CHAPTER 3.6

Arid Forest Research Institute Jodhpur

Arid Forest Research Institute (AFRI), Jodhpur (Rajasthan), is one of the eight Institutes under the Indian Council of Forestry Research and Education (ICFRE), an autonomous body of the Ministry of Environment and Forests, Government of India. The objectives of the Institute are to carry out scientific research in forestry and allied fields to enhance the productivity and vegetative cover and to conserve the biodiversity in Rajasthan, Gujarat and Dadra & Nagar Havelli with special emphasis on the hot arid and semi-arid region and also to develop the technologies for the end users in the mandated area. The main thrust areas of the institute are soil, water and nutrient management, technologies for afforestation of stress sites, management of plantations, growth and yield modelling, planting stock improvement, biofertilizers and biopesticides, agroforestry, JFM and extension, photochemistry and non-timber forest products, integrated pest and disease management and forestry education.

PROJECTS COMPLETED DURING THE YEAR 2005-2006

Project 1: Provenance trial on *Acacia nilotica* and *Ailanthus excelsa* [AFRI-40/FGTB/1994-2006]

Findings: *Acacia nilotica:* Seeds of 28 provenances from different agro - climatic zones of the country were collected for the trial. Seed morphology and germination studies were carried out and observations were recorded daily for the calculation of germination percentage, germination energy and energy period for the each provenance. The parameters for tree growth characters of different provenances were recorded initially at six months interval and later on yearly basis. Tree height varies from 44.59 cm to 72.53 cm in the first year and from 386.00 cm to 270.00 cm in the eight years. The ranking of height also varies from one year to another; Gurgaon is the only provenance which has come under first three since the beginning of the trial followed by Agra, Etawah, Hastinapur, Aligarh, Haldwani and Jhabua. The mineral values of different provenances to be used as fodder were also estimated. The phosphorous varies from 4522.30 ppm to 1849.30 ppm; nitrogen varies from 3233.2 ppm to 5656.50 ppm; manganese varies from 308.40 ppm to 65.60 ppm and copper varies from 71.90 ppm to 21.20 ppm.

Ailanthus excelsa: The morphological characters of the seeds of the different provenance were recorded in terms of seed length, seed width and test weight. The highest test weight recorded in Jodhpur provenance was 120 g followed by Jodhpur and Kajipet of 105.8 g and 105.1 g, respectively. The lowest test weight 55.5 g was recorded from a provenance of Bilaspur. The seed length was highest (6.6 ± 0.5 cm) in the provenance from Kajipet. The seed length of other provenance varied from 5.60 to 2.52 cm. The maximum seed width was claimed by Bikaner provenance, which was 1.46 ± