.

Various trials on spacing, pollarding, irrigation and fertilizer have been initiated from the seeds provided by CSMCRI, Bhav Nagar. Percent survival varied from 13.75percent in (2x2) to 38.75 percent in (3x3). Maximum mean plant height was observed 218.79cm in (2.5x2.5) spacing treatment, while number of branches and collar diameter was maximum 51.58, in (2.5x2.5) and 6.99cm in (3x3) spacing. Minimum plant height, number of branches and collar diameter was observed 192.00cm, 27.60 in (2x2) and 6.75cm in (2.5x2.5) spacing. Only one treatment seeded this year 86.4g per plant in (3x3) spacing. Data were non-significant for all the parameters.

From the result of main plot analysis (irrigation effect) average plant height was 230.00cm in I0 and varied up to 245.52cm in I_1. Maximum number of branches and collar diameter was observed 85.02 and 10.19cm in I_3, respectively while these were noticed minimum 50.54 and 8.09cm in control. From sub-plot analysis (effect of fertilizer) result revealed that mean plant height ranged from 227.01cm in (F_1) to 246.56cm in (F_2). The mean number of branches and collar diameter was observed maximum 80.83 & 10.12cm in F_2 and minimum 57.47 & 8.25cm in F1and control,

respectively. Three fertilizer treatments were seeded this, year except control, which ranged from 3.2g in F_1 to 32.10g in F_2 treatment. Plant growth performance was not significantly affected by fertilizer. Interaction of irrigation and fertilizer does not showed any significant effect on growth performance of *Jatropha* after 61- month of planting. Percent survival varied from 24 percent in (except control) to 32 percent in (T_0). The mean plant height and collar diameter ranged within 171.75cm (T_2) to 216.13cm (T_3) and 6.71cm (T_0) to 7.97cm (T_2), respectively. Whereas, the mean number of branches ranged from 16.34 in control (T_3) to 30.70 in (T_0). In pollarding trial, fruiting were observed in control and T_2 treatments during 2011-12. Analysis of variance suggested that effect of pruning is non -significant on all parameters of plant growth after 56 months of planting. Most of the plants started dying.

Project-7: Network research project on guggal *Commiphora wightii* Arn. Bhandari(AFRI-76/Silvi/ NMPB/2008-13).

Principal Investigator : Dr. D.K. Mishra, Scientist F

The clonal performance trial was established in RBD design with 4 replications and each replication has 8 plants per accession in September, 2007. The trial is 72-months old and survival varied from 40.63 of Jalore to 93.75% of Jaipur and Dausa. Mean plant height varied from 140.38±26.83a cm of Jodhpur to 223.33±41.88g cm of Jaipur, mean crown diameter from 113.08±40.51a cm in Jalore to 236.85±48.46g cm in Tonk and mean number of branches ranged from 5.62±0.85a in Jodhpur to 9.44±2.50i in Tonk. The data were significant for all the growth parameters at <0.05 probability level. On the basis of DMRT, height of all the 21 clonal sources divided in 7 groups, while crown are in 7 and branches are divided in 9 groups.

After 72-months of field planting, the main effect of various irrigation treatments showed that mean plant height (cm), number of branches and crown diameter (cm) ranged from **242.48±33.97**cm in I_1 to **253.98±31.67**cm in I_3, **9.13±2.17**in I_1 to **9.47±2.31**in I_2 and **264.79±41.68**cm in I_2 to **266.39±32.36**cm in I_3, respectively. The analysis of variance showed that irrigation intervals had significant effect on mean plant height and number of branches and crown diameter was unaffected by irrigation.

The main effect of fertilizer treatments showed that the mean plant height, number of branches and crown diameter varied from 241.28±40.47cm in F_2 and F_5 to 252.89±29.07cm in F_0, 8.64±1.69 in F_1 to 9.98±2.24 in F_7 and 254.20±48.10cm in F_1 to 274.33±37.96cm in F_2, respectively. Analysis of variance revealed that effect of fertilizer on plant growth with respect to number of branches was highly-significant while the plant height and crown diameter were significantly affected by fertilizer response.

Experiment was performed with the seeds collected from different time period (2010, 2011 & 2012). Seeds were collected from guggal germplasm at AFRI Arboretum. Nursery beds were prepared and filled with sand. Seeds were sown in the beds and germination counted daily. It started after three days and germination data was taken upto 20 days. Seed germination varied from 16.45% in 2010 to 36.73% in 2012.

Effect of fertilizers on various parameters like; mean seedling shoot height (cm), shoot collar diameter (cm), root length, number of primary branches, number of secondary branches, root

fresh weight (g), total fresh weight (g), root dry weight (g) and total dry weight (g) ranged from 19.90±10.32cm in M_3 to 47.83±16.15cm in C_4, 0.49±0.13cm in M_3 to 0.82±0.18cm in, 10.33±3.87cm in M3 to 21.00±8.65cm, 6.23±2.18 in to 10.87±3.44 in C_1, 12.80±5.18 in M_3 to 22.33±8.07 in C_1, 0.99±0.85g in to 4.51±2.23g in, 3.90±3.24g in to 13.89±7.31g in C_1, 0.19±0.19g in M_3 to 1.32±1.02g in $C_1$and 1.12±1.24g in M_3 to 5.76±3.39g in C_1, respectively. The analysis of variance showed that fertilizer affected all parameters significantly.

Poly-bag or root trainer size treatments on *Commiphora* seedlings have been studied and showed that mean seedling shoot height (cm), shoot collar diameter (cm), root length, number of primary branches, number of secondary branches, root fresh weight (g), total fresh weight (g), root dry weight (g) and total dry weight (g) varied from 23.09±7.75cm to 48.43±15.92cm in poly-beg large (PL), 0.56±0.11cm in root trainer small (RTS) to 0.78±0.15cm in poly-beg large (PL), 12.78±5.17 in to 21.43±6.62cm in poly-beg large (PL), 6.55±2.45 in root trainer small (RTS) to 9.66±3.12 in poly-beg large (PL), 13.78±4.82 in root trainer small (RTS) to 23.19±7.54 in poly-beg large (PL), 1.76±1.28g in root trainer small (RTS) to 3.94±2.69g in root trainer large(RTL), 5.35±3.24g in root trainer small (RTS) to 12.85±5.78g in poly-beg large (PL), 0.37±0.21g in root trainer small (RTS) to 1.12±0.94g in root trainer large(RTL) and 1.66±1.03g in root trainer small (RTS) to 5.79±3.49g in poly-beg large (PL), respectively. Analysis of variance revealed that effect of poly-beg or root trainer size on seedling total biomass parameter diameter were significantly affected by poly-beg or root trainer size response.

Effect of fertilizers and size of root trainers and poly bags on sturdiness quotient, volume index, and quality index and root shoot ratio have also been studied. The maximum SQ was 605.44 in C4, VI (304.40) in C1, QI (7.04) in G2 and RSR (0.37) in V4 was observed. However, in case of polybags and root trainers, it was maximum in 620.90, 294.65, and 5.31 and 0.31, respectively.

Keeping in view the important medicinal properties and large scale demand of oleo gum resin derived from *Commiphora wightii* (Guggal), experimental trials have been laid out to standardize various aspects of macropropagation of Guggal. Experiment were performed with different concentrations (100, 200, 500 and 1000ppm) of Indole-3-acetic acid (IAA) and Indole-3-butyric acid (IBA) on adventitious root formation on cuttings of 0.25-0.50cm in diameter in comparison to control. Maximum rooting percentage (93.33%) was recorded in 200ppm of IBA, followed by 500ppm (86.66%) as compared to control, which showed only 60 per cent sprouting. Third experiment was performed with newly formed juvenile micro-cuttings treated with varying concentrations of IAA and IBA. The juvenile cuttings of less than 8-10cm in length having less than 0.25cm basal diameter were selected as micro-cuttings. The cuttings treated with IBA (500ppm) showed 64.30% rooting as compared to other treatments. The aim of these studies was to develop a suitable macro-propagation technique for large scale production of superior clonal stock with maximum success at commercial scale with minimum input. The main finding of these experiment is that *Commiphora wightii* can also be propagated through micro cuttings having diameter of <0.25-0.50cm at large scale.

Project -8: A Coordinated project on integrated management of Khejri mortality for socio-economic upliftment in Rajasthan (AFRI-1/FPD).

Principal Investigator : Dr. S.I. Ahmed, Scientist G

Component I - Forest Protection Studies:

Co-PI: Dr.K.K.Srivastava, Scientist F

Data pertaining to infestation caused by pests/diseases was collected after six months of second treatment to evaluate the effectiveness of different treatments in the various experimental sites. It was observed that the treated trees exhibited improvement in comparison to control. Detail study on the bio-eco logy of *Acanthophorus serraticornis* has been carried out. Observations on the durations, dimension and weight of different larval instars have been recorded. Data has been collected on the egg laying behavior, incubation period and hatching of larval instars and development. The length of the body of 1^{st}, 2^{nd}, 3^{rd},4^{th} and 5^{th} instars reached a maximum of 2.58 ± 0.35, 4.47 ± 0.26, 6.75 ± 0.31, 9.7 ± 0.41 and 13.81 ±0 .82 cm, respectively. The larva developed through 5 instars in about 490 to 590 days with a total life-cycle of about 670 to 730 days. Data on the morphology of adult male and female beetles pertaining to their different body-parts has been recorded and study is in progress. Mortality percentage in different larval instars was also recorded. Data has been recorded and compiled on the emergence of adult, longevity of adult, mating behavior, fecundity of females etc. Further study on such aspect is in progress.

Pathogenecity test using *Ganoderma lucidum* as pathogen and Khejri as host has been successfully proved on one and half year old seedlings. The typical top drying symptom was observed after two months of inoculation of the pathogen. Moreover, the pathogen was re-isolated from the infected root of the seedling. *Ganoderma lucidum* has also been inoculated in collar portion of khejri tree at FPD field to study pathogenecity. After 9 months of inoculation no symptom of infection has been observed.

Component II - Genetics and Biotechnology:

Co-PI: P.H.Chawaan, Scientist F

Survey has been conducted in various districts of Rajasthan viz; Nagaur and Jaisalmer, 41 more CPTs were selected from these sites. Emphasis was given to select trees from the areas relatively free from mortality and successive lopping in order to insure that pods can be harvested for further investigation and establishment of germplasm in the form of production population. The selected trees exhibited vide variation as indicated by the range and variance for different selection criteria, which is beneficial for maintaining breeding population with wide genetic base.

Pods have been collected from selected CPTs where available and parameters from individual pods of these CPTs like length, width and weight has been taken. The data from collected pods

Fig 10. CPTs of *Prosopis cineraria*

from individual trees was subjected to statistical analysis, followed by estimation of genetic parameters. Analysis revealed highly significant variation (P=.000) amongst the 11 CPTs for all the pod characters. Variation in trees contributed significant amount to the total variation as suggested by higher proportion of genotypic coefficient of variation (Fig 11). All three pod parameters were very highly heritable these values ranged from 93 to 96 percent. The broad sense heritability values were also coupled with high genetic gain estimates (Fig 12.) suggesting improvement in these traits by individual selections.

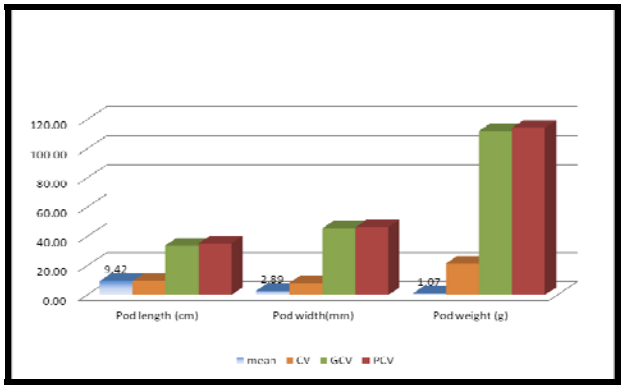

Fig 11. Descriptive parameters in pod characters of *P. cineraria*

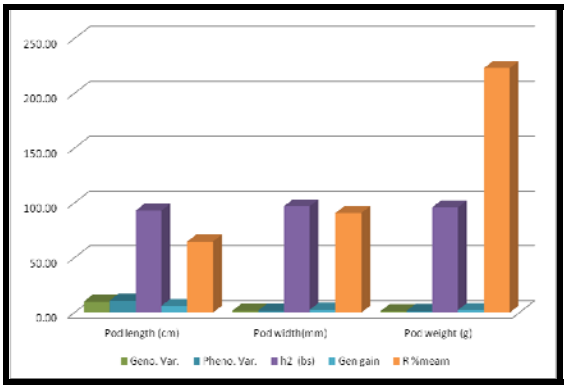

Fig 12. Estimates of genetic parameters in pod characters of *P. cineraria*

Experiment (12) on rooting of cutting utilizing semi hardwood cuttings were conducted with different rooting hormone treatments and conditions viz; open, shade house, poly tunnels and mist chamber. However, none of the treatment combinations were found to be inducing rooting. Only sprouting in treatment with 600 and 800 PPM of IAA, NAA and IBA alone or with thiamine under polytunnel and mist chamber conditions was observed. In addition to this, layering experiments has done on mature plant of *P. cineraria* using different concentration of plant growth hormone IBA like 500ppm, 1000ppm and 1500ppm.

Component III - Biotechnology:

Co.PI.- Dr. Tarun Kant, Scientist E

Stem nodal segments from mature tree were taken from tree directly without lopping and after lopping and the emerging new shoots were used. These nodal stem segments were cultured on MS medium supplemented with auxin (IAA) and cytokinins (Kn and BAP). Micro-shoot multiplication has been achieved from seedling derived material on MS+5.0 mg/l+ 1.0 mg/l IAA+addetives. Experiments on achieving micro-shoot multiplication are continuing from mature stem nodal segments. Rooting experiments were performed on the micro-shoots obtained. Best rooting was achieved on MS medium supplemented with 3mg/l IBA. DNA isolation and purification has been optimized. PCR conditions have been optimized. 10 out of Genei Primer sets of 25 primers have been tested.

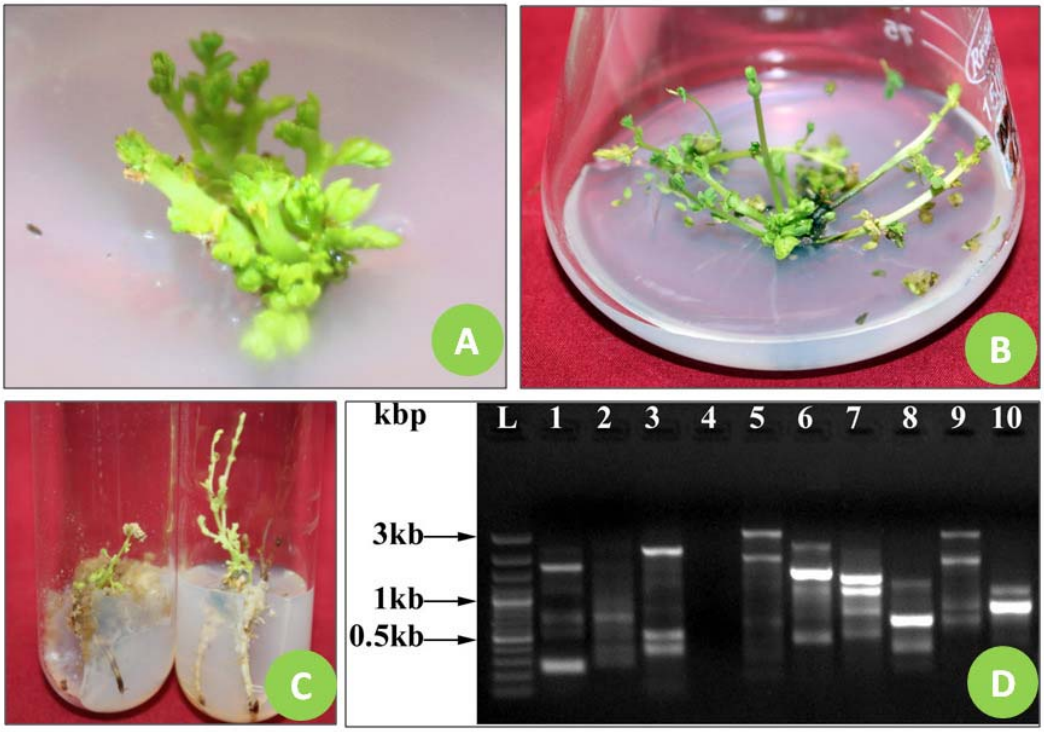

Fig 13. (A-D): Tissue culture of Prosops cineraria: A. Multiple shoot initiation from mature stem nodal segment on MS+5mg/l BAP+ Additives; B Multiple shoot elongation; C. in vitro rooting of shoots on half strength MS + 3 mg/IBA; D. DNA Banding pattern using 10 Genei RAPD primers

Component IV- Ecological Component:

Co- PI: Dr. Abha Rani, Gupta, Scientist E

Survey of Khejri mortality areas in like Merta Road and Rotu in Nagaur district and Fatehpur in Sikar district was done for vegetation studies and soil sampling. For vegetation studies 100m X

100m plots were laid out and tree species were recorded in all the above mentioned districts. For shrubs 5m X 5m and herbs 1m X 1m subplots were laid down in the main plot. Vegetation data has been computerized and biodiversity analysis is in progress. For abiotic stresses, metrological data like; maximum and minimum temperature, vapor pressure, relative humidity, evaporation, wind speed, sunshine and rain fall of Jodhpur were recorded. For Jodhpur district in 2012, maximum rainfall was recorded in the month of August which was 291.1 mm. Maximum temperature was recorded in the month of May (41.6 C) and minimum in January (9.3 C). Maximum evaporation was recorded in the month of June (12.9 mm) and minimum in January (3.5 mm). Highest wind speed recorded was in the month of June (11.2 km/h) and minimum in October (1.7 km/h). Maximum sunshine recorded was in the month of May (10.3 h) and minimum in January (7.7 h). Pre monsoon ground water table data of Churu, Jhunjhunu, Nagaur and Sikar were also recorded.

Soil samples were collected from 4 depth (0-15, 15-30, 30-45 and 45-60 cm) from each site and being analyzed. According to the analysis of soil samples, it was found that minimum pH was recorded in soil sample collected from Merta Road i.e. 6.82 and maximum i.e. 764 from Fatehpur. Maximum Electrical Conductivity (EC) was found in the soil sample collected from Merta road (0.331 mScm-1) and minimum (0.067 mScm-1) from Fatehpur.

Component V- Biochemical Studies:

Co-PI: Dr.Mala Rathore,Scientist D & Dr.Sangeeta Singh,Scientist D

For systemic acquired resistance study in Khejri, initial step was establishment of pathogen (*Ganoderma lucidum*) on the host. The pathogen was inoculated and successfully established on the host (*Prosopis cineraria*). The infected stem portion was removed and systemic chemical (10 mM) Salycilic acid was sprayed on the seedling. Meanwhile samples at one months interval are being collected to study the induction of defense enzymes like PAL and phenolics.

Leaf and pod samples were collected from infected and healthy trees of *P. cineraria* (Khejri) from Jodhpur, Nagaur, Sikar, Churu, Jhunjhunu districts and their morphological parameters were recorded. Samples were analysed for various biochemical parameters. Sugar content was found to decrease from 6.8 % in resistant trees to 5.6% in infected trees (Surani site) and 8.18% (in resistant trees) to 5.32% (in infected trees) at Nagaur site. The healthy tree leaves of Jhareli (Nagaur) were found to have 65.8 µg/g phenol content as compared to 77.8 µg/g in infected trees. Average content of petroleum ether extract in pods was found to be higher in healthy trees and less in infected trees in Surani and Raghunathpura sites. Methanol extractives were maximum in infected (15. 58%) and minimum in resistant trees 13.31% (Raghunathpura site) . Similarly, methanol content was higher (19.36%) in infected trees and less (18.83 %) in healthy trees (Surani site). Ash content was high in infected trees (8.5%) and less (7.39%) in resistant trees. Average potassium content was found higher in healthy tree leaves (0.40mg/g) as compared to in infected tree leaves (0.32mg/g) from Jhareli (Nagaur) region. Average proline content was found higher in infected trees (6.25 µmoles per gm) than in healthy trees (5.1 µmoles per gm).

Component VI - Socio-Economic:

Co-PI: Dr.Sunil Kumar, Scientist E

A detailed socio-economic survey of 121 villages of Jodhpur, Churu and Nagore districts were conducted to know the overall assessment of khejri mortality in terms of livelihood and economic losses and on fodder and fuel availability to the farmer. The farmers were interacted and questionnaire was filled up by direct face to face interview. Nearly 1200 of farmers were interacted and information regarding khejeri mortality was recorded.

On the basis of visual observation given by the farmers, it can inferred that a healthy well grown khejri tree is providing 30 to 35 kg of fodder in Nagore district in addition to fuel wood to the farmers (10 to 12kg.). The Women are spending nearly 2 to 3 hours daily to collect the fuel wood from their own landor from community land.

Component VII - Extension Component :

Co-PI: Mrs.Bhawana Shrama,Scientist C

Brochures about the problem of Khejri mortality were distributed to stakeholders and visitors during various activity of Institute. Under miscellaneous extension activities, brochures about problem of Khejri mortality were distributed in kisan melas, organized by CAZRI Jodhpur on 12 Sep., 2012. During socioeconomic survey, brochures were distributed to farmers of Nagore District for raising awareness in public about Khejri mortality problem. In this pamphlet, problem of khejri mortality and recommendation for control and various factor affecting khejri tree were explained in simple language. A lecture on Khejri mortality problem was delivered under DTC training at KVK Pali. Lecture on Khejri mortality problem was also conducted under IWNP training programme.

Project 9: Induction of systemic acquired resistance in rohida against stem canker (AFRI-100/FPD/ICFRE/2010-2014).

Principal Investigator : Dr. Sangeeta Singh, Scientist D

The potted experiment of nursery was transplanted in field, in which the pathogen was established in the seedlings and then they were treated with Jasmonic acid (10mM), salicylic acid (10mM) and *Trichoderma viride* 10 g/litre of water (10 ml per seedling). Samples after 30 days, 60 days and 90 days were collected for further biochemical studies. The biochemical study has been in terms of change in concentration of total protein, sugar, phenolics and phenylalanine lysase (PAL) of the seedling treated with chemicals with that of seedling which were not treated with chemicals. It is evident from the results that when the pathogen infected seedlings were treated with SA (10 mM), JA (10 mM) and *Trichoderma viride* a bioagnet (10 g /litre), the concentration of protein, phenolics and (PAL) increases as days passes from 30 to 60 to 90 days as compared to only pathogen infected seedlings in which concentration of protein decreases, while there in non

significant increase in concentration of PAL and phenolics. Total sugar concentration is decreasing in all the treatments as well as in pathogen infected seedlings.

The result has been observed of protein, without treatment of seedlings after 30 days, 60 days and 90 days. Protein level in 1 gm leaves of control was 0.26mg, 0.70mg and 1.00mg. Whereas, in the infected seedlings level of protein after 30 days, 60 days and 90days were 0.45mg, 0. 75mg and 0.82mg, respectively.

In the other case, when seedling treated with JA, SA and *Trichoderma* after 30 days, 60 days and 90 days, protein contain in 1gm of leaves treatment with Salicyclic acid (5mM) is 0.76 mg, 0.94 mg and 0.94 mg, treatment with Salicyclic acid (10mM) was 0.52 mg, 0.68 mg and 1.00 mg, treatment with jasmonic acid (10mM) was 0.61, 0.71 and 0.90, treatment with *Trichoderma* (1 plate full growth population plate use at 500ml of water) was 0.42 mg, 0.63 mg and 0.80 mg and with pathogen total protein contain in 1 gm. Of leaves sample is 0.82 mg, 0.76 mg and 0.76 mg, respectively.

Sugar

The result has been showed in sugar, without treatment of seedlings after 60 days and 90 days. Sugar level in 1 gm. leaves of control was 428 and 457. Whereas, in the infected seedlings level of sugar was after 60 days and 90days were 285 and 294 respectively.

In the other case, when seedling treated with JA, SA and *Trichoderma* after 30 days, 60 days and 90 days, sugar contain in 1gm of leaves treatment with Salicylic acid (5mM) was 452, 307 and 72, treatment with Salicylic acid (10mM) was 498, 267 and 239, treatment with jasmonic acid (10mM) was 243, 240 and 149, treatment with *Trichoderma* (1 plate full growth population plate use at 500ml of water) was 167, 261 and 41 and with pathogen total protein contain in 1 gm of leaves sample was 486, 329 and 37 respectively.

Phenol

Phenol level in 1 gm. leaves of control was 0.47 and 1.5. Whereas, in the infected seedlings level of phenol was after 60 days and 90 days was 0.42 and 1.5, respectively.

In the other case, when seedling treated with JA, SA and *Tricoderma* after 30 days, 60 days and 90 days, phenol contain in 1gm of leaves treatment with Salicylic acid (5mm) was 0.76, 0.76 and 1.71, treatment with Salicylic acid (10mm) was 0.66, 0.66 and 1.54, treatment with jasmonic acid (10mm) was 0.66, 0.50 and 2.58, treatment with *Trichoderma* (1 plate full growth population plate use at 500ml of water) was 0.30 ,0.79 and 2.20 and with pathogen total protein contain in 1 gm. Of leaves sample was 0.40, 0.64 and 0.96 respectively.

PAL

PAL level in 1 gm. leaves of control was 10, 11.8 and 11.9. Whereas in the infected seedlings level of protein after 30 days, 60 days and 90days was 21.44, 24.41 and 27.77, respectively.

In the other case when seedling treated with JA, SA and *Tricoderma* after 30 days, 60 days and 90

days, PAL contain in 1gm. Of leaves treatment with Salicyclic acid (5mm) was 25.92, 25.94 and 24.90, treatment with Salicyclic acid (10mm) was 12.7, 12.8 and 13, treatment with jasmonic acid (10mm) was 11.5, 11.7 and 12.5, treatment with *Trichoderma* (1 plate full growth population plate use at 500ml of water) was 10.2, 10.5 and 11.2 and with pathogen total protein contain in 1 gm of leaves sample was 28, 28.9 and 30, respectively.

Project-10: Studies on seed insect pests of indigenous and exotic forest tree species and to develop IPM packages for major insect damages in Gujarat (AFRI-107/GCR/SFD-Guj./2011-2014).

Principal Investigator : Dr. Meeta Sharma (RO)

The seed samples of eight tree species have been collected from ten selected sites of Gujarat. The nine species of Bruchidae, three species of Tortricidae, two species each of Coreidae, Tineidae, Pyrealidae, and one species each of Anthribidae, Lycaenidae, Curculionidae, Pyraustidae, Thripidae, Eurytomidae, Tenebrionidae, Geometridae, Cosnopterygidae, Noctuidae, Arctiidae were found on the seeds, fruits and flowers of *Acacia nilotica.* The four species of Geometridae, three species each of Yponomeutoidea and Curculionidae, two species of Chrysomelidae, one species each of Oecophoridae, Psychidae, Tortricidae, Lymantridae, Arctiidae, Papilionidae, Saturniidae and Noctuidae were found on the seeds, fruits and flowers of *Ailanthus excelsa*. The seven species of Bruchidae, two species of Muscidae, one species each of Otitidae, Cicadellidae, Tarymidae, Cosmopterigidae, Olethreutidae, Coreidae and Curculionidae were found on the seeds, fruits and flowers of *Prosopis cineraria.* The one species each of Phlaeothripidae and Coccoidea were found on the seeds, fruits and flowers of *Azadirachta indica.* The two species of Pyralidae, one species each of Anobiidae, Crambidae, Membracidae, Hyblaeidae, Geometridae, Chrysomelidae and Arctiidae were found on the seeds, fruits and flowers of *Tectona grandis.* The two species of Pieridae were observed on the seeds, fruits and flowers of *Salvadora persica.*One species of Yponomeutoidea was observed on the seeds, fruits and flowers of *Boswellia serrata.* Some larval parasitoids, tachnids, mantids, chalcoids, reduviids and carabids were also found as predators. The life cycle of some major pest like *Atteva fabriciella, Eligma* sp. on *Ailanthus excelsa,* and *Caryedon serratus* on *Acacia nilotica* had been done. The studies related to fluctuations in seasonal population of important seed pests are in progress. Preparation of checklist of insect pest spectrum is being carried out. The collected seeds from various sites in Gujarat have been kept in different types of containers to find out the efficacy of containers for the storage purposes.

Fig 14. *Atteva fabriciella*(dorsal view) (microscopic photograph)

Fig 15. Caterpillars of *A. fabriciella*

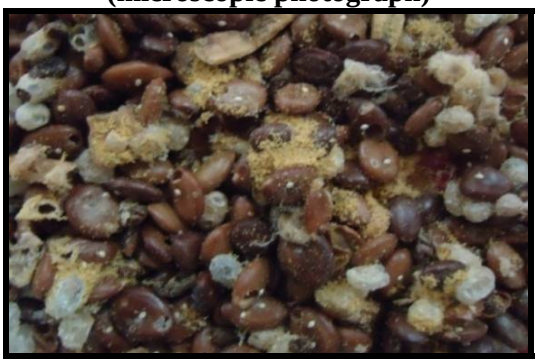

Fig 16. Infested seeds of *Prosopis cineraria*

Fig 17. Infested pods of *Acacia nilotica*

Fig 18. *Caryedon serratus* attack on seeds of *A. nilotica*

Fig 19. Pupa of *Caryedon serratus*

Fig 20. 5th instar larva of *Eligma narcissus* on *A. excelsa* leaves

Fig 21. Adult of *Eligma narcissus* on *A. excelsa* leaves

Project-11: Evaluation and selection of efficient strains of AM fungi & Rhizobium for *Acacia nilotica* and *Ailanthus excelsa* in Western Rajasthan (AFRI-103/FPD/2010-2014).

Principal Investigator : Dr. Neelam Verma, RO

Rhizosphere soil of *Acacia nilotica* var. *cupressiformis* and *Ailanthus excelsa* were collected from Pali and sojat. Soil samples were analyzed for pH, EC, (%) organic carbon (% OC), phosphorous (P). The important five genera namely, *Glomus, Gygospora, Scutellospora Acaulospora* & *Sclerosystis* and 12 sp. *viz. G. aggregatum, G. constrictum, G. deserticola, G. fasciculatum, G. macrocarpum, G. microcarpum, G. occultum, G. pubescens, Glomus sp., Sclerosystis indica, Scutellospora bionarta*, *Acaulspora biculata* were isolated & identified in natural plantations of *A. nilotica var. cupressiformis* from Jodhpur & Pali districts. Among these five genera, *Glomus* occurred most frequently. Out of which, *G. fasciculatum* was dominant species in all the sites in plantations. The soil pH is important factor for spore germination. Soil pH of *Acacia nilotica* ranged between 7.3-7.4 and in *Ailanthus excelsa* from 6.9-7.4 in rhizosphere soil.

In nursery experiment, different doses of indigenous inocula with *Rhizobium* were tested on *A. nilotica var. indica*. The observations showed indigenous dose was superior to non-indigenous. The AM/*Rhizobium* treated plants performed better in increasing biomass (shoot height, root length, shoot & root fresh weight, shoot & root dry weight), percentage of root colonization than un-inoculated plants. Similar observation was with *Ailanthus excelsa* seedlings treated with indigenous inoculum of *G. fasciculatum*. The optimum dose of inoculum was 50 gm/polybags and was found the best for better growth of *Acacia nilotica* with dual inoculation of AM and *Rhizobium* as compared to *A. excelsa* (100gm/polybag).

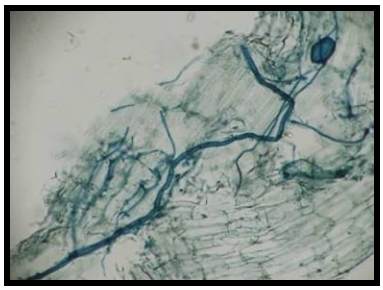

Fig 22. ***Intercellular hyphae present in root of A. excelsa***

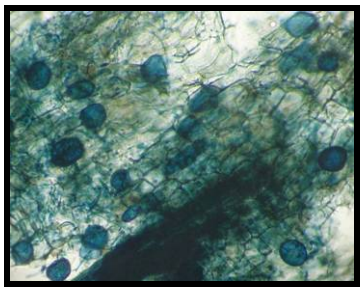

Fig 23. ***Vesicles present in root of A. excelsa***

Fig 24. ***Glomus spores attached with root of A. excelsa***

Fig 25. ***Germination of young spore of Glomus sp. collected from A. excelsa***

Fig 26. ***Two young sporse of Glomus sp. collected from A. excelsa***

Fig 27. ***Glomus sp. colleceted from A. excelsa***

Fig 28. ***Sclerocystis sp. Collected from A. nilotica cupressiformis***

Fig 29. ***Sclerocystis sp. Collected from A. nilotica cupressiformis***

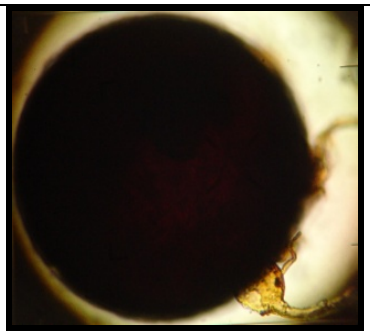

Fig 30. ***Scutellospora sp. collected from A. excelsa***

Project-12: Innovative approaches for augmentation of composting and biofertilizer production in hot arid regions (AFRI-111/FPD/2011-14).

Principal Investigator : Dr.K.K. Srivastav, Scientist F

Litter decomposition mycoflora were isolated and identified as *Aspergillus niger, Aspergillus flavus, Trichoderma viride*, *Fusarium* sp and *Actinomycetes* and identified as *Streptomyces*. Three litter decomposing fungi, *Trichoderma viride*, *Aspergillus niger* and *Streptomyces* were selected for amendment for rapid composting process. It was observed that the microorganisms were responsible in decreasing the duration of compost and within 50 days compost was ready to be used. Whereas, in anaerobic composting (in pits) by using Farm Yard Manure + Dried leaves + Niprovat (containing *Trichoderma viride*) with mulching has taken 120 days in winter. Mass multiplication of indigenous consortium inoculum with dominancy of *Glomus fasciculatum* of AM fungi of *Prosopis cineraria* (Khejri), *Azadirachta indica* (Neem) and *Acacia nilotica* (babul) were prepared in pots and beds. Data on moisture content (%) and temperature were recorded regularly of the experiment laid out on anaerobic composting by using different host species and *Trichoderma* sp. & *Strepotomyces* sp. Compost samples collected from traditional and non-traditional methods were analysed for Soil Organic Carbon (SOC) and pH. The samples were analysed for Soil Organic Carbon (SOC), pH, EC, and isolation of litter decomposing mycoflora associated in process of composting and vermi-composting by adopting standard technique. The microbial population was noticed higher in vermi-compost as compared to compost.

An experiment was laid out with various combinations of host species with the amendment of *Trichoderma viride, Aspergillus niger* and *Streptomyces* sp. The microbial population was studied by serial dilution technique in which colony forming units were counted at 10^2, 10^4 and 10^5 dilutions for fungi and actinomycetes and 10^6, 10^7 for bacteria. Media used for fungus was Potato Dextrose Agar (PDA) and nutrient agar was used for bacterial cultures. Microbial population was measured in the compost and the total fungal population varied from 10^4 to 10^5 per gram of compost in the treatments T1 to T4 (**T1:** Neem leaves with FYM (+); **T2:** Only neem leaves (+); **T3**: Mixed leaves with FYM (+) and **T4:** Only mixed leaves (+) supplemented with additional microflora) while the treatments in which additional supplement of fungus and actinomycetes was not added the fungal population was 10^4. Bacterial population was 10^7 per gram of soil invariable in each treatment.

Multiplications of bio-agents –*Trichoderma viride* has been successfully maintained in sorghum seeds and are being used as amendment in aerobic and anaerobic composting process. The bacterial biofertilizers like, *Azospirillum leporum* , *Bacillus coopilense* and *Azotobactor crucoccum* are being maintained in nutrient broth medium and further mass multiplication in liquid media for experimentation.

Aerobic composting (heap method) is being prepared in shade house by using indigenous strain of *Trichoderma viride* (500gm in 20 kg FYM) + PSB (250ml in 20 lit. of water) + dried leaves. The treatment was given by layering method. The composting process has taken 90 days, whereas in traditional process, it takes 120 days. The nutrient status and microbial population was also recorded high with the amendment of *Trichoderma* and PSBs.

(A) *T. viride* (indigenous strain) and PSB suspension

(B) Mixing of *Trichoderma* culture in FYM

(C) Layering of *Trichoderma* culture on raw material

(D) Drenching with PSB suspension

Fig 31 (A-D). Aerobic composting by using *Trichoderma viride* and PSBs

Project-13: Evaluation of antifungal potential and identification of broad spectrum antifungal compound from selected tree/shrubs/weeds of Indian arid region (AFRI-93/AFE/2009-14).

Principal Investigator: Smt. Bhawana Sharma, Scientist C

Name of plant Species:

i. *Balanites aegyptiaca* Linn
ii. *Tephrosia purpurea (L.) pers*
iii. *Citrullus colocynthis L. (Tumba)*
iv. *Tribulus terristis L.*
v. *Argemone maxicanaLinn. (*Prickly poppy*)*
vi. *Solanum xanthocarpum L.(*Kantakari*)*
vii. *Datura stramonium L. (*Thorn apple*)*

Antifungal properties of selected plant parts were evaluated against fungal pathogen. Collection of leaf, root & flower bud of *Datura stramonium*, leaf & root of *Tribulus terrestris*, root, flower and fruit of Argemone *mexicana,* seeds of *Tephrosia purpurea* were carried out. The collected plant material were washed with distill water and dried in shade. Dried plant material was finely grinded. The powdered plant material of each plant was further extracted with respective solvents (water and ethanol) using soxhlet. Ethanolic extracts were dried with the help of rotary evaporator and water extracts were dried with the help of water bath. These two types of extracts were prepared aqueous and ethanolic from every plant, and evaluated against target fungi.

After evaluating antifungal properties against five fungus, following results were obtained for antifungal assay, pure culture of fungal pathogen were periodically sub-cultured and maintained on PDA medium and pure cultures were stored in refrigerator for further use. Antifungal activity of extract was determined by poison food technique. PDA potato dextrose agar was used as the medium for anti fungal assay. In petriplates, known concentration of extracts were mixed with melted medium and inoculated with fungus (5mm disk of fungus was cut from actively growing fungus and transferred in the central of petriplate containing plant extract) and kept in incubator at 28˚C temperature, the inhibition zones from the centre was measured in millimeters and recorded.

i) Alcoholic extract of *Datura stramonium*, root showed good antifungal activity against A*lternaria alternata* (ii) Alcoholic extract of *Datura stramonium* root showed mild antifungal activity against *Fusarium solani*. (iii) Aqueous extract of *Tephrosia purpurea* seeds showed mild antifungal activity against *Rhizoctonia solani* and good antifungal activity against *Fusarium solani.* (iv) Alcoholic extract of *Datura stramonium* bud showed good antifungal activity against *Fusarium vertecelleoides.*

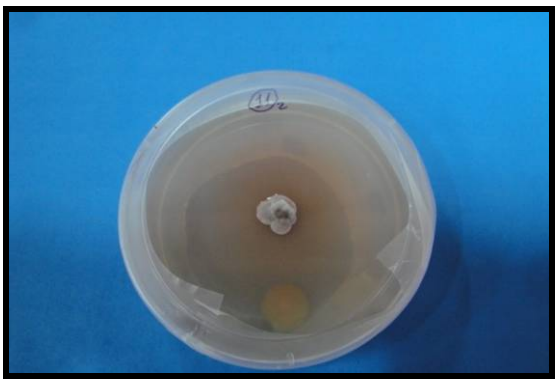

Fig 32. Datura root ethanolic extract *against Alternaria alternata*

Fig 33. Datura root ethanolic extract *against Fusarium solani*

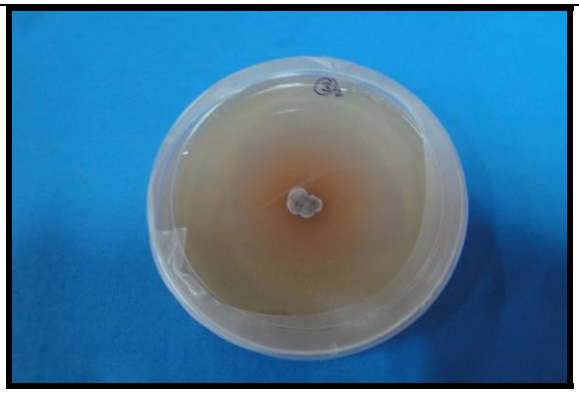

Fig 34. *Tephrosia purpurea* seed aqueous extract against *Fusarium solani.*

Fig 35. *Tephrosia purpurea* seed aqueous extract against *Rhizoctonia solani*

Project-14. Productivity and biometrics studies on some important species in semi-arid regions of Rajasthan for their sustainable management (AFRI-95/Silvi/SFD/2009-12).

Principal Investigator : Dr. Sunil Kumar, Scientist E

Laid out 14 sample plots in IGNP area (Mohangarh) and Dadia (Sojat) of *Prosopis cineraria* and *Ailanthus excelsa*. Measurements were taken of all eight sample plots at 3 RD, 08 RD, 1447 RD, 1340 RD, 1387 RD, 1355 RD, 740 RD & 704 RD of *P. cineraria and s*ix sample plots of *A. excelsa* laid down at 19KJD, CSP-KJD 0-17 RD, 802 RD, 9 MD, 0-2 RD & Dadia (Sojat). Also crown diameters and height at first branching, merchantable height at 8 cm diameter. Mid diameter over and under bark of log at each of 3 meter of felled trees were recorded,. The surrounding of sample area selected for permanent sample plots of *P. cineraria & A. excelsa* (both sides) were marked with rings of red colour paints for its identity. The trees lying within the selected area were numbered and plus marked with black paints at 1.37 m height, L-shaped trench were dug in corner of each permanent sample plots. Diameters, height of every standing tree in permanent plots were recorded for both of the species were recorded for year 2012-13.

Project -15: Productivity study and modeling growth and yield in Teak Plantation in Gujarat state (AFRI-96/Silvi/SFD/2009-14).

Principal Investigator : Dr. Sunil Kumar, Scientist E

The survey of teak plantations was conducted at Varodara, Narmada, Panchmahal, Baria, Vyara, Dangs, Rajpiplla, Dahod and Godhara divisions. Out of the thirty two sites visited. , Nine suitable sites were selected for studies. The PCCF, Gujarat State Forest Department has granted permission of lying out of nine permanent sample plots and also permission for felling of total 40 numbers of trees of *Tectona grandis* of different diameters classes, five each from the surrounding of each permanent sample plots of the plantations for productivity studies.

Project-16: Market survey on selected species in selected markets (AFRI-58/Silvi./1994-

continue).

Principal Investigator : Dr. Sunil Kumar, Scientist E

Data pertaining prices of timber such as *Tectona grandis, Dalbergia sissoo,* fuel-wood of mixed species, bamboo and poles were collected from the private markets of Jaipur and Ahmadabad in the end of each of four quarters. Data were compiled on prescribed formats and submitted to ADG (Stat.), ICFRE, Dehradun for publication of Timber and Bamboo Trade Bulletin.

Project-17: Productivity enhancement of Kair (*Capparis decidua*) to generate livelihood in rural area of 'Thar Desert" (AFRI-07/NWFP/Ext/(SFD-RAJ)2013-16).

Principal Investigator: Dr. Ranjana Arya , Scientist F

This project was sanctioned in March 2013 for three years. Fruit of *C. decidua* are valuable products which yield supplementary income to the rural people. Project aims to develop technology for fruit yield enhancement of Kair. The Short term objectives of the project are as;

- **To study the effect of moisture conservation methods on fruit yield**
- **To study the effect of organic (FYM) fertilizers on fruit yield**
- **To study the effect of inorganic (NPK & Zn) fertilizers on fruit yield**
- **To extend the package of practices to be developed to the villagers**

Kair has the ability to survive in various habitats under extreme condition of temperature of arid region. Discussions were held with Sh A. K. Singh, CCF Jodhpur regarding availability of forest area with sufficient Kair population to lay the trials. Accordingly preliminary survey was undertaken in Khari Khurd Jode, Forest Range Luni, Grass Jode A, Hariyada in Bilada and Panchayat land at Joliyadi phanta near Bambore, Jodhpur for site selection. At Khari Khurd Jode Forest Range Luni and Grass Jode A, Hariyada in Bilada.

3. Biodiversity Conservation and Ecological Security

Project-18: Documentation of sacred groves of Rajasthan and assessment of biological diversity in some of them for improved management and people livelihoods. (AFRI-09/FE/Ext(SFD-RAJ)/2013-15)

Principal Investigator: Dr. G. Singh, Scientist - F

Sacred groves (Oran in western Rajasthan) are scattered all over the country, but do not enjoy protection via a federal legislation. Whereas, many sacred groves represents certain forest types and help to conserve some important species like; *Anogeissus cerecea*, *Salvadora oleoides*,

Zizyphus spp., *Phoenix* groves, *Holoptelia integrifolia* etc., these are threatened because of increasing pressure of human and livestock population. Several encroachments have taken place, and have been regularized by the Governments. These lands have not even been declared as forest lands, thus effective legislation is not applied in the case of offenders. There is need to inventories biological diversity and the various issues related to it in detail. In view of the above, this project was with the objectives (i) to document and assess floral diversity of the important 'sacred groves' in different districts of Rajasthan; (ii) to identify and record faunal diversity countered in the above-mention 'sacred groves'; and (iii) to suggest suitable management strategies to increased diversity and productivity for improved local benefits and climate change adaptation. Survey done for 11 sacred groves showed that high plant and animal diversities are available in these areas. Out of 11 sacred groves surveyed, IVI value indicates that *Salvadora oleoides* (IVI, 125.1-199.7) and *Capparis decidua* (IVI, 198.1-300.0) dominated at three sites each. *Anogeisus serecea* (IVI, 279.2), *Prosopis juliflora* (IVI, 156.1), *Acacia leucophloea* (148.6), *Prosopis cineraria* (IVI, 300.0) and *Tectona grandis* (IVI, 149.7) dominated among tree species at one site each. Among the shrubs, *Cassia auriculata* (IVI, 205.5-300.0) dominated in Pali, whereas *Z. nummularia* (IVI, 178.7-300.0) is dominated in Jaisalmer districts. *Lantana camara* (IVI, 122.1) is dominated shrub in Banswara. *Anogeissus serecea* at Lavaji Ka Oran in Pali and *Capparis decidua* in Kolu Pabuji Ka Oran in Jaisalmer does not have shrub as the under canopy. Because of invasion, *P. juliflora* superseded *Salvadora oeoides* at one site in Pali resulting in change in vegetation type. *Salvadora-Cassia auriculata* type, *Acacia leucophloea- Cassia auriculata* type, *Salvadora* scrub type, *Zizyphus* scrub types Dry teak type of forest are some examples.

Fig 36. *Anogeissus rotundifolia* trees in Lavaji Oran, Pali

Fig 37. *Acacia leucophloea-Cassia* type in Mataji Ka Oran, Pali

Fig 38. *Salvadora- Cassia* type in Devnarayanji Oran, Pali

Fig 39. Invasion of *Salvadora* area by *P. julflora* in Devnarayanji Oran, Pali

Project-19: Screening, identification and preparation of a comprehensive check- list of the Lepidopteron fauna of Sasan Gir Wildlife Sanctuary of Gujarat state" (AFRI-108/GCR/2011-14).

Principal Investigator : Dr. Meeta Sharma, RO

The survey had been conducted in Gir Wild life Sanctuary to identify the suitable sites, where the prominent population of butterflies and moths are found and the sites had been identified. Periodical visits had been conducted in selected sites (East &West Gir) in order to collect systematic & random sampling. Detailed record and description of various sampling sites had been maintained and displayed in the map. The record sheet of butterflies and moth had been maintained along with the photographic documentation. The sixteen species of Nympalidae, ten species of Pieridae, four species of Papilionidae, two species of Arctiidae, two species of Sphingidae, two species of Noctuidae and two species of Lycaenidae have been identified in sixty eight locations of East and west Gir. The detailed life history of *Danais chrysippus* (Nymphalidae) had been studied. A checklist of Lepidopteron fauna associated with plant species present in Gir Wildlife Sanctuary, Sasan is under preparation. Screening and listing of most important rare and endangered species of lepidopteron fauna is under preparation.

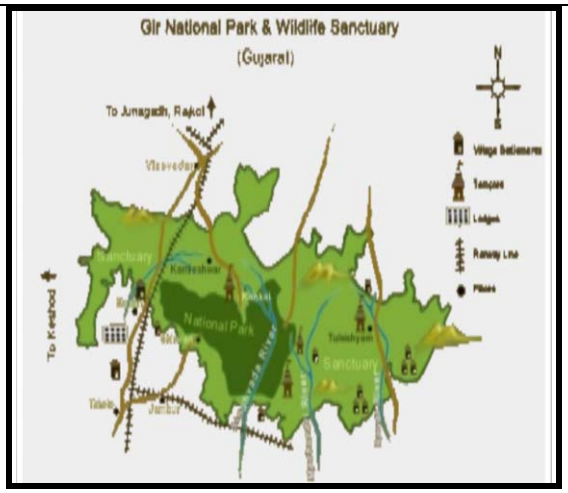

Fig 40. Map of Gir wild life sanctuary

Fig 41. ***Hypolimnas misippus*** **(Nymphalidae) Schedule-II Indian wildlife protection act 1972**

Fig 42. ***Euploea core*** **(Nymphalidae) Schedule-IV Indian wildlife protection act 1972**

Fig 43. ***Castalius rosimon*** **(Lycaenidae) Schedule-I Indian wildlife protection act 1972**

Project-20: Impact of *Prosopis juliflora* on biodiversity, rehabilitation of degraded community lands and as a source of livelihood for people in Rajasthan State (104/AFRI-2010-2014).

Principal Investigator : Mrs. Seema Kumar, Scientist D

Extensive studies were carried out in Jodhpur, Pali, Jaipur (Sambhar) and Bharatpur districts of Rajasthan state to study the impact of *P. juliflora* on biodiversity, rehabilitation of degraded lands and as a source of livelihood. Recorded 38 species of herbs, shrubs and trees found associated with *P. juliflora*. 30 species of invertebrates and 72 species of vertebrates were also found associated and dependent on *P. juliflora*. *P. juliflora* was recorded as new host for two species of insects belonging to Order Coleoptera (*Mylabris* sp.) for the first time. 12 faunal species under various conservation status were found associated and dependent on *P. juliflora.*

Studies on utilization aspect revealed that *P. juliflora* is a tree of innumerable uses. The main utilization of *P. juliflora* was as fuel wood & bio-fencing. It is utilized as fodder by the human for cattle. Pods are utilized by herbivores as food. Dry twigs were found to be utilized by 18 species of birds for making nests. The tree provides shade to both humans and animals including wildlife

for their dwelling beneath it. Tender leaves are of medicinal value. *P. juliflora* can be utilized for rearing of cantharidin producing beetles *Mylabris* species.

Studies on plant species revealed that both exotic as well as indigenous tree species are growing well in the areas of *P. juliflora* spread. Some of the important tree species were *Azadirachta indica*, *Prosopis cineraria*, *Tecomella undulata*, *Anogeissus* sp. *Salvadora* sp., *Acacia tortilis*, *Leuceana leucopholea*, etc.

4. Forest and Climate Change

Project-21: Studies on carbon sequestration in different forest types of Rajasthan (AFRI-88/EED/ 2008-12).

Principal Investigator: Dr. G. Singh, Scientist - F

Project was started with objectives (i) to estimate carbon stock in forest soils, (ii) to estimate carbon stock in forest litters, and to estimate carbon stock in aboveground and below ground biomass; with broader objective 'to provide an estimate of carbon stock of forests in Rajasthan' for its utilization in planning and execution of afforestation/ reforestation programme in this region. In the year 2012-13, data compilation on dominant vegetation (tree/shrubs) in 196 forest blocks of six districts namely Alwar, Ajmer, Baran, Bikaner, Kota and Sirohi indicated 26 dominant types of forest (including TOF). Out of the total, 36 forest blocks are dominated by TOF, 32 forest blocks by *P. juliflora*, 25 by *Anogeissus pendula* forests, 17 by *Butea monosperma*, 14 by Desert Dune scrub, 12 by *Acacia leucophloea - Z. nummularia* and 10 forest blocks are dominated by *Acacia senegal* tree. Other dominant types cover less than 5 forest blocks (Figure 44).

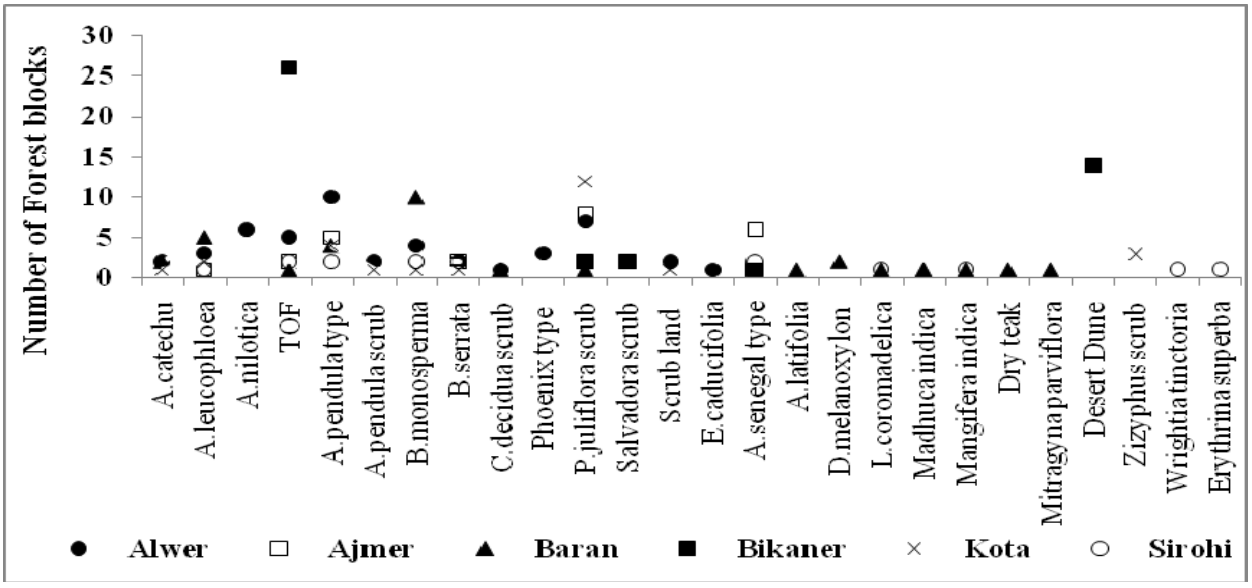

Figure 44. Number of forest blocks dominated by different tree/shrubs in the six districts of Rajasthan.

Carbon study in 1 m soil layer of 139 forest blocks in Jodhpur indicated that soil organic carbon stock of 11.4 tones ha^{-1} in Osian to 26.2 tones ha^{-1} in Balesar range. Soil carbon stock was greater in 0-30 cm soil layer in Baleser, Bilara, Baap, Falodi and Luni ranges, in 30-60 cm soil layer in Bhopalgarh and Osian range and in 60-90 cm soil layer in Mandore and Shergarh ranges. Higher soil organic carbon stock in deeper soil layer was because of sand deposition on surface soil. Substantial amount of carbon is also available in inorganic form, which ranges from 50.6 tones ha^{-1} in Osian to 229.6 tones ha^{-1} in Luni Range. Soil inorganic carbon was greater in 0-30 cm soil layer in Osian and Falodi ranges, in 30-60 cm soil layer in Shergarh and Baap ranges and in 60-90 cm soil layer in rest of the ranges (Figure 45).

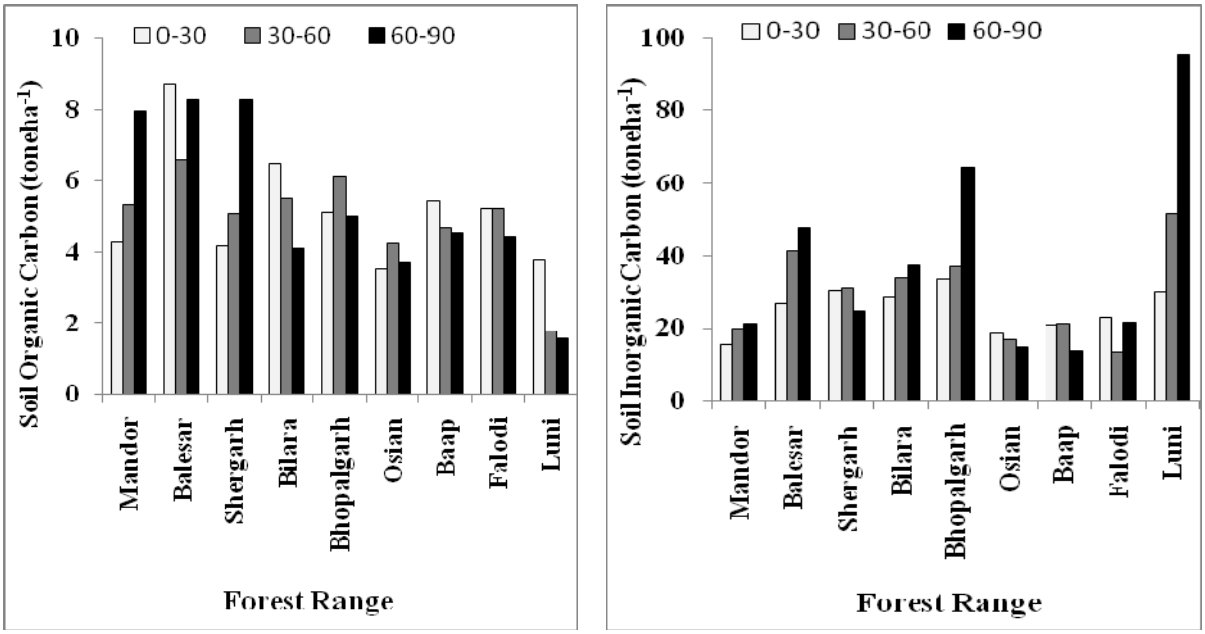

Figure 45. Distribution of soil organic carbon (left) and soil inorganic carbon (right) stock in the forests of Jodhpur district.

Project-22 : Characterization and classification of forest soils of Rajasthan (AFRI-85/FED/2007-2012)

Principal Investigator: N. Bala, Scientist - E

Soil samples collected from different forest blocks of Rajasthan were analysed in laboratory for physico-chemical characterization of the soils. Soils were analysed for soil texture (sand, silt and clay content), structure, consistency, colour, pH, electrical conductivity, organic carbon, inorganic carbon, NO_3 and NH_4 – nitrogen and phosphorus. Data on species composition, regeneration status, forest floor litter, carbon stock in soils in different forest blocks were compiled and tabulated.

Analysis of 556 soil samples from different districts revealed that soil pH of Alwar, Baran and Pratapgarh varied between 6 and 7, whereas, it was 7 to 8.58 in Hanumangarh, Sri Ganganager and Pali. In Bikaner soil pH was as high as 9.04 at Mehrasar block. Forest soils of Jalore district were neutral in nature with pH ranging between 7.0 and 8.3. Electrical conductivity of soils of

Jalore varied from 0.06 to 1.75 dSm^{-1} indicating non saline status. High EC was observed in soils of Sri Ganganagar (0.26 to 1.31 dSm^{-1}). Soil organic carbon was low in Bikaner, Hanumangarh, Tonk and Sri Ganganagar ranging between 0.02 and 0.3%. It is higher in soils of Alwar (0.04 to 1.06%), Baran (0.23 to 1.01%, Jaipur (0.02 to 2.21%), Pali (0.12 to 1.28%) and Pratapgarh (0.26 to 0.74%). High SOC was observed in soils of Kotputli in Jaipur. Soils are mostly sandy in nature with 44% soils falling in the textural class sandy loam, 41% in loamy sand, 11% in sand and 4% in sandy clay loam. (Fig 46).

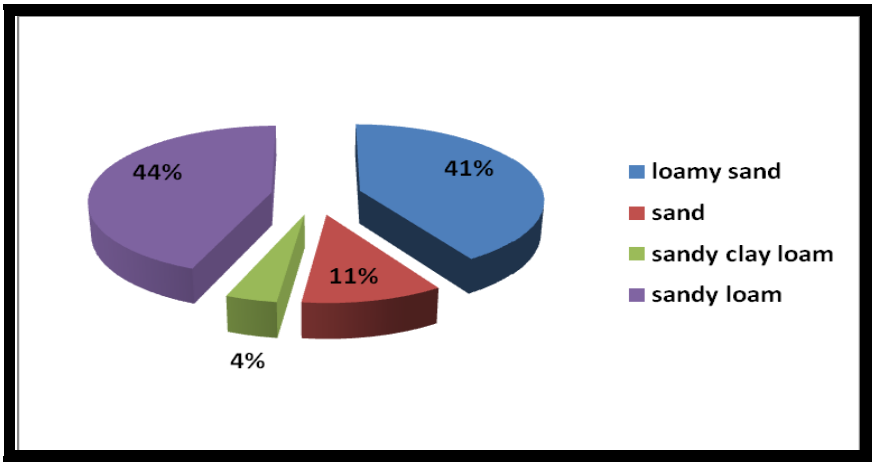

Fig 46. Relative abundance of different soil textural class

Project-23 : Identification of soil-vegetation relations and indicator species for assessment and rehabilitation in lower Aravalli of Rajasthan (AFRI-101/EED/ 2010-14).

Principal Investigator: Dr. G. Singh, Scientist F

Study being carried out at five different locations with varying rainfall of 988 mm, 961 mm, 950 mm, 568mm and 424 mm in Banaskantaha (Trisulia), Motimori (Sabarkantha), Banaswara (Bara Nandra kho), Rajasmand (Sabalia) and Pali (Borvad forest block) (i) to study on physical properties and nutrient status of soil derived from different parent material, and (ii) to study on vegetation structure and indicator species on dominant soil types. Based on IVI values, these sites were dominated by *Wrightia tinctoria*, *Tectona grandis*, *Lanea coromadelica* and *Anogeissus pendula* among trees *Nyctanthes arbor-tristis*, *Lantana camara*, *Rhus mysorensis* and *Euphorbia caudicifloia* among shrubs, respectively. Alph-diversity for herbaceous vegetation was 79, 108, 113, 85 and 75, respectively for the years 2011 and 2012 (combined). Gama-diversity in 2012 is 142. There were average decrease in number of herbaceous species, their population, herbaceous biomass and species dominance, whereas species richness, diversity ($P>0.05$) and species evenness ($P<0.05$) increased in 2012 as compared to 2011. Ambaji site was dominated by *Hyptis suaveolens* (IVI= 70.1 and 37.6) herb in both 2011 and 2012. The dominant grass was *Hecklocloa granularis* (IVI=1.5) in 2011 and *Aristida mutabilis* (IVI= 8.2) in 2012. *Boreria pusila* (IVI=31.2) and *Triumfetta rhomboidea* (IVI=17.8) dominated as herbs, whereas

Andropogon lanceolatus (IVI=64.8) and *Apluda mutica* (IVI=78.3) dominated as grass in 2011 and 2012, respectively at Maeghraj site. At Banswara, *Indigofera cordifolia* (IVI =11.0) and *Commelina benghalensis* (IVI=14.1) dominated as herbs in 2011 and 2012, respectively, whereas *Themeda quadrivalvis* (IVI= 42.0 and (42.7) dominated among the grasses in both the years. Rajsamand site was dominated by *Heteropogon contortus* (IVI=127.8 and 103.1) in both the years, whereas among herbs the site was dominated by *Zornea gibbosa* (IVI=13.0) in 2011 and *Evolvulus alsinoides* (IVI=9.1) in 2012. Sendra site in Pali was dominated by *Apluda mutica* (IVI=80.7 and 37.4) grass in both the years, whereas *Sida cordata* (IVI=32.25) and *Triumfetta rhomboidea* (IVI=38.0) dominated among the herbs in 2011 and 2012, respectively. Studies on soil properties in 2012 showed a slight increase in soil pH, EC and SOC in 2012 as compared to 2011.

Fig 47. *Adiantum lunulatum* in Trisulia forests of Ambaji Palanpur, Gujarat

Fig 48. *Tectona grandis* and *Nyctanthes-arbor-tristis* dominated forest in Motimori in Sabarkantha

Fig 49. *Vernonia scinerescence* dominated at Borvad, Pali

Fig 50. *Acacia catechu* and *Dendrocalamus strictus* dominated at Sabalia, Rajasamand

Project-24:Phyto-remediation of soil for productivity enhancement during land disposal of effluent (SFD Rajasthan) (AFRI-113/FED/SFD-Raj/2011-16).

Principal Investigator: Dr. Abha Rani, Scientist E

Survey was conducted of a. Luni river basin starting from Ajmer (near Govindgarh , Pushkar), Pali, Nagaur, Barmer, Jalor and up to the its merging area *i.e*. Rann of Kutch, Jojri river in Jodhpur and Bandi river in Pali district for collection of water and soil samples in effluent disposal area and recording dominant plant species alongside the river bank. Several locations were selected for vegetation studies alongside the river and geographical coordinates were recorded and validated with the existing maps and GPS locations. Data on vegetation was collected and most prominent plant species observed were *Acacia nilotica*, *Aerva persica, A. pseudotomentosa, Argemone mexicana Azardirachta indica, Alhagi maurorum, Haliotropium curassavicum, H. supinum, H. marifolium, Cassia angustifolia, C. italica, Crotalaria burhia, Cressa cretica, Echinops echinatus, Eclipta prostrata, Fagonia bruguierii, Glinus lotoides, Leptadenia pyrotechnica, Oligochaeta ramosa Prosopis juliflora, Pulicaria crispa, P. wightiana, Salvadora oleoides, S. persica, Solanum surattense, Sueada fruticosa*, *Tamrix aphylla, T. species, Tephrosia purpurea and Zizyphus nummularia.*

According to the water analysis of effluent water samples collected from Pali, Balotra and Jodhpur, it was found that alkaline pH is found in effluent sample collected from CETP Pali that is 8.67, whereas acidic pH (5.94) was found in water sample collected from Jasol i.e. 5.94. Highest Electrical conductivity (EC) was found in effluent sample collected from Punayta which was 100.89 mS cm-1, whereas, lowest was found in water collected from Pali outskirts (0.83 mS cm-1). Highest Dissolved Oxygen (DO) was found in Pali outskirts sample (4.56 mg/l), whereas, lowest is found in effluent water sample collected from Salawas steel rolling mills i.e.1.63 mg/l. Highest amount of TDS was found to be in the effluent water sample collected from Jasol (17,500 mg/l) whereas, lowest (78 mg/l) is found in water sample collected from Pali outskirts. Highest (204.8 mg/l) amount of SS was found in the effluent sample collected from CETP Balotra, whereas, lowest was found in water sample collected from Pali outskirts (12.4mg/l). Highest COD was found in the effluent water sample collected from Jhawarya village Pali (310 mg/L), whereas lowest was found in water sample collected from Pali outskirts (22.6mg/L).

Soil analysis performed in the laboratory showed highest pH of soil sample collected from Sindari (9.41) whereas lowest was found in sample collected from Jhawarya village Pali (5.24). Highest (80.33 mS cm-1) EC was found in soil sample collected from Sindari, whereas lowest (0.11 mS cm-1) was found in sample collected from Guda malani (Barmer district). Highest (22.4 ppm) phosphorus content was found in soil sample collected from Jhalamand, Jodhpur, whereas lowest (3.15 ppm) was found in soil sample collected from Laadpura. Highest (13.88 ppm) Ammonia content was found in soil sample collected from Doli, whereas lowest (2.06 ppm) was found in soil sample collected from Kankani. Lowest (1.76 ppm) nitrate content was found in soil sample collected from Pali outskirts, whereas highest (29.51 ppm) was found in soil sample collected from Doli.

The field experiment in Lysimeter (2m x 2m x 2m) situated at Forest Ecology Field, Arid Forest Research Institute, Jodhpur was established. In this experiment seven forestry tree species *viz*. *Prosopis cineraria, Prosopis juliflora, Azadirachta indica, Eucalyptus camaldulensis, Tamarix aphylla, Salvadora persica and S. oleoides* with four irrigation levels and three control implying Completely Randomized Design (CRD) were planted. Data on growth parameters like plant height; collar diameter and crown diameter are being taken on monthly basis. Maintenance, cleaning and irrigation of seedlings in lysimeter are being done on regular basis.

Fig 51. *Alhagi maurorum*

Fig 52. *Cassia angustifolia*

Fig 53. *Fagonia bruguierii*

Fig. 54. *Prosopis juliflora*

Fig 55. *Tamarix* sp.

Fig 56. *Pulicaria crispa*

Fig 51-56. Important Plant/Tree species found at Luni and Jojari river basin

Project- 25: Identification of extent of forest land in forest fringe villages (NRAA) (AFRI-114/FED/NRAA/2011-2013).

Nodal Officer: Sh. M. K. Singh, Scientist – B

Socio-economic survey and vegetation studies done in 11 districts of Rajasthan viz; Pali, Sirohi, Banswara, Dholpur, Chittorgarh, Kota, Jaipur, Baran, Bundi, Jhalawar, and Swai madhopur. Vegetation studies in forest fringe villages showed dominance of trees like; *Acacia leucophloea, Boswelia serrata, Holoptelia integrifolia*, *Maduca indica*, *Butea monosperma, Anogessus pendula, Prosopis juliflora, Phoenix sylvestris, Tectona grandis* (Table 3) whereas, among shrubs, undershrubs and grasses *Capparis desidua, Zizyphus numularia, Lantana camara, Lasiurus sindicus, Leptadenia pyrotechnica, Saccharum munja* etc. are prevalently growing there. However, socio-economic studies of forest fringe villages revealed that people of tribes Mena, Ragor, Bheel, Rewari, Meghwal, Rawat etc. are mainly dwelling there and also almost every village have primary school, electricity and sufficient irrigation facility. They mainly grow peanuts, maize, soybean and pulses as there cash crop.

Table 3. District wise list of dominant tree species, tribes and crops

District	Dominant tree species	Dominant tribes	Major Crops
Pali	*P. julliflora*	Rawat and Raika	Bajra
Sirohi	*A. pendula*, *B. monosprema*	Ghrasiya and Meena	Maize, Wheat
Kota	*A. pendula*, *A. senegal*	Bheel and Meena	Wheat
Jaipur	*A. tortlis*, *T. undulata*	Meena, Keer and Gurjar	Jau, Mustard, Wheat and Bajra
Bundi	*A. pendula*, *B. monosprema*	Gurjar and Jhala	Maize and Wheat
Baran	*A. pendula*, *B. monosprema*	Ahir and Ghrasiya	Dhaniya and Wheat
Swaimadhopur	*A. lucophloea*, *A. pendula*, *B. monosprema*	Meena and Gurjar	Mustard
Dholpur	*A. pendula*, *S. cumini*	Gurjar	Wheat and Cicer
Chittorgarh	*A. pendula*, *A. catechu*, *D. melanoxylon*	Gurjar and Meena	Soybean and Wheat
Banswara	*A. latifolia*, *A. ferruginea*	Bhil, Damor and Meena	Maize, Rice and Cotton
Jhalawar	*A. pendula*, *M. parviflora*	Gurjar and Meena	Wheat and Mustard

Project-26 : Reassigning Forest Type of India for better management of Forests in India (2012-2013).

Nodal Officer: Dr. G. Singh, Scientist F

This project was formulated by ICFRE on all India Coordinated basis in view (i) to understand the impact of climate change on forest vegetation, and (ii) to prepare a change matrix of forest types of India with long terms objectives of devising a forest classification from management perspective, developing a forest classification system in line of international organizations like FAO for better understanding, and improving the scientific understanding on extent and composition of forest species in different forest types for use of planners, policy makers and resource managers. A total number of 168 sits were assigned to AFRI, Jodhpur covering the Gujarat, Rajasthan, D& NH, Daman and Diu (states and UT). A total of 171 (3 additional) sites were surveyed and all the tree species of >30 cm girth at breast height (GBH) were counted and measured (9 plots of 10 m x 10 m size) for GBH and height. Tree sapling (<30 cm GBH) and shrubs were measured for girth at ankle height in a nested plot of size 3 m × 3m in the above-mentioned plots. Collected data were analyzed and various diversity variables including importance value index (IVI) were calculated. Data recorded for the given coordinates for data recording demonstrates 40 forest sub types. In this, 19 forest sub types were in Rajasthan, 34 types in Gujarat, 3 types in D&NH, 3 in Diu and one in Daman. Interestingly, out of 80 sites in Gujarat and 83 sites in Rajasthan for which the data analysed, *P. juliflora* was present at 40 sites in Gujarat and 41 sites in Rajasthan. In the study sites, the availability of *P. juliflora* trees of >30 cm GBH was at 26 sites in Gujarat and at 32 sites in Rajasthan. While considering the dominance (based on IVI values), saplings (in 3 m × 3 m plots) of *P. julifora* had highest IVI value at 27 sites each in Gujarat and Rajasthan, whereas, trees (10 m × 10 m plots) of *P. juliflora* showed highest IVI (among trees) at 19 sites in Gujarat and 25 sites in Rajasthan. This indicates that *P. juliflora* is present at almost 50% sites in both the states, though its concentration varied at different locations.

Table 4. Number of forest sub type observed in different states and union teritories

State/UT	No. of Points observed	No. Forest sub type
Daman	1	1
Diu	2	2
Dadra & Nagar Haveli	5	3
Gujarat	80	34
Rajasthan	83	19
Total	171	40

Project-27. Designing and Development of Urban Forestry Model For Indian Institute of Technology (IITJ), Jodhpur, Rajasthan (AFRI-05/FE/Ext(IIT-J)/2012-2014).

This project has been funded by Indian Institute of Technology Jodhpur, Rajasthan for developing shelterbelt with aesthetic value on a very shallow calcareous soil of IITJ campus. The objectives were (i) to design a model shelterbelt plantation for urban forestry; (ii) to study the bio-remediation effect of shelterbelt plantation on soil properties; and (iii) to increase carbon stock of a land with low productivity. In fact farmlands productivity and air quality are improved by

'Shelterbelt' which reduces wind speed, sand movement and pollutant transportation in air by way of phyto-sanitary activity. Further, shelterbelt plantations ameliorate microclimate and help sequester carbon in growing biomass and soil. As composition of trees and shrubs of varying phenological nature provide different microclimate and carbon accumulation rate, plantation of trees and flowering shrubs in a stretch of 5000 m along roads and the institute boundary was carried out September-October, 2012. In this a 25 feet (7.62 m) wide area accommodated one row of *Bougainvillea* in outer skirt, one row of *Tecoma stans, Nerium oleander* and other shrub species in between; and a row of different species of trees. Because of shallow soil depth plantation was done after complete replacement of soil along with the calcium carbonate aggregates (murram layer) and refilling of pits with a mixture of sand, farmyard manure and pond silt. Due to non availability of land 4000, seedlings of different species were planted. The tree species are *Azadirachta indica* (97.0%), *Tabebuia aurea* (96.0%), *Terminalia catappa* (81.0%), *Millingtonia hortensis* (96.0%), *Peltophorum ferrugineum* (96.0%), *Bauhinia racemos*a (87.9%) and *Butea monosperma* (76.9%) tree species with height and collar diameter growth of 40.7 to 152.1 cm and 1.1 to 5.1 cm, respectively with an average survival of 93.8%. The shrubs are *Ceasalpinea pulcherima* (92.0%), *Bougainvillia glabra* (80.7%), *Plumeria alba* (94.6%), *Nyctanthes arbore-tristis* (83.1%), *Tabernaemontana divaricata, Nerium oleander* (91.5%) and *Tecoma stans* (90.2%), which varied from 57.8 cm for *Bougainviliia* to 105.7 for *Plumeria alba* with an average survival of 85.8%. Plantations are being maintained through irrigation and other cultural operations. Initial survival and growth parameters, viz. collar diameter and height of the plants recorded and soil samples collected for soil organic carbon and nutrient analysis.

Fig 54. Plantation by VIP at IIT (J)

Fig 55. View of plantation site at IIT (J)

Project -28: Carbon stock and soil classification mapping for Rajasthan Forest (AFRI-115/FED/ICFRE/ 2011-16).

Principal Investigator : N. Bala, Scientist F

GIS laboratory has been established in AFRI with work stations and facilities like plotter and printer. Integrated GIS software has been procured having the capabilities of spatial analysis, image processing, RADAR Analysis, hyper spectral analysis, photogrammetry, network analysis,

	GIS Modeling, surface analysis, watershed modeling and atlas creation, publishing geo-referenced image/map in printable format and also in a format easily readable in the systems not having GIS software. Forest type maps developed by the Forest Survey of India (FSI) have been procured for Rajasthan and Gujarat which will serve as the base map for carbon stock and soil characterization map.
5.	**Forest Genetic Resource Management and Tree Improvement** **Project-29: Investigations on genetic variation and inheritance of Western Indian Teak. (*Tectona grandis* L.f) (AFRI-94 /Silvi/2010-2015).** ***Principal Investigator: Sh. Praveen Chawhaan, Scientist F*** Teak (*Tectona grandis*) is the chief source of high quality timber valued all over the world. In India, it is widely distributed in central and south regions and represents about 14.37% of total forest area. The Western Indian region harbours ecologically diverse forests of teak; it includes dry teak forests (5A/C 1b) to very dry teak forests (5A/C 1a). The extent of teak forest of Western Indian states together harbours about 6, 192 sq. km. of teak forests. Amongst the states of the region Gujarat have the largest teak forest amounting to 5,637 km2, followed by Rajasthan (426 km2), and Dadra and Nagar Haveli (129 km2). The extent of these forests, account for about 46, 3.2 and 63 percent of the total forest cover of these states and UT, respectively. This project is planned for ascertaining the genetic worth of the selected trees besides understanding the inheritance pattern of different economically important traits of Western Indian teak, on which scientific information is lacking. This study would help in genetic up gradation of the existing seed orchards and identification of good general combiners and as well as selection promising sergeants for establishing advance generation seed orchards and breeding populations. Statistical analysis of progeny trial and investigation on inheritance of growth traits in Teak and selection of phenotypically selected trees. Data from four progeny trials established with 18, 16, 28 and nine half-sib families of teak at Rajpipla Shivrajpur, Sajjangarh and Jodhpur respectively were used. The Rajpipla and Shivrajpur trials were the existing trials established by Division, Rajpipla the SFD Gujrat, in 1999 and 2008, respectively. Whereas, other two trials were established in 2010 under this project. Individual tree data from these trials was collected.

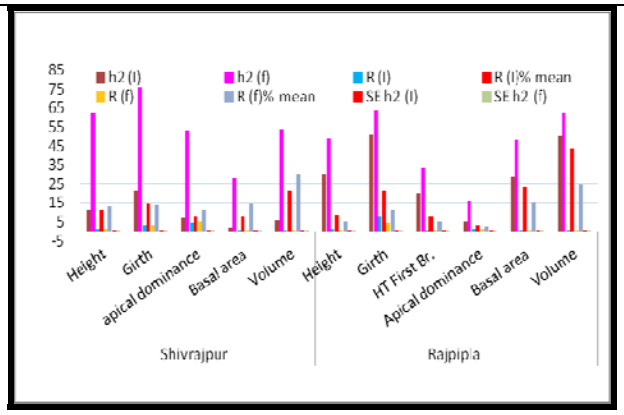

Fig 56. Estimates of genetic parameters in existing old trials of Teak

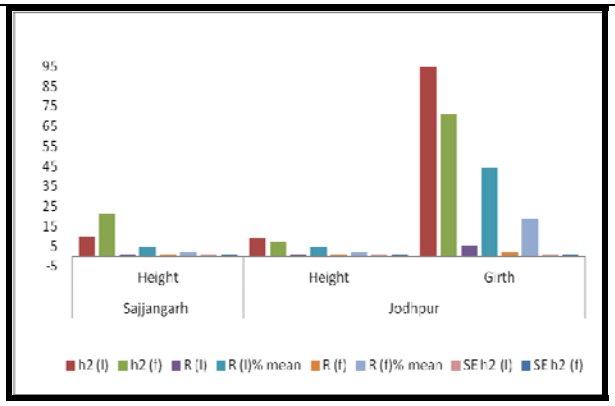

Fig 57. Heritability and genetic gain estimates in new trials of teak

Analysis of variance of these trials revealed that variation due to families was significant to highly significant for most of the traits indicating scope for family selection except for basal area in Shivrajpur and hight and girth in case of Sajjangarh material. Availability of variation in the population is a prerequisite to make selection effective; similarly the information on extent and nature of genetic variation is of almost importance to develop effective breeding strategy.

While heritability values express the proportion of variation in the population that is attributable to genetic differences among individuals, genetic advance indicates average improvement in the progeny over the mean of the parents. The detailed genetic analysis to compute variance components, genetic parameters was performed. Computation of genetic advance was done using selection intensity of 5 %. In the existing trials at Rajpipla individual and family heritability values for height and girth were 30 and 49 and 51 and 64 percent, respectively. Where, as that for Shivrajpur these estimates were 11 &63 and 21 &76 percent. In case of new trials heritability for height was 9 and 10 percent at individual level and 7.3 and 21 percent at family level. In all the trials narrow sense heritability ranges from 2 to 97 percent for various traits. Height and collar girth exhibited low to moderate estimates of narrow sense heritability, respectively at individual as well as family level. Family heritability values were considerately higher for both the traits suggesting effectiveness for family selection.

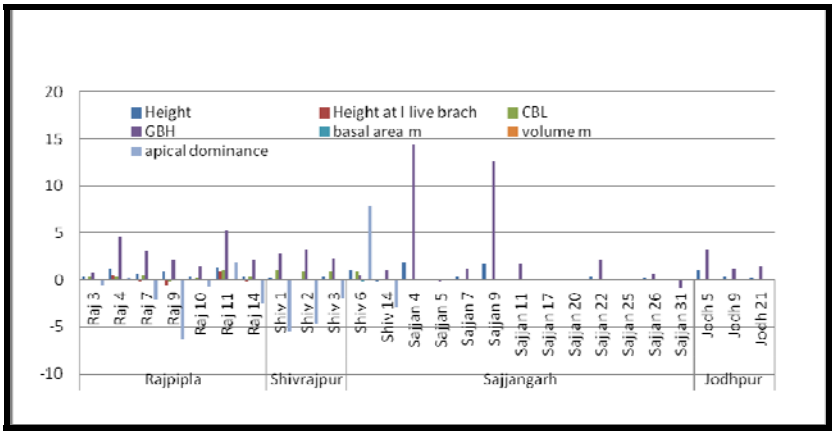

Fig 58. Parents with + gca values for important traits in different trails

Genetic advance estimates for these traits also followed similar trend and ranged from 6.41 to

24.32 percent. General combining ability (gca) analysis was also performed. This analysis reveals that in all 26 parents exhibited positive gca values. These parents are expected to harbor desired combination of alleles. In addition to this, 7 new phenotypically superior trees were selected from different locations. Open pollinated seeds from 61 trees including clones from CSOs have been collected. Seedlings were raised in the nursery using last year collections.

Project-30: Assessment of Guggul germplasm for studying population density, diversity, female-male plant's ratio for in situ and ex situ conservation in Rajasthan (AFRI-106/FGTB/SFD-RAJ/2010-13).

Principal Investigator: Dr. U.K. Tomar, Scientist F

Commiphora wightii (Guggal, Guggul or Mukul myrrh tree) is one of very important medicinal plant. Many commercial products have been marketed nationally and internationally, therefore the demand of Guggal has increased and the plant is subjected to destructive tapping procedures, thus the Guggal has become so scarce due to overexploitation that World Conservation Union (IUCN) has declared it as an endangered species. It is very essential to study population density and record the present status of this valuable species and assessment of germplasm.

All 33 districts were covered viz; Ajmer, Alwar, Banswara, Baran, Barmer, Bharatpur, Bhilwara, Bikaner, Bundi, Chittorgarh, Churu, Dausa, Dholpur, Dungarpur, Hanumangarh, Jaipur, Jaisalmer, Jalore, Jhalawar, Jhunjhunu, Jodhpur, Karauli, Kota, Nagaur, Pali, Pratapgarh, Rajsamand, Sawai Madhopur, Sikar, Sirohi, Sri Ganganagar, Tonk and Udaipur. Guggul density was found high in Sawai Madhopur (≈74 ha^{-1}) and Jhunjhunu (≈69 ha^{-1}) districts. Survey also revealed that Bikaner, Banswara, Churu, Shri Ganganagar, Hanumangrah and Pratapgrah districts are lacking natural guggul population. Whole data collected so far from 33 districts are classified on the basis of population density is given in following summary table 5.

Table 5. Summary of population density in various districts of Rjasthan.

Population Density class	District numbers and names	Population density class	Remark
A (above 40 plants/ha)	7	A (above 40 plants/ha)	Only Sanctuary Sariska (Alwar District) was not included in survey. Permission of the same is awaited from R.S.F.D. authorities.
B (11-40 plants/ha)	11	B (11-40 plants/ha)	
C (1-10 plants/ha)	9	C (1-10 plants/ha)	
D (below 1 plants/ha)	6	D (below 1 plants/ha)	

It was also observed that altitudinal variation also influence the density when data were arranged in different altitude classes (Table 6). Maximum average density (3.6 plants /plot or about 40 plants per ha) was recorded in a class of 301-350 m sla (Figure 59).

Table 6: Sixteen altitude classes developed to study altitudinal factor on guggul plants density.

Altitude class	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Meter (m)	150-200	201-250	251-300	301-350	351-400	401-450	451-500	501-550	551-600	601-650	651-700	701-750	751-800	801-850	851-900	901-950

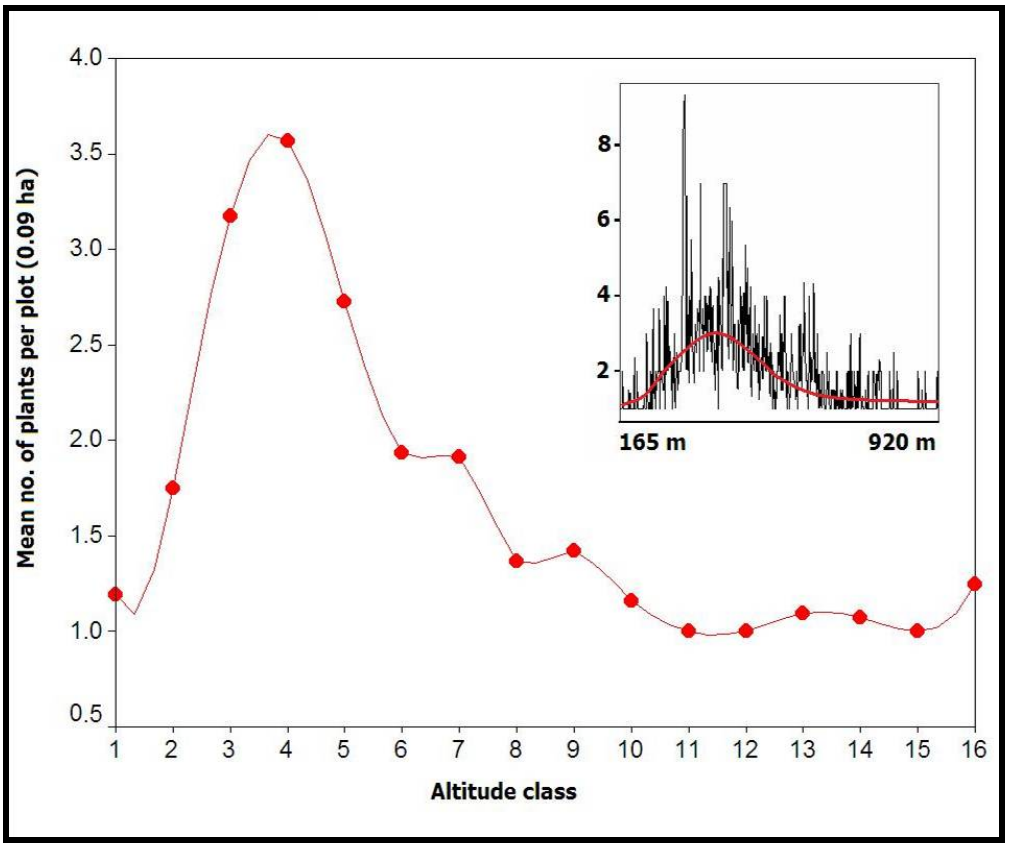

Figure 59: Guggul plants average populatition density per plot against altitude classes.

Summary of achievements:

Out of 33 districts of Rajasthan, Guggul distribution is in 33 districts as per SFD Rajasthan information available. A total of 2660 sample plots, 141 sites in 33 districts were surveyed

covering 10294 ha where Guggul occurrence has been recorded. In many sites male plants are totally lacking. Male plants were available in only at few places. Female and Male plants ratio was 99.9: 0.01. In other words male plants less than 0.01% in Rajasthan State.

Germplasm collected for *ex situ* conservation from identified 117 CPPs. About 1428 vegetative cuttings with source details (GPS locations) were collected and raised in our vegetative propagation area for rooting. Differential response in sprouting and rooting was studied. Progenies of 10 CPPs are available to study apomixis behavior of these CPPs. DNA and Isozyme marker studies revealed that many of these CPPs produces genetically different progenies, which means all the offspring's are not produced through apomixis. Marking of genotypes with high apomixis and poor apomixis are important tools for conservation and improvement of this species. Flowering and fruiting were data also collected in every month at one site to study the phenological aspects and its annual pattern. Seeds were collected from six sources and 26 CPPs as mature seeds. Some genotypes have potential to produce high percentage of viable black seeds. Data analysis also indicates that location of genotype also playing important role in black and white seed (non fertile/non viable) ratios. Guidelines for seed germination in nursery bed developed.

Project-31: Assessment of variability, improvement and refinement of cloning techniques of *Tecomella undulata* (Sm.) Seem (AFRI-04/FGTB/SFD-RAJ/2010-13).

Principal Investigator: Ms. Desha Meena, RO

Farmers of arid and semi-arid region consciously maintain and promote a few naturally growing trees of *Prosopis cineraria* (Khejri), *Tecomella undulata* (Rohida), *Zizyphus mauritiana* (Ber) etc. in their fields with the aim to obtain fodder, fuel and timber. *Tecomella undulata* (Sm.) Seem (Bignoniaceae) is a medicinally and economically important threatened tree species restricted to the arid parts of western India and southeastern parts of Pakistan. Tree is used for its high quality timber. Its wood has excellent physical and mechanical properties thus also called as 'Marwar Teak'. Indiscriminate felling for timber and fuel, coupled with poor regeneration and sluggish growth has severely depleted the natural population of this valuable tree, with an associated loss of valuable germplasm. Therefore, to rationally manage the existing wild populations, knowledge on the population structure is required, thus the present project is proposed to expand the area of CPT selection to entire Rajasthan and establish a progeny trial.

Survey and selection of Candidate plus trees (CPTs) of *Tecomella undulata* were carried out in seven districts viz. Sikar, Churu, Jaipur, Nagaur, Bikaner, Pali and Jalore of Rajasthan. Total 41 CPT'S were identified on the basis of quantitative (height, girth, clear bole and crown diameter) and qualitative traits (straightness and health). Phenological observations like flowers initiation time its color variation and seed setting were also recorded from all the identified CPT's of Tecomella undulata in Rajasthan.

Along with this the growth parameters of the existing progeny trial of Tecomella undulata was also evaluated and it was observed that the progeny trial at AFRI Jodhpur is performing better as

compared to Bikaner trial with 87% of survival at Jodhpur and 58% at Bikaner at the age of 4 1/4 years. An average height of plants at Jodhpur is 150cm and at Bikaner 85.32 cm. An average collar diameter at Jodhpur is 2.1 cm, whereas at Bikaner it is 0.9cm.The progeny of CPT-23 from Chohtan (Barmer) gave best growth at Jodhpur attaining the height of 290 cm and minimum was of progenies of CPT-4 (Mohangarh) of 50 cm whereas, the progeny of CPT-45 from Baytu (Barmer) gave best growth at Bikaner attaining the height of 170 cm and minimum (30 cm) was of CPT-8 (Mohangarh). Considering the collar diameter CPT- 37 at Jodhpur proved the best 5.1cm and CPT-18 Chohtan exhibited minimum collar diameter 1.2cm at Jodhpur. At Bikaner highest collar (2.8cm) diameter was of CPT-24 (Chohtan) is and minimum (0.9cm) of CPT-2 (Mohangarh).

Fig 60 (a-c) : Identified Candidate plus trees of *Tecomella undulata* from Rajasthan

Project 32: Refinement of modern nursery practices for raising quality seedlings of selected important forest tree species (AFRI-109/Silvi/ICFRE/2011-2016).

Principal Investigator : Dr. Naveen Kumar Bohra, RO

All India Coordinator Project on nursery technique (Nodal FRI)

Name of Species :

Prosopis cineraria Druce Mimosoideae
Azadirachta indica A .juss Meliaceae
Tecomella undulata (Smith) Bignoniaceae

Aim of the project is to develop/refine modern nursery practice of the three most important tree species of arid and semi arid region of Rajasthan & Gujarat for the production for the plantation programme for better survival and growth. An experiment was laid down at AFRI nursery, to find

out the best potting mixture (potting media ingredients & their ratio) and container size for the production of quality seedlings in selected arid zone species viz; ***Prosopis cineraria, Azadirachta indica*** and ***Tecomella undulata.*** Seed from the selected trees were collected and sown in the different potting mixture ratio and different containers viz polybags and root trainers. Analysis of different potting mixture was also carried out. Periodic growth data's were collected. Interim results showed that in ***Prosopis cineraria*** - 8 months old data revealed that compost (with different potting mixture and containers) the height was in the range of 53.1 cm to 73.1 cm, whereas the collar diameters in the same was in the range of 2.2 cm to 3.5 cm . Similarly, in vermicompost (with different potting mixture and containers), the height was in the range of 44.5 cm to 97.8 cm, whereas the collar diameters in the same were in the range of 2.0 cm to 3.5 cm.

In FYM manure (with different potting mixture and containers) the height was in the range of 38.6 cm to 72.9 cm, whereas the collar diameters in the same were in the range of 2.4 cm to 3.8 cm was observed. In leaf compost manure (with different potting mixture and containers) the height was in the range of 34.9 cm to 102.0 cm, whereas the collar diameters in the same were in the range of 2.1 cm to 3.8 cm. In Goat manure (with different potting mixture and containers) the height was in the range of 37.4 cm to 61.0 cm, whereas the collar diameters in the same were in the range of 2.1 cm to 3.6 cm.

Azadirachta indica - 6 months old data revealed that in compost manure (with different potting mixture and containers) the height was in the range of 14.8 cm to 42.7 cm, whereas the collar diameters in the same was in the range of 2.4 cm to 4.8 cm . Similarly, in vermicompost manure (with different potting mixture and containers) the height was in the range of 14.7 cm to 31.8 cm whereas the collar diameters in the same were in the range of 2.7 cm to 4.4 cm.

In FYM manure (with different potting mixture and containers) the height was in the range of 6.3 cm to 16.5 cm, whereas the collar diameters in the same were in the range of 2.3 cm to 3.9 cm was observed. In leaf compost manure (with different potting mixture and containers) the height was in the range of 9.6 cm to 22.4 cm whereas the collar diameters in the same were in the range of 2.1 cm to 3.9 cm. In Goat manure (with different potting mixture and containers) the height was in the range of 12.2 cm to 36.8 cm whereas the collar diameters in the same were in the range of 2.3 cm to 3.9 cm.

Project- 33: Multilocational trials of *E. camaldulensis* and *D.sissoo* clones in Gujarat state (AFRI-41/FGTB/ICFRE/2002-12).

Principal Investigator : Dr. U.K. Tomar, Scientist F

E. camaldulensis and *D. sissoo* both are important tree species at national as well as states level (Gujarat). Multilocational clonal trials of both species were established at four locations in Gujarat viz. Gandhinagar, Deesa, Kheralu and Rajpipala in 2003. Data were collected on various growth parameters every year in winters (December to February). Site factors information was also collected along with soil samples to compare with growth patterns of these species under

these agro-climatic conditions.

Gandinagar site is best as far as soil properties are concern, followed by Kheralu, Deesa, and Rajpipala (Table 7). Rajpipala site is having higher percentage of clay, which is not suitable to both these woody species in spite of high annual rain fall area as compare to other three sites. Kharalu is best for *D. sissoo* clones, followed by Gandhinagar, Deesa and Rajpipala (Fig 61a). However, Kheralu, Gandinagar and Deesa are more or less similar for growth of *E. camaldulensis* clones and here also Rajpipala is not suitable site for this species (Fig 61b).

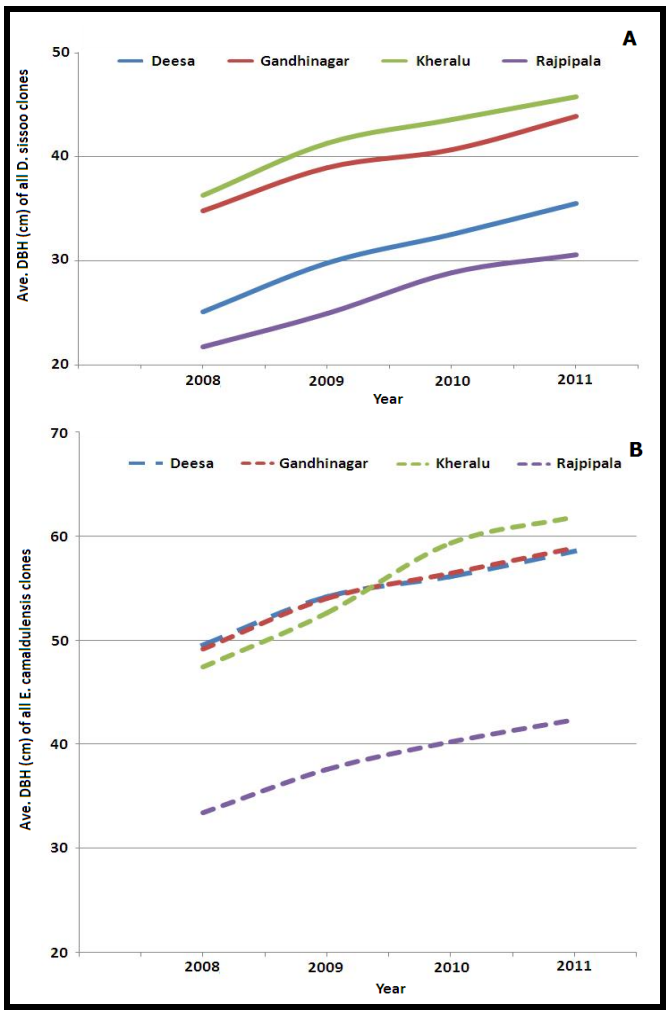

Fig 61. Effect of site factor on growth of (a) *D. sissoo* (b) *E. camaldulensis* clones

Table 7. Differences in soil properties and climatic conditions at four different site of Gujarat.

Sites details		**Gandhinagar**	**Kheralu**	**Deesa**	**Rajpipala**
Soil	pH	7.4	8.43	6.74	7.2
	EC	0.11	0.63	0.08	0.16
	N	15.41	4.98	8.82	1.69

	P	3.81	6.67	2.56	3.25
	K	5.87	2.37	1.84	7.96
	SOC	0.440	0.178	0.138	0.597
Rainfall (mm)		957	967	635	1402
temp	Min (^{0}C)	41	40	40	41
	Max (^{0}C)	9	9	9	11

However, data on physiological parameters as photosynthesis and transpiration rate and qualitative parameters (wood properties etc) are in the process of analysis before final recommendations to release selected clones.

Project-34: Screening of high oil and Azadirachtin in Neem (AFRI-34/FGTB/ICFRE/2002-2013).

Principal Investigator: Dr. U.K. Tomar, Scientist F

Neem progeny trial was established in year 2002 at Govindpura, Jaipur with seedlings of selected 17 CPTs for high Aza (above 5000 ppm) and oil (above 40%) contents . Seeds collected from few trees (27 trees in 2011-12 and 50 in 2012-13) gave highly encouraging results average. Both years, oil content was more than 40% in 81% of samples analysed (59 samples).

Project-35: Project: Demonstration trial of male and female *Ailanthus excelsa* plants raised through grafting (AFRI-79/FGTB/ICFRE/2006-14).

Principal Investigator: Dr. U.K. Tomar, Scientist F

Ailanthus excelsa is an important tree species in Rajasthan and locally known as "Ardu" and "Maharukh". Its timber is also utilized for various propose and it also has some medicinal properties. Significant variations have been observed in seedling-raised plantations in terms of growth and fodder value. Therefore, productivity can be improved by mass multiplication of selected superior genotypes through clonal propagation. Unfortunately, this tree is very difficult to propagate clonally by conventional methods (Sharma & Tomar, 2003; Tomar 2003). AFRI has developed grafting technique for raising clonal plants of male and female *Ailanthus excelsa* trees. This technique can be easily adopted by farmers and field staff of forest departments. It is equally beneficial to the firms which are exploiting Ardu for fodder, timber or biomass.

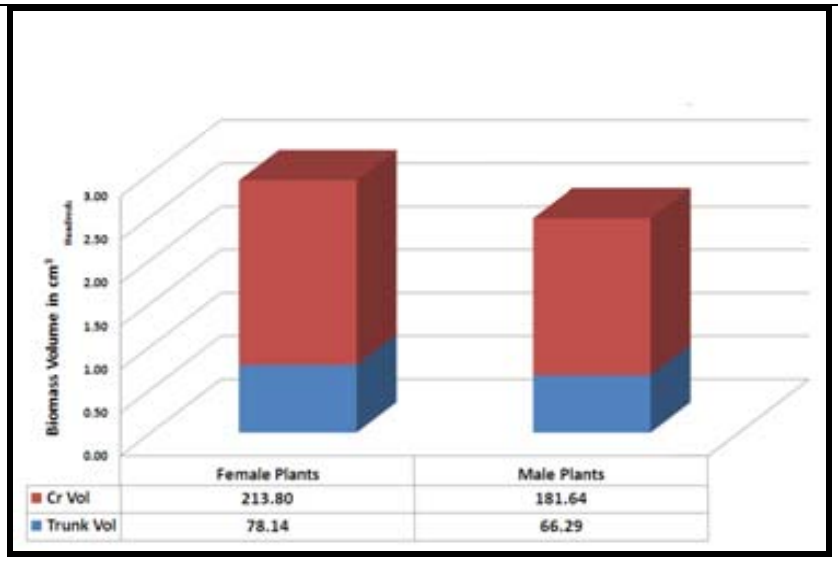

Fig 62. Differences in crown and trunk volume of female and male *A. excelsa* plants

Demonstration trial of male and female plants was established in August, 2008 using grafting technology developed by AFRI. This trial is being maintained and data on height and girth are collected at six months interval. In both the parameters, female plants are taking lead and difference is also increasing gradually. Growth data collected on height, girth and canopy parameters as per observations indicate that the female plants are performing better in height (11.89% higher), girth (12.01% higher), trunk wood volume (17% higher) and canopy volume (18% higher) as compare to male plants within three years of growth.

Project-36: **Development of technologies for multiplication of economically important desert plant - *Capparis deciduas* (AFRI-105/FGTB/ICFRE/2009-2015).**

Principal Investigator: Dr. Sartia Arya, Scientist F

Experiments for rooting of stem cutting were conducted in April to March. Cutting harvested during the month of March-April and August-September-October were found to be suitable for rooting. Effect of various rooting medium was studied and Sand:Soil (2:1) was found to be the good for rooting of stem cutting.

Cuttings were collected from different selected CPT's from Rohat, Sanderav, and Balotra and planted in various types of media having different composition of Sand: Soil: FYM/ Compost. Best results were obtained on FYM: Sand: Soil in the ratio 2:3:5, respectively.

Macropropagation results indicates that use of various concentration of IBA (500,1000,2000 & 4000 ppm) in water and W/W with telcom powder gave rooting from the cuttings.

Nodal segments of *Capparis decidua* were surface sterilized with 0.1% HgCl2 for 3-4 min. Surface sterilized nodal segments were inoculated on MS medium supplemented with BAP (4.0 mg/l) + NAA (0.1 mg/l) +additives (ascorbic acid 50mg/l, citric acid 25 mg/l, adenine sulphate 50

mg/l) with 2-3 shoot/explant. MS medium supplemented with BAP (2.0 mg/l) + IAA (0.1 mg/l) and additives was found to be best for *in vitro* shoot multiplication with 3-4 fold shoot multiplication in each cycle. Well developed *in vitro* shoots of 5-6 cm length were used for various *in vitro* rooting experiments. In vitro shoots regenerated were elongated on MS media supplemented with additives. Effect of auxins (IAA, NAA, IBA) were studied. Amongst all the auxins tried IBA supplemented MS medium produce maximum number of roots as compared to NAA and IAA. Effect of strength of MS medium (1X,1/2X, 1/3X,1/4X) were investigated for *in vitro* rooting of *in vitro* raised shoots. It was observed that 1/4x MS medium found to be best for *in vitro* rooting. Different media like; MS, WPM, B5, and white medium were tried for *in vitro* rooting experiment. MS medium found to the best for *in vitro* rooting experiment.

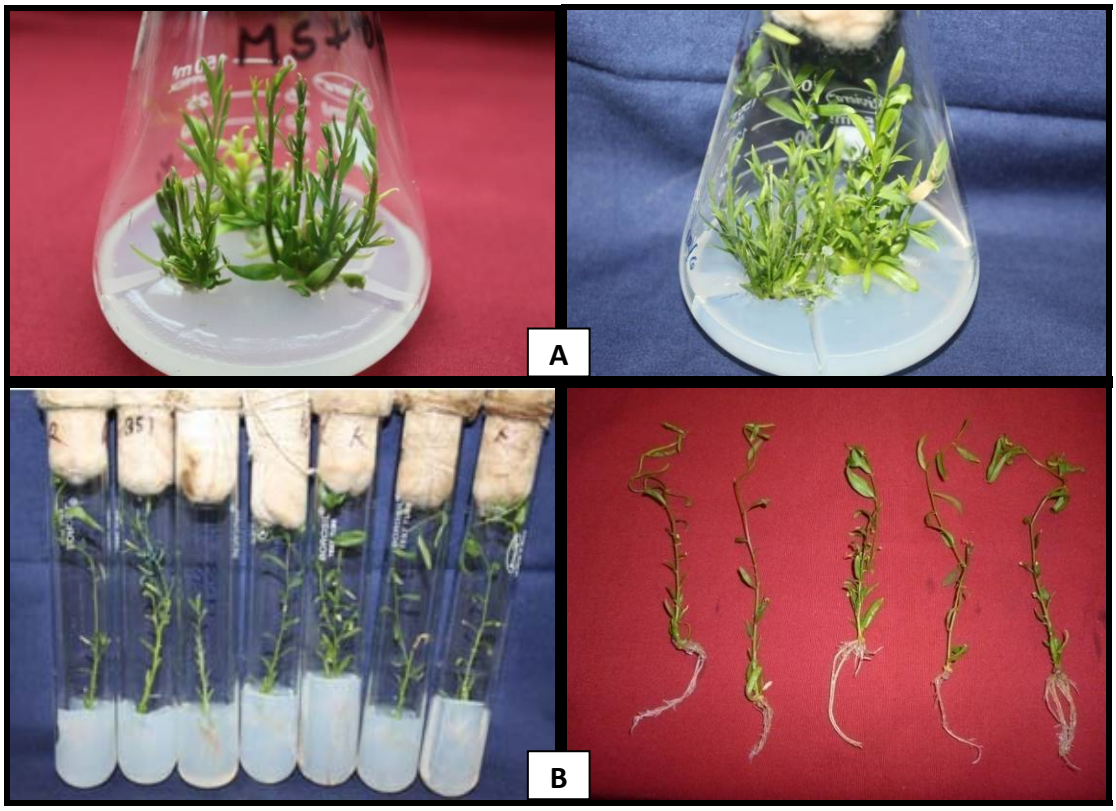

Fig 63. Micropropagation of *Capparis decidua:* (A) Shoot multiplication and (B) *in vitro* rooted shoots

Project-37: Assessment of Guggul germplasm for studying population density, diversity, female-male plant's ratio for *in situ* and *ex situ* conservation in Rajasthan (AFRI-106/FGTB/SFD-RAJ/2010-13).

Prinicipal Investigator: Dr. U.K. Tomar, Scientist F

As per the demand of State Forest department a package of simple and scientific vegetative propagation method was developed so that field officials can follow these guidelines in their nurseries. When stem cuttings were collected from the field for our Institute, many times there was a delay of 3-4 days before raising them in Mist chamber for rooting. So the data was analysed

and compared with freshly raised cuttings (0 day) vs cuttings stored at normal room temperature in air container for 1, 2, 3 & 4 days. Interestingly, stem cuttings raised after 2-3 days responded better than freshly raised stem cuttings (Fig. 63) for sprouting as well as rooting. Experiment was repeated and results were almost same.

Detailed guidelines in Hindi for vegetative propagation of Guggul plants in mist chamber are prepared and submitted to State Forest Department for implementation in their nurseries.

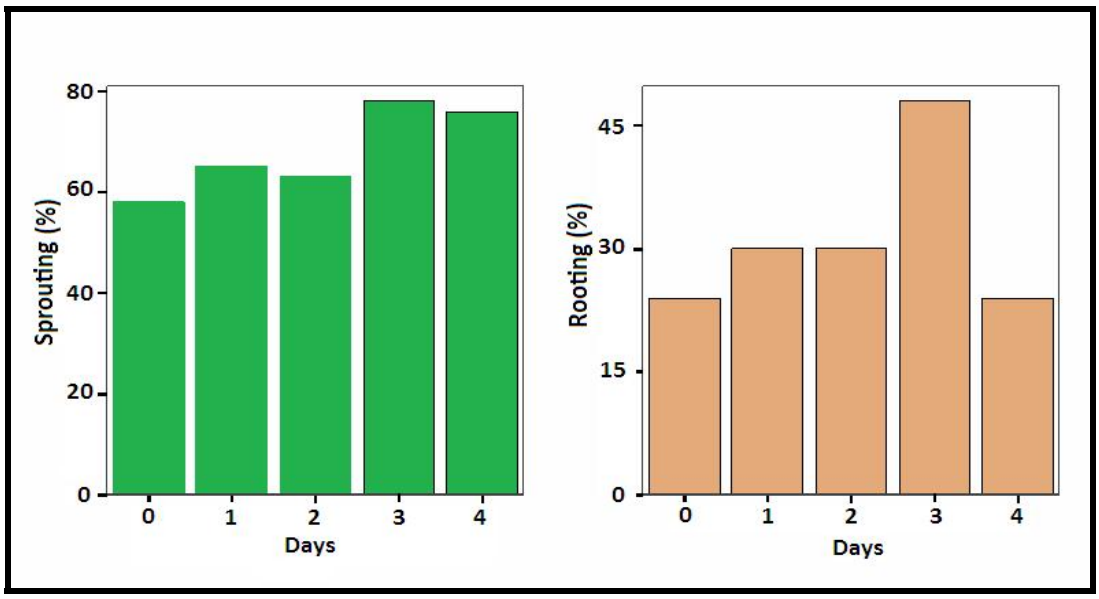

Fig 63. Sprouting and rooting of fresh stem cuttings vs stored stem cuttings for few days when raised in Mist Chamber

Project 38: Development of tissue culture technology for multiplication of economically important desert plant – *Salvadora persica* (AFRI-92/FGTB/ICFRE/2009-2014).

Principal Investigator : Dr. I.D. Arya, Scientist G

The aim of the study is to develop refined protocol for rapid and mass clonal production of plus tree / superior genotypes of *Salvadora persica*. Towards this end, studies were conducted on the effect of media, growth hormones and incubation conditions (temperature, light, humidity) for high frequency multiple shoot induction and growth. MS medium supplemented with BAP (7.5 mg/l) proved best and favoured multiple shoot induction (2-3 shoots per explants) in four weeks at the 28^0C temperature with 2500 lux intensity of light. *In vitro* shoot were maintained and multiplied on MS medium supplemented with 1.0 mg/l BAP (2.0 mg/l) + (0.1 mg/l) IAA. Different types of basal medium were tested for shoot multiplication and in vitro rooing experiments. Effects of different types of medium; MS, WPM, and B5 were studied for in vitro shoot multiplication and MS medium was found to be best for in vitro shoot multiplication. In vitro shoots regenerated were elongated on MS media supplemented with additives. In vitro shoots were transferred on MS medium supplemented with auxins for in vitro rooting and results so far indicated that auxin IBA is suitable for *in vitro* rooting.

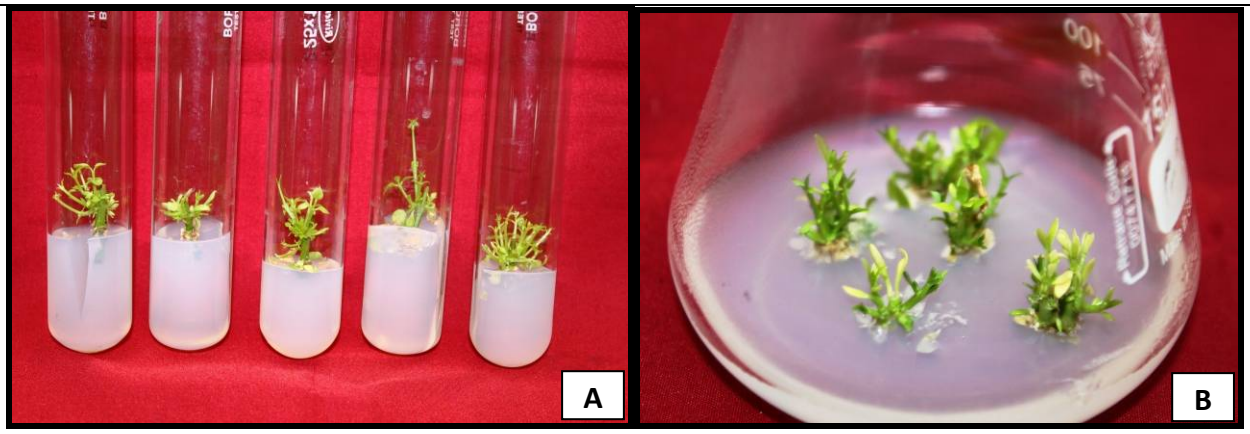

Fig 64. Micropropagation of *Salvadora persica* (A) Multiple shot inductions (B) Further shoot multiplication

Project-39: Study of salt tolerance through gene expression pattern analysis (AFRI-102/FGTB/ICFRE/2010-2014).

Principal Investigator: Dr. Tarun Kant, Scientist E

With the aim of analyzing salt-induced genes through a comparative genomics approach, establishment of fresh set of *Lepidium sativum* (selected halophyte) was done hydroponically. Snap freezing plant growing hydroponically in salt solutions at different time intervals of 0, 1,3, 5, 10, 15, 24, 48 and 72 hours was done. RNA extraction and purification for above experiment was successfully carried out using Ribozol method. RT-PCR for selected genes (NHX1, HKT1, SOS1 and CLC-c). Electrophoresis of RT-PCR products was carried out to analyze the gene expression levels under different time intervals. Analysis of expression of gene product formation at over different exposure intervals of salt solution was carried out. The amplicons were regularly sent for sequencing and the sequence data was analyzed to fine tune the primers for their specificity. Moreover, using Gene Expression Omnibus, Athamap, and Genevestigator co-expression analysis tools, 9 putative genes were identified that have been found to be expressing under high salt conditions (100 and 140 mM NaCl).

Fine tuning of gene expression products through primer redesigning after sequencing. Nine putative were genes identified. These genes have possible role in abiotic stress physiology.

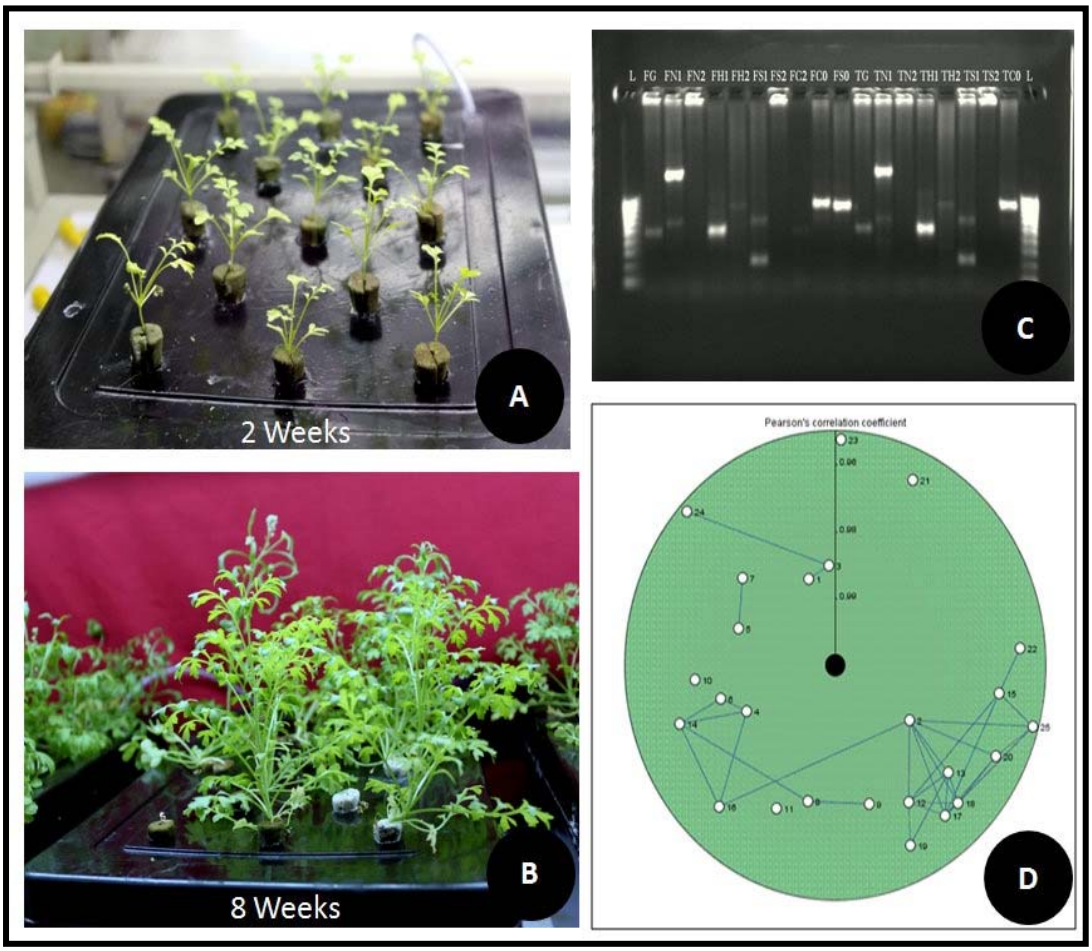

Fig. 65 (A-D). Study of gene expression pattern in *L. sativum* : A. *Lepidium sativum* plants growing hydroponically at 2nd Week; B. plants growing hydroponically at 8th Week; C. A gel image showing bands generated from different genes under salt stress using gene specific primers D. Circular plot predicting closely correlated genes (including putative genes with unknown function) using Pearson's correlation coefficient for *NHX1* (showing genes with correlation above 0.957).

Network project on guggul (AFRI-76/Silvi/NMPB/2008-13).

Principal Investigator : Dr. D.K. Mishra, Scientist F

Component III : Tissue Culture and DNA Fingerprinting

CO-PI : Dr. Tarun Kant, Scientist E

The NMPB funded project has been successfully concluded. More than five years old embryogenic callus were maintained continuously on modified MS medium supplemented with hormones and hormone free medium with alternate sub-culturing. Secondary and tertiary somatic embryos (SEs) were also obtained. White long matured SEs were harvested for the germination on hormone-free modified MS medium. Successfully germinated SEs were carried out for *in vitro*

	hardening. Growth data (height, collar diameter, primary and secondary branches and number of leaves) were collected at regular intervals from the tow year old field trial of tissue culture raised plants. Plants are growing well in the field condition for the last two year with 100% survival. The plants exhibited normal development and no morphological abnormality was noticed. A second field trial was initiated with 120 somatic embryo derived plants in August, 2012 in FGTB field at Jodhpur. The plants have shown 100% survival in last 6 months and are performing well. DNA isolation and purification from fresh leaves of tissue culture raised *C. wightii* plants growing in field was completed. Using Six RAPD primers, that were reported to be most polymorphic for *C. wightii,* complete genetic fidelity test was carried out for all the samples. The UPGMA dendrogram obtained from the SHAN clustering analysis by using Jaccard's similarity coefficient of RAPD data revealed that all axillary shoot derived plants were more than 90% similar to mother plant. The dendrogram showed multiple branches and distance between somatic embryo derived *in vitro* plants and mother plant varied from 0.84 to 1.00. With the aim of economizing the TC protocols, low cost gelling agent (isabgoal, sago, guar gum) and their 35 blends were tested for media solidification. The media thus solidified was then tried out for micropropagation of *C. wightii* through refined protocols of somatic embryo and axillary shoot proliferation developed under this project. **Progress of Project:** Complete micropropagation protocol using axillary shoot derived and somatic embryo pathway have been developed and plants successfully out planted in field condition with cent percent survival. Revival of embryogenecity in long term maintained cultures was achieved enabling cyclic embryogenesis for over five years old cultures. Genetic fidelity test of in vitro raised *C. wightii* plants using DNA fingerprinting involving RAPD markers has been done for the first time. Eestablished and maintenance of two field trials of micropropagated plants of *C. wightii.* Economic analysis done and per plant cost calculated using various protocols developed in the present project. The cost of single plant produced through somatic embryogenesis pathway, comes out to be Rs. 19, while that produced through axillary shoot proliferation protocols comes out to be Rs. 27.

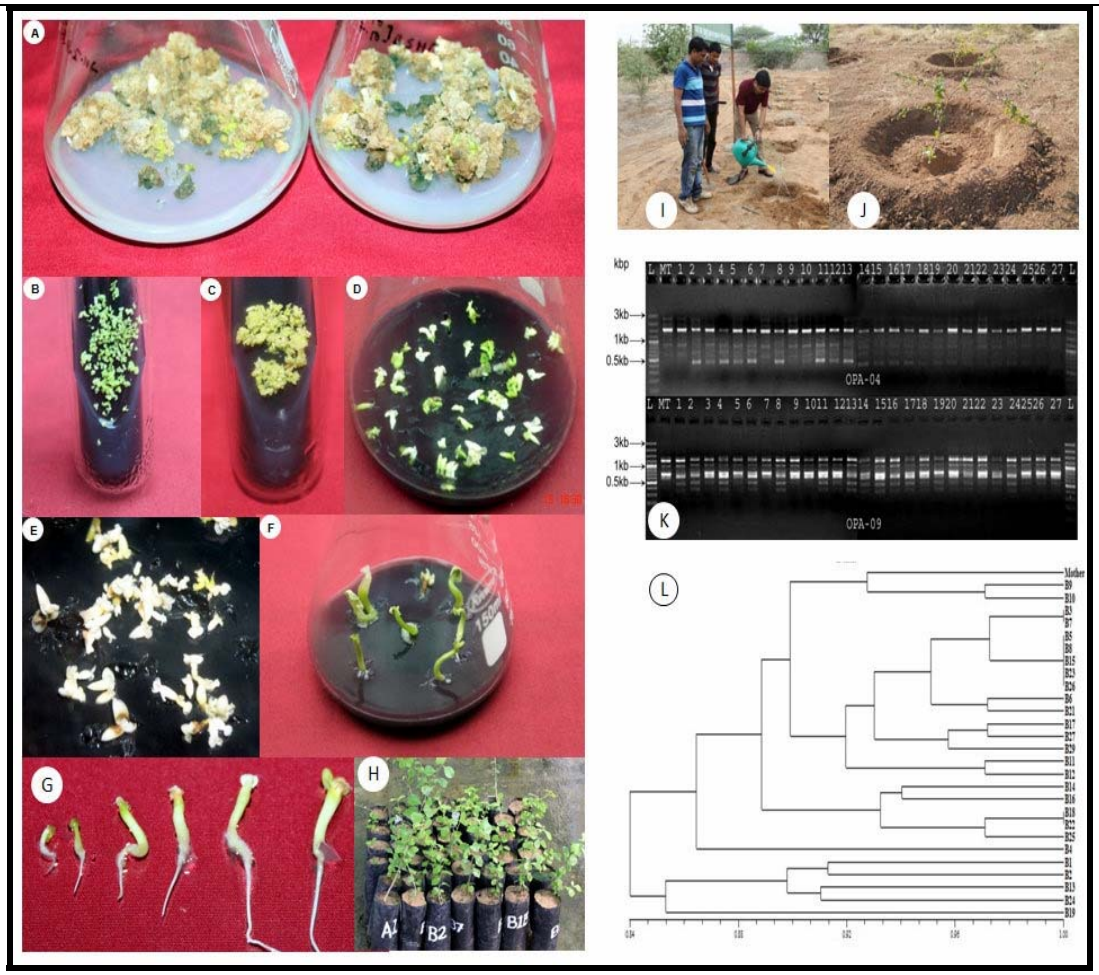

Fig 66. (A-L) –*In vitro* propagation and evaluation of *Commiphora wightii* and genetic fidelity plants: A. Embryogenic callus of *Commiphora wightii* (guggal); B. Somatic embryo (SE) development; C. SE multiplication; D. cotyledonary stage SE conversion; E. mature SEs.; F. Germination of SEs; G. various stages of germination of SEs; H. SE derived hardened plantlets; I & J. field trial of SE derived plants; K. DNA fingerprinting using RAPD markers and L. Dendrogram showing genetic fidelity of regenerated plants.

Project 39: Utilization of Biotechnological tools for clonal propagation and supply of genetically superior trees of neem, ardusa and bamboo (AFRI-06/FGTB/Ext/SFD-GUJ/2013-16).

Principal Investigator: Dr. I. D. Arya, Scientist, G

(New project initiated in March, 2013 funded by SFD Gujarat)

6. **Forestry Education and Policy Research to Meet Emerging Challenges**

Project-40: Development of the web portal for forestry research extension (AFRI-82/IT-Cell/2007-2011).

Principal Investigator: Sh. A. K. Sinha, Scientist D

Project Duration: 2007-2013

The development of the web application of the plants database was completed during this year. The bilingual web application has been developed in Hindi and English so that a user may easily use it by reading the content in Hindi. The content of the web application was prepared in English and was translated to Hindi for developing the bilingual application. The content for the web pages containing the information about the project, How to use the web application, Project team page, Contact us page, description of the main parameters like; different type of soil types, Soil textures, Tree shapes, leaf shapes, leaf margins, inflorescence, flower shapes etc were prepared in Hindi as well as English containing pictorial description of these parameters for easy understanding by the users. By going through these pages on the application site, the user will be able to use the web application effectively. All the searches provided in the web application were also tested thoroughly by entering the data, running the searches and finally rectifying the errors. The Datasheet of a particular plant species which will be produced by the web application has been designed in a systematic way. The overall design of the web application has been improved.

The data on fifty four (54) parameters for 160 plant species of arid and semi arid region including the important tree species, shrubs, herbs, grasses and medicinal plants have been collected so far. The data for the plants species have been collected using the authentic sources like; books, monographs, brochures, technical reports and authentic websites of government organizations. The relevant original photographs of the whole tree, leaf, flower; seed etc. has already been collected for 100 species out of 160 species. All these photographs are originally snapped.

The domain name of the web application has also been registered and hosting of the web application on the web server is shortly. The validation of the data collected is under process. The data entry into the application will start as soon as the data is validated completely and the web application is hosted on the web server. The snapshots of the web application developed and original photographs of some of the plant species collected during this period are as follows :

Fig 67. Home page of the Web Application

Fig 68. Web Page Describing the Flowershapes

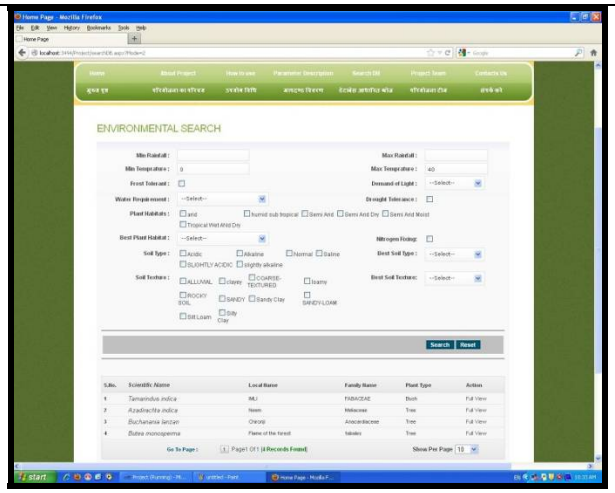

Fig 69. Environmental search on the web application

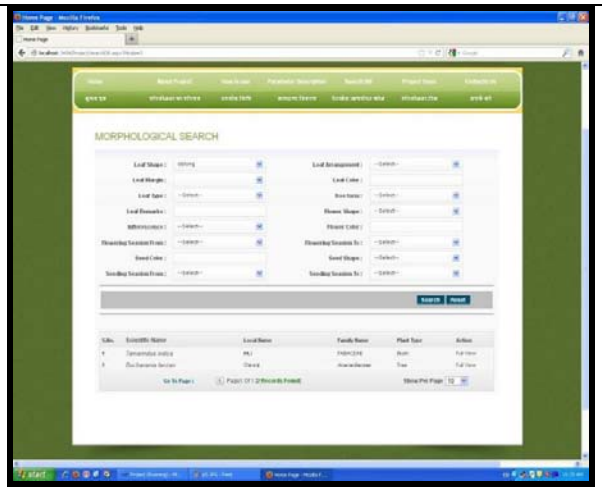

Fig 70. Morphological search on the web application

Fig 71. *Acacia nilotica* (Desi Babool) Tree

Fig 72. Flower of *Acacia nilotica*

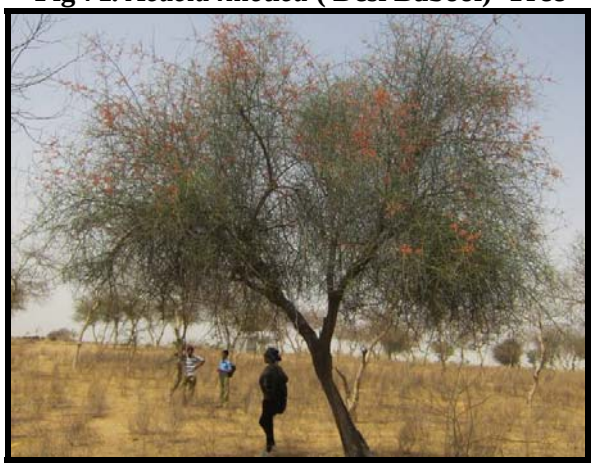

Fig 73. *Capparis decidua* (Kair) Tree

Fig 74. Flower of *Capparis decidua* (Kair)

In addition to the web application, the bilingual dynamic website of the institute developed under this project was updated through out the year. The status and information of all the new, ongoing and completed projects were updated on the site. The research publications made by the the scientists of the institute during the year were updated on their profile on the website. All the other features like institutes directory, bulletin board, image gallery etc. were updated regularly on

the website.

Project-41: Documentation of important Research findings and technologies for application to forestry in Rajasthan (Funded by SFD Rajasthan). (AFRI-08/FE/Ext/SFD:Raj)/2013-16)

Principal Investigator : Dr G. Singh, Scientist, F

(New project initiated in March, 2013 funded by SFD, Rajasthan)

6.1 Improving Formal Forestry Education

6.1.1 FRI University (Applicable for FRI, Dehradun only)

6.2 Accreditation of Universities

6.3 Networking Forestry Education with research and extension

6.3.1 Participation in Seminars/Symposia/ Workshops/Trainings

1. S.R. Baloch, Scientist B, participated three days CITES Awareness Training Workshop 2013 organized by IFGTB, Coimbatore, from 19 to 22 March, 2013.

2. Dr. Sunil Kumar, Scientist E attended training on data mining and data warehouses from 18th-22nd March 2013 at ICFRE, Dehradun.

3. Dr. S.I. Ahmed, Scientist G, Dr. K.K. Srivastava, Scientist F and Dr. Meeta Sharma, Research Officer, participated in one day workshop on "Mehndi avum isabgol ki faslo par lagne wale rog avum keeto ki pehchaan avum unki rokthaam ke upaaye"- held on 20th March 2013 at KVK,Pali, organized by the AFRI, Jodhpur.

4. S.R. Baloch, Scientist- B participated in two days National Seminar on "Climate change and biodiversity" organized by "तकनीकी सबदावली आयोग "Human Resources and Development Ministry held at Udaipur,(Rajasthan) on 17 -18 March, 2013

5. Dr. I.D. Arya, Scientist G, attended National Symposium on plant tissue culture and Biotechnology from 11-13th March 2013.

6. Dr. Sangeeta Singh, Scientist D, participated in one week training on Nanotechnology: Production, establishment and characterization of nanoparticles at IWST Bangalore from 25th February to 1st March 2013.

7. Dr. G. Singh, Scientist F, participated and presented a paper in a national workshop on '*Prosopis juliflora*: Retrospect and prospects' organized by Central Arid Zone Research Institute Jodhpur at

Bhuj, Gujarat from 26-28th February 2013.

8. Dr. U.K. Tomar, Scientist F, attended Specialized Training cum Experience Sharing Workshop on Nursery and Clonal Propagation Techniques at FRI Dehradun on 12 Feb., 2013, organized by the FRI, Dehradun.

9. Dr. Tarun Kant, Scientist E, attended workshop on "Laboratory Accreditation" held on 5th February, 2013 at Desert Medicine Research Centre, Jodhpur.

10. Dr. G. Singh, Scientist F, and N. Bala, Scientist E, participated in one days 'Biodiversity workshop Programm: CRP1.1 Dry land System, at CAZRI, Jodhpur on 22 January 2013.

11. Dr. Tarun Kant, scientist E, attended 100th session of the Indian Science Congress on 6th January, 2013, at Kolkata.

12. Dr. G. Singh, Scientist F, participated in one days monitoring workshop of MPOWER, Jodhpur on 27 December 2012, organized by MPOWER, Jodhpur at AFRI, Jodhpur.

13. Dr. G. Singh, Scientist F, participated in one day Zone level orientation workshop on 'Biodiversity survey, protection and Conservation' on 13th December 2012 organized by SFD Rajasthan at AFRI, Jodhpur and delivered a lecture on 'Effect of climate Change on Biodiversity'.

14. Dr. U.K. Tomar, Scientist E attended and Chaired 'In 3rd National Conference on Man and Environment held at SS Memorial College, Ranchi on 12th December, 2012.

15. Dr. T.S. Rathore, Director, attended 8th Intl. conference on Microwave, Antena, propagation and remote sensing on Dec. 11th, 2012, organized by the Intl. Centre for Radio Science (ICRS), Jodhpur.

16. Dr. T. S. Rathore, Director, N. Bala, Scientist E and A. K. Sinha, Scientist D attended one day inaugural workshop on 8th 'International conference on microwaves, antenna, propagation and remote sensing' on 10th December, 2012

17. Dr. T.S. Rathore, Director, attended national conference on Biotechnology for Environmental management on 4th & 5th Dec., 2012, organized by the P.G. Mahila Mahavidhyalaya, Jodhpur.

18. Dr. T.S. Rathore, Director, attended national symposium on managing stress in drylands under climate change scenario on 1st & 2nd, Dec. 2012, organized by the CAZRI, Jodhpur.

19. S.R. Baloch, Scientist- B, participated in five days Training on" Assessment of soil quality Indicator" organized by FRI, Dehradun , from 3- 7th December 2012.

20. Dr. G. Singh, Scientist F, participated in 2 days symposium on ''Managing stress in Dry lands under Climate Change Scenarios' organized at CAZRI, Jodhpur on 1-2 December 2012.

21. Dr. Sunil Kumar, Scientist E, attended symposium organized by Arid Zone Research Association of India, Jodhpur on Golden Jubilee AZRAI (1962-2012) at CAZRI, Jodhpur from1st-2nd December, 2012.

22. Dr. T.S. Rathore, Director, attended workshop-cum-meeting on date palm tissue culture at Anand, organized by the ICAR, New Delhi on 27th Nov., 2012.

23. Dr. T.S. Rathore, Director, attended XXII workshop cum meeting of Zone V, regional committee at CAZRI on 16th & 17th Nov., 2012, chaired by the D.G., ICAR and organized by the CAZRI, Jodhpur.

24. Dr. G. Singh, Scientist F, and N. Bala, Scientist, participated in two day Dialogue on 'Environmental Governance in the context of sustainable development in India: The cases of Desert Ecosystem' organized by TERI-NLU-KAS at National Law University, Jodhpur on 15-16th November 2012.

25. Dr. T.S. Rathore, Director, attended 24th Session of Intl. Poplar Commission at Dehradun from Oct., 29th to Nov. 2nd, 2012, organized by the FRI, Dehradun.

26. Ashish Kumar Sinha, Scientist, D attended Conference on the National Knowledge Network (NKN) at IIT, Powai, Mumbai, from 31st October to 2nd November, 2012.

27. N. Bala, Scientist E attended special training programme on 'Agroforestry & Land Management' from 15-19 October, 2012, at Department of Forestry, Punjab Agricultural University, Ludhiana.

28. Dr. Tarun Kant Scientist E attended and delivered an invited lecture "Forestry research to ensure an ecologically and economically secure India" at the National Seminar on Science for shaping the future of India from 6-7th October, 2012, organized by the Indian Science Congress Association, Jaipur Chapter at Cenre for Converging Technologies (CCT), University of Rajasthan, Jaipur.

29. Dr. G. Singh, Scientist F, Participated in a workshop at MoEF, GoI, related to preparation of 5th National Report for UNCCD Secretariat on 6th September 2012.

30. Dr. T.S. Rathore, Director and Dr. Ranjana Arya attended brainstorming workshop on Rehabilitation of degraded rangeland for sustainable livelihood of the thar desert, organized by the CAZRI, Jodhpur, UNESCO, Flermish, Govt. of Belgium and UNU – INWEH at Jaisalmer on 5th Sept., 2012

31. Dr. Sunil Kumar, Scientist E, attended training on Science and Technology for Rural Science from 19th August 2012 to 1st September, 2012 at LBSNAA, Mussoorie

32. Ashish Kumar Sinha, Scientist D, attended the E-Champion training cum workshop from 27th-31st August, 2012 held at IFGTB, Coimbatore.

33. Dr. Tarun Kant, Scientist E and Dr. Sangeeta Singh, Scientist D, participated in one week specialized training on Extension Strategies in Forestry Sector for Scientists of ICFRE held at Indian Institute of Forestry Management (IIFM), Bhopal from 27-31st August, 2012.

34. Dr. G. Singh, Scientist F, participated and chaired a session in the interactive Workshop on "Findings of Baseline Study and Monitoring and Evaluation Framework under SLEM Project" held on 16-17 July, 2012 at ICFRE, Dehradun

35. Dr. G. Singh, Scientist F, participated in one day seminar on 'Right to Information Act, 2005' held at Institute of Secretariat Training & Management, New Delhi on 29th June 2012.

36. Dr. T.S. Rathore, Director, attended subject expert committee meeting of DST, Govt. of India for the formulation of All India Coordinated Programme on Arid and Semi-arid Region (CP-ASAR) for 16th to 18th April, 2012 at Jodhpur.

6.3.2 Visits Abroad:

Dr. I. D. Arya & Dr. Sarita Arya visited (Personal visit) Netherland during 2012.

6.4 Capacity Building Scientific and Management Cadre (Trainings Organized)

1. Organized training at AFRI, Jodhpur, for 25 research staff of ICFRE Institutes on Value addition of NTFP, analytical methods and medicinal plants from 10-14 Dec, 2012 under HRD programme of ICFRE.
2. 19 trainings were organized from January 2013 to March 2013 at AFRI, Jodhpur for integrated watershed management members in which 500 members were trained.
3. Six months project work training was imparted to 14 students of M.Sc. Plant Biotechnology by the AFRI, Jodhpur during the year.
4. Organized two training under direct to consumer scheme in March, 2013 for officials of the SFD, Rajasthan, farmers and NGOs.
5. Organized three training on Jatropha cultivation under biofuel project in Rajasthan.

7.	Forestry Extension for Taking Research to People

7.1 Collection, Compilation and Publication of forestry reports/journals

7.1.1 Research Publications

1. **Abha Rani and** Pravin H. Chawhaan (2012). Starch of *Curcuma angustifolia* Roxb. in comparison with other starches of forest origin. Indian Forester. **138(11)**.
2. **Abha Rani** and Pravin H.Chawhaan (2012). Extraction and scanning electron microscopic studies of *Curcuma angustifolia* Roxb. Starch. Indian Journal of Natural Products and Resources. **3(3):** 407-410.

1 Ashok Kumar Parmar and Tarun Kant (2012). Effecient micropropagation and evaluation of genetic fidelity of *in vitro* raised plants of *Commiphora wightii* Arn. (Bhandari) - a medicinally important red-listed species of arid regions. *J Plant Develop.* 19: 29 – 40.

2 B. Ram, G.R.S. Reddy, and T.S. Rathore (2013). Molecular analysis of micropropagated *Melia dubia* plants using RAPD and ISSR markers for ascertaining clonal fidelity. In: Abstract of the Biofutra 2013, Natl. conference on biomedical sphere of Life Sciences, organized by the CMR Institute, Bangalore, held on 6th March, 2013, p.7.

1. B. Ram, T.S. Rathore and G.R. S. Reddy (2012). *In vitro* propagation of *Melia dubia* Cav. from seedling explants. Biotechnology, Bioinformatics and Bioengineering. ISSN 2249-9075.
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7.1.2 **National Forest Library and Information Centre** (NFLIC) (Applicable for FRI, Dehradun only)

7.1.3 Environmental Information System (ENVIS) (Applicable for FRI, Dehradun only)

7.2 Dissemination of developed technologies

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

Progress/Status Report of Van Vigyan Kendras, under AFRI, Jodhpur

State wise locations of established VVKs

(a) Bichhwal (Bikaner), Rajasthan
(b) Chhipardi Beedi (Rajkot) Gujarat
(c) Rudana Nursery, Khanwel (Silvasa) Dadra & Nagar Haveli and Daman.

1. VVK at Bichhawal Nursery, Bikaner (Rajasthan)

A meeting was conducted between AFRI officials and Shri D.R. Sahran, DCF, IGNP Stage II, Bikaner and discussed about various VVK activities to be carried out during 2012-13. MOU of VVK was signed between RFD and AFRI for extension of the period of five years (2012 -17).

Maintenance of Hi-Tech Nursery Bichhwal, Bikaner

Polythene bags, insecticide, fertilizers, seed and pipe were procured for the Hi –Tech VVK nursery at Bichhwal, Bikaner.

During the last financial year (2011-12), 3000 seedlings of *Prosopis cineraria* and *Delbergia sissoo* were raised under VVK Hi-tech nursery Bicchwal Bikaner. A revenue of Rs.15000/- was collected after selling quality seedlings to farmers.

As regards to extension linkage with the Krishi Vigyan Kendras of ICAR, discussions were held with

Zonal Director, Krishi Vigyan Kendra, Jodhpur. In principle agreed for show casing AFRI/ICFRE research outcome in KVKs.

Raising of Seedlings: About 3000 quality seedlings of *Prosopis cineraria and Dalbergia sissoo* have been raised in Hi-Tech nursery Bichhwal, Bikaner for the demonstration and distribution to the farmers to promote agroforestry under VVK during 2012-13.

AFED staff visited Hi-Tech nursery Bicchawal, Bikaner from 26 to 27th Dec 2012, observed various activities of nursery and discussed about the nursery activities with forest officials and Nursery In-charge. A progeny cum performance demonstration field trial of *Tecomella undulata* was also visited along with forest officials, Bikaner.

2. VVK at Chhipardi Beedi, Rajkot (Gujarat)

Meetings organized between AFRI official and additional PCCF (Research), CF (Research) and DCF (Research) & Nodal Officer (VVK) at GFRI, Gandhinagar regarding maintenance of VVK nursery and raising of high quality seedlings and other activities for financial year 2012-13. DCF (Res.) was briefed about the works under VVK which need to be taken up at VVK Display Centre & VVK's modal nursery at R&D Centre, Rajkot.

Maintenance of Hi-Tech Nursery: Garden pipe, fogger and accessories, fertilizer & insecticide were procured for the maintenance of Hi-Tech nursery at Research and Development Centre, Chhipardi Beedi Rajkot under VVK in Gujarat.

During the last financial, year about 2500 high quality seedlings of *Cordia mixa, Casuarina equisetifolia* and *Eucalyptus* hybrid were raised from seeds/cutting and *Zizyphus mauritiana*, *Emblica officinalis* grafted/budded plants. Each species; 500 seedlings were raised under VVK Hi-tech nursery Rajkot. Total Rs.4700/- (Four Thousand Seven Hundred only) were collected after selling these seedlings to farmers.

Raising of Seedlings: During 2012-13 raised grafted plants of *Embelica officinelis* and *Ziziphus mauritiana* and high quality seedlings of *Casuarina equisetifolia*, *Eucalyptus* hybrid species. Each speices consisted of 500 seedlings and total 2000 seedlings were raised to promote agroforestry among the farmers.

3. VVK at Khanwel, Silwasa (Dadra & Nagar Haveli and Daman, UT)

MOU was signed between SFD, Silvasa and AFRI, Jodhpur. Due to various reasons, the establishment of Agroshed and other works at Rudhana nursery could not be executed. Trainings under in VVKs and Demo Village programme also could not be organized during 2012-13.

4. Demo village, Salavas, (Jodhpur)

Maintenance and strengthening the Demo sites: Demo village nursery was maintained through different silvicultural practices. Demonstrated cattle proof trenches and planted lives hedges, medicinal plants. Eight medicinal plants species were planted at Demo village nursery, Salawas for knowledge and use of local people. The planted five medicinal plants are *Nyctanthus arbortrestus* (Harsingar), *Cymbopogon citrates* (Leman grass), *Asparagus racemosus* (Satawari), *Crinumasi aticum* (Sudarsan), *Adhatoda beddomei* (Adusa) and three creepers were *Tinospora cordiflora* (Neem giloi), *Argyreia nervosa* (Tambeshwar Ghav Bel) and *Tylophora asthmatica* (Dama Bel).

Demonstrated technologies on soil and water conservation and silvipastoral model of *Cenchrus ciliaris* grass along with *Cordia gharafa* and *Zyziphus nummularia* with intervention of *in-situ* water conservation were maintained. Growth data recorded after 12 months of planting. In *Z. mauritiana,* plants attained 153.3 cm and 146.6 cm as mean height and crown diameter respectively while due to grazing *C. gharaf* attained more mean crown diameter (138.4 cm) than height (57.9 cm). In *Z. mauritiana* plants attained 4.5 & 3.3 times more height and 6.1 & 5.4 times more crown diameter in control and grass treatments, respectively as compared to values in December, 2011. However, due to grazing damage, increase in *C. gharaf* which was 2.1 & 2.4 times for height and ~3.9 times for crown diameter in both the treatments. Low germination of grass seed in last year, therefore, grass sowing was done again in August 2012 after very good rain, subsequent rains helped in germination and very good grass growth was observed. The green grass yield was not influenced by the treatments and ranging from 618.3 g/m^2 for *C. gharaf*, 633.0 g/m^2 in control and 675.6 g/m^2 with *Z. mauritiana*. For other parameters, control recorded maximum height (78.9 cm) and no of clumps 11.4/m^2 however, no of tillers were maximum in *Z. mauritiana* (47.5) and minimum in control (36.5).

Contour line, V-ditch, box trenches, saucer pits, rings pits were constructed/dug-up to promote the improved soil and water conservation devices among the people.

Demonstrated technologies at Demo village, Salawas to various visitors of AFRI.

7.2.2 Direct to Consumer Scheme

1. A training was organized on "मेहंदी एवं इसबगोल पर लगने वाले रोगों एवं कीटों से बचाव" at Krish Vigyan Kendra, Pali under "Direct to Consumers schemes" under the project entitled "Management of Insect pests and diseases in Mehndi and Isabgol" about 45 farmers have participated from different villages of Pali District on March 20th 2013. Three lectures were delivered about the important isect pest of Mehndi and Isabgol and their control measures.

Fig 75 (A-D). One day training programme on " Mehndi avam Isabgol ki fasal par hone wale rog avam roktham" at KVK, Pali.

2. For wider publicity and use by the stakeholders for implementation in field published two brochures ;

i. Mehnhi ki fasal par lagane wale kit avam rog avam roktham.under Direct to consumer scheme in Hindi
ii. Isabgol ki fasal par lagane wale kit avam rog avam roktham. under Direct to consumer scheme, in Hindi

3. Organised one day training cum workshop on 'Rainwater Harvesting and Afforestation for the Rehabilitation of Degraded Hills' at Banswara on 13th March 2013 under '**Direct to Consumer Scheme**' and participants were briefed about the work by two lecture as well as field visit to the experimental site 'Gauapada/Chhatripada' village, Bara Nandra Kho forest Block, Banswara.

4. Published following brochures in Hindi and English for the distribution to stakeholders for field implementation;

i. Rainwater harvesting in restoration of degraded hills and people livelihood. Prepared under 'Direct to Consumer Scheme' for different Stakeholders

ii. voØfer igkfM;k dk iuokZlu ,oa ml {k= esa jgus okyk ykxksa dh vkftfodk esa o"kk ty lajxg.k dh Hkfedk. Prepared under 'Direct to Consumer Scheme' for different Stakeholders.

iii. Carbon sequestration during rehabilitation of degraded hills. Prepared under 'Direct to Consumer Scheme' for different Stakeholders.

iv. voØfer igkfM;k dk iuokZlu dk nkjku dkcZu lp;u. Prepared under 'Direct to Consumer Scheme' for different Stakeholders.

7.2.3 Technologies transferred

To demonstrate the effects of rainwater harvesting and conserve soil and water, different rainwater harvesting structures were prepared in hilly/gravelly pediment area at Demo village Salavas in 2012-13. Other expected benefits are control of soil erosion and losses, ground water recharge and improvement in biological diversity in the area. These structures are pits like saucer pits and ring pits, each 25 in numbers at 5 m interval; trenches like; regular trenches (box trench), V-ditch and Gradonie ditch (Figure below), each 100 m in length. In addition contour trenches of about 5000 running meter were also excavated in 2011-12 for conserving soil and water and harvest rainwater. Five masonry check dams and two loose stone check dams were also prepared during 2011-2012 under drainage line treatment. These different rainwater harvesting structure were prepared for demonstration purpose to field functionaries, villagers, NGO etc.

Fig 76. Saucers of 3.0 m diameter

Fig 77. Ring pits

Fig 78. Contour trench

Fig 79. V-ditch

7.3 Evolving and coordinating comprehensive extension strategies in forestry research

7.3.1 SLEM -Nil

7.3.2 Seminars/Symposia/Workshops Organized

1. Organised one day training cum workshop on 'Rainwater harvesting and afforestation for the rehabilitation of degraded hills' at Banswara on 13th March, 2013 under '**Direct to Consumer Scheme**'.
2. Organized workshop in collaboration with Department of Science and Technology, Govt. of India, New Delhi for the Sub-expert committee for the development of Coordinated Programme on Arid and Semi-Arid Regions (CP-ASAR) on 16-18th April, 2012 at AFRI, Jodhpur.
3. Organized stakeholders meeting at Van Bhawan, Jaipur, Rajasthan on 22nd August, 2012, in which officials from SFD, Universities, research institute, leading farmers and NGOs were participated.
4. Organized stakeholders meeting at FTI, Gandhinagar, Gujarat on 10th September 2012, in which officials from SFD, Universities, research institute, leading farmers and NGOs were participated.
5. Organized Research Advisory Group Meeting at AFRI, Jodhpur on 7th-8th November, 2012.
6. Organized one day workshop on Biodiversity on 13-12-12 in collaboration with State Biodiversity Board, Rajasthan, Jaipur.
7.

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

International Biodiversity Day: International Biodiversity Day was celebrated on 22 May, 2012 in collaboration with State Forest Department, Rajasthan at Yoga Kendra, J,N,Vyas University, Jodhpur. On this occasion 50 seedlings of tree species were planted. The chief guest was Dr. B. S. Rajpurohit, Vice Chancellor; JNV university, Jodhpur, guest of honur was sh. A.K.Singh, CCF, Jodhpur and sh. Indraj Singhji, CCF (WL). Dr.T.S.Rathore, Director AFRI given speech on Biodiversity of Arid Zone.

In another event in the afternoon at AFRI two lectures one on Elephant-Habitat and Behavior by Sh.M.R.Baloch,IFS and another by DFO,Jodhpur Sh.SRV Murthi on Conventional treaties were organized.

Fig 80. Celebration and inauguration of AFRI pamphlet on World Biodiversity Day 22 nd May, 2012

Fig 81. Lecture by Sh.M.R.Baloach, IFS on World Biodiversity Day 22 nd May, 2012

World Environment Day: World Environment Day was celebrated at AFRI on 5th June, 2012. On this occasion a painting competition for children on "our environment" was organized. Seedlings of tree species were planted in AFRI campus on this occassion. Director AFRI, Dr.T.S.Rathore expresses his view on the theme "GREEN ECONOMY".

Fig 82. Plantation of Seedlings By Dr. T.S.Rathore, Director, AFRI, On World Environment Day

Fig 83. Speech By t Dr. T.S.Rathore, Director, AFRI, on World Environment Day

World Combating Desertification Day: World Combating Desertification Day was celebrated at AFRI on 17 th June, 2012 . The theme of this year was "HEALTHY SOIL,SUSTAINABLE LIFE ". On this occasion plantation of seedlings of Chandan was planted. In this programme Director AFRI Dr.T.S.Rathore, Sh. M.R. Baloach, IFS GC(R), Dr. R. Arya etc express their view on combating desertification.

Fig 84. Plantation of seedling by Diretor, AFRI and others

Fig 85. Speech By Director,AFRI

Van mahotsav 2012: Arid Forest Research Institute, Jodhpur celebrated Van Mahotsav 2012 at Central School No.1. on 19th July, 2012. The Chief Guest of Program was Air commodore R.N.Gayakwad. On this occasion Director, AFRI Dr.T.S.Rathore delivered talk. In van mahotsav, Group co- coordinator(R) AFRI, Principal KV 1 Dr.R.K. Meena and officials (Scientist, Technical & Ministerial) along with scouts of Rajasthan & Gujarat Planted various tree species seedlings in school premises. Students of KV performed in cultural programme.

Fig 86. Diretor AFRI Dr. T.S. Rathore and Chief Guest Air Commodor Air Commodor R.N. Gyakvad in plantation ceremony

Fig 87. Cultural programme by students and scouts in Van Mahotsava

Hindi Pakhwada: Hindi Pakhwada was celebrated in AFRI from 14-28th Sep., 2012. In the inaugural programme During the Pakhwada various programme viz. English to Hindi translation, Hindi essay competition, and General administrative words. Scientific Workshop in Hindi Language & working Hindi knowledge competitions were also held in which AFRI official participated. The Pakhwada close on September 28th, 2012 with kavya path in hindi.

Kisaan Mela: Kisaan Mela organized by CAZRI-Central Arid Zone Research Institute (CAZRI), Jodhpur on September 12th, 2012. AFRI's information about various Research work was demonstrated

and pamphlets published by AFRI were also distributed to the farmers.

Fig 88. Farmers at AFRI Stall in CAZRI Kissan Mela

Fig 89. Giving information about AFRI activities to chief guest and other at CAZRI Kissan mela

Vigilance Awareness Week: As per the Direction of Govt. of India, AFRI celebrated Vigilance Awareness Week during 29-10-2012 to 3-11-2012. The programme stated with oath ceremony for Vigilance awareness by Vigilance Officer AFRI Sh. M.R.Baloch. During this week easy & slogan competition on "Awareness in present era & Importance of awareness" subject was also held. In the closing ceremony, Administrative officer of CAZRI Sh. I.R. Kumar delivered talk about the importance of Vigilance awareness week.

Fig 90. Celebration of Vigilance Awareness Week

7.4 Consultancy Services

(1) Plantation site of "Dry land Agroforestry" project at Salawas, Jodhpur and Data, Sikar was evaluated which was funded by ONGC.

(2) Proved technical consultancy to grow *Jatropha curcas* in Rajasthan to State Biofuel authority, Jaipur, Rajasthan.

7.5 Activities of Rajbhasha

jkt Hkk"kk okf"kd ifronu& 2012&2013

2012–2013 के दौरान संस्थान का हिंदी पत्राचार 75.87 फीसदी रहा तथा फाईलों में औसतन 82.85 फीसदी टिप्पणियां हिंदी में लिखी गई। नियमित तौर पर हिंदी कार्यशालाएं व वैज्ञानिक गोष्ठी संस्थान में आयोजित हुई। वर्षपर्यन्त निर्धारित चार तिमाही बैठकें आयोजित हुईं। नराकास की नियमित बैठकों में भाग लिया। संस्थान की वेबसाईट का हिंदीकरण कार्य किया गया। संस्थान की हिंदी पत्रिका आफरी दर्पण का नियमित प्रकाशन हुआ जिनमें संस्थान की प्रौद्योगिकियों के विशेषांक भी सम्मिलित हैं। दिनांक 14 से 28 सितम्बर 2012 को हिंदी पखवाड़ा आयोजित किया गया जिसमें सरकारी कामकाज में हिंदी के प्रयोग को बढावा दिए जाने से संबंधित विभिन्न प्रतियोगिताओं का आयोजन हुआ। हिंदी पखवाड़ा के दौरान वर्ष 2011–2012 के हिंदी कार्यो के लिए संस्थान कर्मियों को राजभाषा पुरस्कार प्रदान किए गए। कार्मिकों को यूनिकोड सॉफ्टवेयर पर प्रशिक्षण दिलवाया गया। संस्थान को वर्ष 2011–12 के हिंदी कार्यो के लिए नराकास, जोधपुर की ओर से नगर राजभाषा चल वैजयंती एवं प्रशस्ति पत्र प्रदान कर सम्मानित किया गया। प्रशिक्षण सामग्री तथा उपयोगी पत्रक/प्रचार प्रसार सामग्री हिंदी में प्रकाशित कर वितरित की गई। वर्ष 2012–13 के दौरान पुस्तकालय हेतु 1317/– मूल्य की हिंदी पुस्तकें खरीदी गई। प्रशासनिक तथा जनता से जुडे पत्राचार को हिंदी में ही करने पर जोर दिया गया। संस्थान कर्मियों ने विभिन्न कार्यशालाओं/राजभाषा संगोष्ठियों में भी भाग लिया। हिंदी की स्तरीय पत्रिकाओं हेतु प्रकाशनार्थ जनोपयोगी सामग्री तथा वैज्ञानिक लेख भेजे गए। आकाशवाणी में हिंदी भेंटवार्ताएं भी दी गई।

संस्थान में आयोजित प्रशिक्षण तथा विस्तार गतिविधियों को व्यापक तौर से प्रचारित–प्रसारित किया गया। निर्वचन केन्द्र में संस्थान की शोध गतिविधियों को हिंदी–अंग्रेजी में अद्यतन प्रणाली के अंतर्गत प्रदर्शित किया गया। हिंदी मे सहज रूप से कार्य करने की दिशा में सारांश हिंदी सॉफ्टवेयर को प्रयोग में लाया जा रहा है। हिंदी भाषा, टंकण, आशुलिपि के प्रशिक्षण लेने हेतु कोई रोस्टरबद्ध नहीं है। कार्यालय प्रयोग की निर्धारित सभी सामग्री द्विभाषिक है। मुख्यालय स्तर पर संस्थान की राजभाषा गतिविधियों का निरीक्षण भी हुआ।

7.6 Awards and Honours

N.Bala, Pramod Kumar, N.K. Bohra, N.K. Limba, S.R. Baloch and G. Singh were awarded the prestigious **S.K. Seth Prize for the year 2010** for the best research paper entitled "Production and decomposition of litter in plantation forests of *Eucalyptus camaldulensis* along canal command area in Indian desert".

8.	Administration and Information Technology

Introduction

8.1 Information Technology

1. Integration of the ICFRE Virtual Private Network (VPN) with the National Knowledge Network.

The VPN of ICFRE has been integrated with the 100 mbps National Knowledge Network (NKN) leased line. With the ICFRE VPN working on the 100 mbps NKN leased line; fast internet connectivity has been provided to users on the VPN of ICFRE. The entire network services including internet, email and VC facilities have been bettered with the higher bandwidth provided by NKN.

2. Rennovation of the IT-Cell

The laboratory of the IT-Cell was renovated thereby giving it a fresh new look by using the modern interior materials and making it eco-friendly by designing it to consume significantly less electricity and also taking care of fire safety measures..

3. Procurrement of equipments for the GIS laboratory

The procurement of the equipments of the GIS laboratory were made after observing the codal formalities. The GIS laboratory is now fully furnished with all the required equipments like workstations, plotter cum scanner and the GIS software. A basic training on the use of the software has also been received by the staff of the IT-Cell and Forest Ecology Division.

4. Manintenance of the IT infrastructure

The existing IT infrastructure was maintained properly with the help of annual maintenance contract of computer, peripherals and the UPS. Several important video conferencing sessions were organized during the year.

5. Manitenance and updation of the website

The Hindi and English website of the institute was maintained and updated regularly throughout the year. The research publications of all the scientists and the status of the projects were updated on the website. The reports of the important events held at the institute were uploaded on the institutes as well as on the ICFRE website.

8.2 Sevottam: Activities relating to the Citizens/Clients Charter as detailed below has to be included in the Annual Report 2011-2012.

8.2.1 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 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, 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. Main research focus of the institute includes :

1. Soil, water and nutrient management,
2. Development of technologies for afforestation of stress sites,
3. Management of plantations,
4. Planting stock improvement and nursery and plantation techniques,
5. Biofertilizers and biopesticides,
6. Phytochemistry; non-wood forest products,
7. Biodiversity conservation and climate change,
8. Agroforestry and JFM,
9. Forestry education & extension.

Procedures have been formulated for identifying the research problems of the arid region; developing the projects based on the problems and dissemination of the research results and technologies to the users.

In order to identify the research problem, stakeholders meeting are organized in the two states viz. Rajasthan and Gujarat falling under the jurisdiction area of the institute. Officials from SFD's, progressive farmers, scientists and NGO's participate in the stakeholders meeting and express the problems on which the research is required.

Based on the research problems given by the stakeholders, in house discussions are made amongst the scientists of the institute and the research projects are formulated by the scientists after the thorough review of scientific literature.

The projects are sent to the external experts for their suggestions. After incorporating the suggestions/modifications, the projects are presented before the Research Advisory Group (RAG) Meeting and subsequently to the Research Policy Committee (RPC) meeting for approval. After the approval of projects, the funds are allotted for the projects and the projects are executed by the scientists. The technologies developed through the projects are demonstrated to the users with the help of demonstration trails, extension trainings, Van Vigyan Kendras, Demovillege, printed material and the website of the institute.

8.2.2 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, and RAG members and finally by RPC for internal funding and implementation. Projects have also been submitted for various donor agencies for implementing the Charter. Stakeholders meet of AFRI; Jodhpur was organized at Jaipur on 22nd August, 2012 and at Forest Training Research Center, Gandhinagar on 10th September, 2012. RAG Meeting of AFRI was held on 8th November, 2012. New project proposals of various divisions were presented by the PIs. RAG Meeting was chaired by Director, AFRI. Projects approved by RAG were sent ot ICFRE for the RPC approval

Several extension trainings were held during the year for dissemination of research results produced by various projects executed in the institute. Two issues of the AFRI darpan, the quarterly magazine of AFRI were published in order to apprise the public about the research findings of the institute. The research results of the projects, the technologies developed by the institute and the events held at the institute were continuously updated on the website of the institute.

In addition to these, environmental awareness programs were organized by the institute in the form of World Environment Day, Biodiversity Day, Combating Desertification Day and Van Mohotsava, the details of which have been mentioned above.

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

Mentioned above under point No. 6.4 & 7.3.2

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

Mentioned above under point No. 7.2 & 7.3.3

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

All the new projects and progress of the ongoing research projects were presented to the internal and external experts of the Research Advisory Group who gave their comments on the quality of the new projects and the progress of the ongoing projects. The experts prioritized the new projects and expressed their satisfaction on the progress of the ongoing projects.

8.3 Welfare measures for the SC / ST/ backward / minority communities

- To promote the general interest of SC/ST/OBC employees and to work for their collective betterment development and upliftment, AFRI SC/ST/OBC Employees Welfare Association was formed on 20th September, 2012 by formulating the BYLAWS and electing the Executive Committee of twelve members. Office bearers of SC/ST/OBC Employees Welfare Association are:

  President: Ms Desha Meena

Vice-President: Shri Manoj Chouhan
Secretary: Shri S.R.Baloch
Joint Secretary: Shri D.S.Sisodia
Treasurer: Shri Chaman Lal
Executive Members: 7no's

- The Association made their efforts to celebrate the 56th Parinirvan Diwas of the architect of Indian Constitution Bharat Ratna Dr. B. R. Ambedkar for the first time at Arid Forest Research Institute, Jodhpur on 6th December, 2012. Dr. T. S. Rathore, Director, AFRI preceded over the program to pay homage to Baba Sabeb Ambedkar. Professsor Tara Ram, Director, Bodh Adyayan Anusandhan Kendra, Jodhpur was invited as the chief guest to deliver lecture on "Constitution of Dr. B. R. Ambedhkar and Conservation of Environment". Shri M.R.Baloch, GCR, A.F.R.I, Jodhpur also addressed the gathering on the ideals of Baba Sabeb Ambedkar.

- For proper functioning of the Association, a separate room was also allotted in Library building which is being utilized by Association for meetings and discussions for the welfare of the SC/ST/OBC Employees.

- Total 3 number of complaints were received during 2012-13 from the employees of weaker section which are under disposal process.

9. 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. G. Singh Scientist F Head Forest Ecoly Division,AFRI Email: gsingh@icfre.org Phone : 0291-2729143 FAX : 0291-2722764	All matters related to AFRI, Jodhpur

	Details enclosed in Annexure I 1. 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 2. Intellectual Property 2.1 Patents Granted - NIL 2.2 Others

RTI Annual Return Information System

Quarterly Return Form

Public Authority : Ministry of Environment & Forests

Quarter: I

Year: 2011-2012

Quarter – April to June, 2012

Mode: Insert Status : New Return

		Progress during the month				
	Opening Balance as on beginning of IV Quarter	No. Of applications received as transfer from other PAs u/s 6(3)	Received during the Quarter (including cases transferred to other PAs)	No. Of cases transferred to other PAs u/s 6(3)	Decision where requests/ appeals rejected	Decision where requests/ appeals accepted
Requests	Nil		09	01	Nil	09
First Appeals	Nil	Nil	Nil	N.A.	N.A.	N.A.

Total no. of CAPIOs designated	Total no. of CPIOs designated	Total no. of AA's designated
01	01	01

Block II (Details about fees collected, penalty imposed and disciplinary action taken)			
Registration Fee Collected (in Rs.) u/s 7(1)	Additional fee collected (in Rs.) u/s 7(3)	Penalities Amount Recovered (in Rs.) as directed by CIC u/s 20(1)	No. Of cases where disciplinary action taken against any officer u/s 20(2)
Rs.90/-	Rs.156/-	Nil	Nil

Block III (Details of various provisions of section 8 while rejecting the requested information) - NA													
No. of times various provisions were invoked while rejecting requests													
Relevant Section of RTI Act 2005													
Section 8(1)										Sections			
a	b	c	d	e	f	g	h	i	j	9	11	24	other

Block IV (Details regarding compliance of direction/recommendation of the Commission) - NA			
S.No.	Reference No. Of cases wherein Commission made specific recommendation as per section 25(5) (max. 20 chars.)	Whether action is initiated to comply with recommendation of Commission.	Details, thereof (max. 250 chars.)
1-		-Select-	
2-		-Select-	
3-		-Select-	
4-		-Select-	
If the Public Authority made any changes in regard to its rules/regulations/procedures as a result of requested information by the citizens, please provide the summarized details of the changes (max. 500 chars.)			

Block V (Details regarding compliance of direction/recommendation of the Commission) - NA		
Last Date of Uploading the Pro-active Disclosures on the webside of PA	Name of the person who is entering/updating data	Designation of the person who is entering/updating data
General Information uploaded	Smt. Kusum Parihar	Research Assistant – I C/o Incharge, IT-Cell of the Institute.

RTI Annual Return Information System

Quarterly Return Form

Public Authority : Ministry of Environment & Forests

Quarter:

Year: 2012-2013

Quarter –july to Sept, 2012

Mode: Insert Status : New Return

		Progress during the month				
	Opening Balance as on beginning of IV Quarter	No. Of applications received as transfer from other PAs u/s 6(3)	Received during the Quarter (including cases transferred to other PAs)	No. Of cases transferred to other PAs u/s 6(3)	Decision where requests/ appeals rejected	Decision where requests/ appeals accepted
Requests	Nil	01	07	02	Nil	07
First Appeals	Nil	Nil	Nil	N.A.	N.A.	N.A.

Total no. of CAPIOs designated	Total no. of CPIOs designated	Total no. of AA's designated
01	01	01

Block II (Details about fees collected, penalty imposed and disciplinary action taken)			
Registration Fee Collected (in Rs.) u/s 7(1)	Additional fee collected (in Rs.) u/s 7(3)	Penalities Amount Recovered (in Rs.) as directed by CIC u/s 20(1)	No. Of cases where disciplinary action taken against any officer u/s 20(2)
Rs.70/-	Rs.564/-	Nil	Nil

Block III (Details of various provisions of section 8 while rejecting the requested information) - NA													
No. of times various provisions were invoked while rejecting requests													
Relevant Section of RTI Act 2005													
Section 8(1)										Sections			
a	b	c	d	e	f	g	h	i	j	9	11	24	other

Block IV (Details regarding compliance of direction/recommendation of the Commission) - NA			
S.No.	Reference No. Of cases wherein Commission made specific recommendation as per section 25(5) (max. 20 chars.)	Whether action is initiated to comply with recommendation of Commission.	Details, thereof (max. 250 chars.)
1-		-Select-	
2-		-Select-	
3-		-Select-	
4-		-Select-	
If the Public Authority made any changes in regard to its rules/regulations/procedures as a result of requested information by the citizens, please provide the summarized details of the changes (max. 500 chars.)			

Block V (Details regarding compliance of direction/recommendation of the Commission) - NA		
Last Date of Uploading the Pro-active Disclosures on the webside of PA	Name of the person who is entering/updating data	Designation of the person who is entering/updating data
General Information uploaded	Smt. Kusum Parihar	Research Assistant – I C/o Incharge, IT-Cell of the Institute.

RTI Annual Return Information System

Quarterly Return Form

Public Authority : Ministry of Environment & Forests

Quarter: III

Year: 2012-2013

Quarter – Oct. to Dec., 2012

Mode: Insert Status : New Return

		Progress during the month				
	Opening Balance as on beginning of lll Quarter	No. Of applications received as transfer from other PAs u/s 6(3)	Received during the Quarter (including cases transferred to other PAs)	No. Of cases transferred to other PAs u/s 6(3)	Decision where requests/ appeals rejected	Decision where requests/appeals accepted
Requests	Nil	Nil	07	Nil	Nil	07
First Appeals	Nil	Nil	01	Nil	Nil	01

Total no. of CAPIOs designated	Total no. of CPIOs designated	Total no. of AA's designated
01	01	01

Block II (Details about fees collected, penalty imposed and disciplinary action taken)			
Registration Fee Collected (in Rs.) u/s 7(1)	Additional fee collected (in Rs.) u/s 7(3)	Penalities Amount Recovered (in Rs.) as directed by CIC u/s 20(1)	No. Of cases where disciplinary action taken against any officer u/s 20(2)
Rs.70/-	Rs.8/-	Nil	Nil

Block III (Details of various provisions of section 8 while rejecting the requested information) - NA													
No. of times various provisions were invoked while rejecting requests													
Relevant Section of RTI Act 2005													
Section 8(1)										Sections			
a	b	c	d	e	f	g	h	i	j	9	11	24	other

Block IV (Details regarding compliance of direction/recommendation of the Commission) - NA			
S.No.	Reference No. Of cases wherein Commission made specific recommendation as per section 25(5) (max. 20 chars.)	Whether action is initiated to comply with recommendation of Commission.	Details, thereof (max. 250 chars.)
1-		-Select-	
2-		-Select-	
3-		-Select-	
4-		-Select-	
If the Public Authority made any changes in regard to its rules/regulations/procedures as a result of requested information by the citizens, please provide the summarized details of the changes (max. 500 chars.)			

Block V (Details regarding compliance of direction/recommendation of the Commission) - NA		
Last Date of Uploading the Pro-active Disclosures on the webside of PA	Name of the person who is entering/updating data	Designation of the person who is entering/updating data
General Information uploaded	Smt. Kusum Parihar	Research Assistant – I C/o Incharge, IT-Cell of the Institute.

(Dr. G. Singh)

Public Information Officer,
AFRI, Jodhpur.

RTI Annual Return Information System

Quarterly Return Form

Public Authority : Ministry of Environment & Forests

Quarter: III

Year: 2013-2014

Quarter –Jan to Mar, 2013

Mode: Insert Status : New Return

		Progress during the month				
	Opening Balance as on beginning of lll Quarter	No. Of applications received as transfer from other PAs u/s 6(3)	Received during the Quarter (including cases transferred to other PAs)	No. Of cases transferred to other PAs u/s 6(3)	Decision where requests/ appeals rejected	Decision where requests/appeals accepted
Requests	Nil	Nil	09	Nil	Nil	09
First Appeals	Nil	Nil	Nil	Nil	Nil	Nil

Total no. of CAPIOs designated	Total no. of CPIOs designated	Total no. of AA's designated
01	01	01

Block II (Details about fees collected, penalty imposed and disciplinary action taken)			
Registration Fee Collected (in Rs.) u/s 7(1)	Additional fee collected (in Rs.) u/s 7(3)	Penalities Amount Recovered (in Rs.) as directed by CIC u/s 20(1)	No. Of cases where disciplinary action taken against any officer u/s 20(2)
Rs.90/-	Rs.62/-	Nil	Nil

Block III (Details of various provisions of section 8 while rejecting the requested information) - NA													
No. of times various provisions were invoked while rejecting requests													
Relevant Section of RTI Act 2005													
Section 8(1)										Sections			
a	b	c	d	e	f	g	h	i	j	9	11	24	other

Block IV (Details regarding compliance of direction/recommendation of the Commission) - NA			
S.No.	Reference No. Of cases wherein Commission made specific recommendation as per section 25(5) (max. 20 chars.)	Whether action is initiated to comply with recommendation of Commission.	Details, thereof (max. 250 chars.)
1-		-Select-	
2-		-Select-	
3-		-Select-	
4-		-Select-	
If the Public Authority made any changes in regard to its rules/regulations/procedures as a result of requested information by the citizens, please provide the summarized details of the changes (max. 500 chars.)			

Block V (Details regarding compliance of direction/recommendation of the Commission) - NA		
Last Date of Uploading the Pro-active Disclosures on the webside of PA	Name of the person who is entering/updating data	Designation of the person who is entering/updating data
General Information uploaded	Smt. Kusum Parihar	Research Assistant – I C/o Incharge, IT-Cell of the Institute.

(Dr. G. Singh)

Public Information Officer,
AFRI, Jodhpur.

LIST OF PROJECTS, AFRI, JODHPUR

S. No.	Thrust Area/ Theme	Title of the projects	Status of project New/ Ongoing /Concluded	Externally Aided (E) Plan (P)	Raj.	Guj.
Managing Forest and Forest Products for Livelihood Support and Economics Growth						
1	Forestry/ Agroforestry/ Farm Forestry	Managing resources to enhance productivity of Agroforestry system in dry areas of Rajasthan (AFRI-01/AFED/Int(ICFRE)AICP/2012-17)	New	P	Raj.	
2	Forest soil and land reclamation	Enhancing fodder productivity through silvipastoral system on degraded land of India (AFRI-93/AFE/ICFRE/2009-2014).	New	P	Raj.	Guj.
3	NTFP Resource Development	Quantification, Value addition of NTFP and improved agricultural productivity in the tribal belt of Sirohi district of Rajasthan (AFRI-03/NWFP/Int(ICFRE)AICP/2012-2017).	New	P	Raj.	
4	Chemistry of Forest Products	Tapping the potential of some selected indigenous lesser known wild edible plants for food and nutrition in arid and semi arid regions (AFRI-110/NWFP/ICFRE/2011-2016).	Ongoing	P	Raj.	Guj.
5	Seed Science & Technology	Establishment of multilocational clonal trial and seedling seed orchard of *Jatropha curcas* (AFRI-81/JU/SILV/DBT/2007-13).	Concluded	E	Raj.	Guj.
6	Bio-fuels and Bio-energy	Genetic improvement of *Jatropha curcas* for adaptability and oil yield. (AFRI-66/JU/Silvi/ CSIR/2005-13).	Ongoing	E	Raj.	Guj.
7	Conservation of Forest Genetic Resources	Network research project on guggal *Commiphora wightii* Arn. Bhandari. (AFRI-76/Silvi/ NMPB/2008-13).	Concluded	E	Raj.	Guj.
8	Integrated Pest and Disease Management	A Coordinated project on integrated management of Khejri mortality for socio-economic upliftment in Rajasthan (AFRI-99/FPD/ICFRE/2010-2015)	Ongoing	P	Raj.	
9	Integrated Pest and Disease Management	Induction of systemic acquired resistance in rohida against stem canker (AFRI-100/FPD/ICFRE/2010-2014).	Ongoing	P	Raj.	
10	Integrated Pest and Disease	Studies on seed insect pests of indigenous and exotic forest tree species	Ongoing	E		Guj.

	Management	and to develop IPM packages for major insect damages in Gujarat (AFRI-107/GCR/SFD-Guj./2011-2014).				
11	Application of Microbes in Forestry	Evaluation and selection of efficient strains of AM fungi & *Rhizobium* for *Acacia nilotica* and *Ailanthus excelsa* in western Rajasthan (AFRI-103/FPD/ICFRE/2010-2014).	Ongoing	P	Raj.	
12	Application of Microbes in Forestry	Innovative approaches for augmentation of composting and biofertilizer production in hot arid regions (AFRI-111/FPD/2011-14).	Ongoing	P	Raj.	
13	Integrated Pest and Disease Management	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).	Ongoing	P	Raj.	Guj.
14	Forest Biometrics and yield modelling	Productivity and biometrics studies on some important species in semi-arid regions of Rajasthan for their sustainable management (AFRI-95/Silvi/SFD/2009-13).	Concluded	E	Raj.	
15	Forest Biometrics and yield modelling	Productivity study and modelling growth and yield in Teak plantation in Gujarat state (AFRI-96/Silvi/SFD/2009-14).	Ongoing	E		Guj.
16	Forest Economics	Market survey on selected species in selected markets (AFRI-58/Silvi./1994-continue).	Ongoing	P	Raj.	Guj.
17	NTFP Resource Development	Productivity enhancement of Kair (*Capparis decidua*) to generate livelihood in rural area of 'Thar Desert (AFRI-07/NWFP/Ext/(SFD:Raj)2013-16).	New	E	Raj.	
Biodiversity Conservation and Ecological Security						
18	Biodiversity Conservation	Documentation of Sacred groves of Rajasthan and assessment of biological diversity in some of them for improved management and people livelihoods (AFRI-09/FE/Ext(SFD:Raj)/2013-15).	New	E	Raj.	
19	Biodiversity Conservation	Screening, identification and preparation of a comprehensive check- list of the Lepidopteron fauna of Sasan Gir Wildlife Sanctuary of Gujarat state (AFRI-108/GCR/2011-14).	Ongoing	P	Raj.	
20	Biodiversity Conservation	Impact of *Prosopis juliflora* on biodiversity, rehabilitation of degraded community lands and as a source of livelihood for people in Rajasthan State	Ongoing	P	Raj.	

		(104/AFRI- 2010-2013).				
Forest and Climate Change						
21	Climate Change and Forests	Studies on carbon sequestration in different forest types of Rajasthan. (AFRI-88/EED/ 2008-14).	Ongoing	P	Raj.	
22	Climate Change and Forests	Characterization and classification of forest soils of Rajasthan (AFRI-85/FED/2007-2013).	Concluded	P	Raj.	
23	Forest ecology	Identification of soil-vegetation relations and indicator species for assessment and rehabilitation in lower Aravalli of Rajasthan (AFRI-101/EED/ 2010-14).	Ongoing	P	Raj.	
24	Forest Soils and Land Reclamation	Phyto-remediation of soil for productivity enhancement during land disposal of effluent (SFD Rajasthan) (AFRI-113/EED/ 2010-16).	Ongoing	E	Raj.	
25	Forest Ecology	Identification of extent of forest land in forest fringe villages (NRAA) (AFRI-114/EED/NRAA/ 2011-13).	Ongoing	E	Raj.	Guj.
26	Forest Botany	Reassigning Forest type of India for better management of Forests in India.	Ongoing	E	Raj.	Guj.
27		Designing and development of urban forestry model for Indian Institute of Technology (IITJ), Jodhpur, Rajasthan (AFRI/05/FE/Ext(IIT-J)/2012-2014).	New	E	Raj.	
28	Climate Change and Forests	Carbon stock and soil classification mapping for Rajasthan Forest (AFRI-115/FED/ICFRE/ 2011-16).	Ongoing	P	Raj.	
Forest Genetic Resource Management and Tree Improvement						
29	Tree Improvement	Investigations on genetic variation and inheritance of Western Indian Teak (*Tectona grandis* L.f) (AFRI-94 /Silvi/2010-2015).	Ongoing	P	Raj.	Guj.
30	Tree Improvement	Assessment of Guggul germplasm for studying population density, diversity, female-male plant's ratio for in situ and ex situ conservation in Rajasthan (AFRI-106/FGTB/SFD-RAJ/2010-13).	Ongoing	E	Raj.	
31	Tree Improvement	Assessment of variability, improvement and refinement of cloning techniques of *Tecomella undulata* (Sm.) Seem (AFRI-04/FGTB /Int(ICFRE)Reg /2012-2017).	New	P	Raj.	
32	Silviculture	Refinement of modern nursery practices for raising quality seedlings of selected important forest tree species (AFRI-109/Silvi/ICFRE/2011-2016).	Ongoing	P	Raj.	Guj.
33	Tree Improvement	Multilocational trials of *E.*	Ongoing	P		Guj.

		camaldulensis and *D.sissoo* clones in Gujarat state (AFRI-41/FGTB/ICFRE/2002-13).				
34	Tree Improvement	Screening of high oil and Azadirachtin in Neem (AFRI-34/IFGTB/ICFRE/2002-2014).	Ongoing	P	Raj.	
35	Vegetative propagation	Demonstration trial of male and female *Ailanthus excelsa* plants raised through grafting (AFRI-79/FGTB/ICFRE/2006-2014).	Ongoing	P	Raj.	Guj.
36	Biotechnology	Development of technologies for multiplication of economically important desert plant - *Capparis decidua*. (AFRI-105/FGTB/ICFRE/2009-2015).	Ongoing	P	Raj.	
37	Biotechnology	Development of tissue culture Technology for multiplication of economically important desert plant – *Salvadora persica* (AFRI-92/FGTB/ICFRE/2009-2014).	Ongoing	P	Raj.	Guj.
38	Biotechnology	Study of salt tolerance through gene expression pattern analysis (AFRI-102/FGTB/ICFRE/2010-2014)	Ongoing	P	Raj.	Guj.
39	Biotechnology	Utilization of Biotechnological tools for clonal propagation and supply of genetically superior trees of neem, ardusa and bamboo (AFRI-06/FGTB/Ext/(SFD:Guj)/2013-16).	New	E	Raj.	Guj.
Forestry Education and Policy Research to Meet Emerging Challenges						
40	Networking Forestry Education with Research and Extension	Development of the web portal for forestry research extension (AFRI-82/IT-Cell/2007-2014).	Ongoing	P	Raj.	Guj.
41	Networking Forestry Education with Research and Extension	Documentation of Important Research findings and technologies for application to forestry in Rajasthan (AFRI-09/FE/Ext/SFD:Raj./2013-15).	New	E	Raj.	

Annexure I

List of Abbreviations

ABA	Abscisic Acid
ADG	Assistant Director General
AFED	Agroforestry and Extension Division
AFRI	Arid Forest Research Institute
AMF	Arbuscular Mycorrhyzal Fungi
AM	Arbascular Mycorhiza
ANOVA	Analysis of Variance
ATMA	Agricultural Technology Management Authority
AICP	All India Co-ordinated Project
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
CD	Critical Difference
CETP	Common Effluent Treatment Plant
CF	Conservator of Forests
CO(F)	Coordinator (Facilities)
COD	Chemical Oxygen Demand
CPTs	Candidate Plus Trees
CPP	Candidate Plus Plant
CRIDA	Central Research Institute for Dry land 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
DTC	Direct to Consumer
DV	Demo Village
EC	Electrical Conductivity
ENVIS	Environmental Information System
FAS	Financial Accounting System
FAO	Food & Agriculture Organization
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
GPS	Global partitioning system
GSFD	Gujarat State Forest Department
GSFDC	Gujarat State Forest Development Corporation
HSCST	Haryana State Council for Science and Technology
HRD	Human Resource Development
ICFRE	Indian Council of Forestry Research & Education
IAA	Indole Acetic Acid
IBA	Indole butyric Acid
ICT	Information and Communication Technology
IFRIS	Indian Forestry Research Information System

IGNP	Indira Gandhi Nahar Pariyojana
IIRS	Indian Institute of Remote Sensing
IITJ	Indian Institute of Technology, Jodhpur
IT	Information Technology
IWST	Institute of Wood Science & Technology
IWMP	Integrated Watershed Management Project
IVI	Importance Value Index
JA	Jasmonic Acid
JFM	Joint Forest Management
MD	Managing Director
Mg	Mega Gram(10^6g)
MKU	Madurai Kamaraj University
MLA	Member of Legislative Assembly
mM	Millimolar
MMS	Modified Murashige and Skoog
MOU	Memorandum of Understanding
MOWR	Ministry of Water Resources
MS	Murashige and Skoog
NABARD	Nationalene 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
MPTs	Multipurpose Tree Species
NS	Not significant
NTFP	Non Timber Forest Product
NWFP	Non Wood Forest Product
OBC	Other Backward Class
PAL	Phenylalanine lysase
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
RADAR	Radio Detection and Ranging
RAPD	Random Amplified Polymorphic DNA
R/S	Root/Shoot
RT-PCR	Real Time Polymerate Chain Reaction
RBD	Randomized Block Design
RD	Relative Distance
RFD	Rajasthan Forest Department
RIMS	Research Management Information System
RSFD	Rajasthan State Forest Department
RSR	Root Shoot Ratio
RTI	Right To Information
SA	Salysilic Acid
SAUs	State Agriculture Universities
SC	Schedule Caste
SE	Somatic Embryo
SFD	State Forest Department
SHAN	Sequential Agglomerative, Hierachial and Nested
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	Tamilnadu Agriculture University
TDZ	Thidiazuron
TERI	The Energy & Resources Institute

TOF	Tree Outside Forest
TREE	Training Research Extension & Education
UPGMA	Unweighted Pair Group Method with Arithmetic Mean
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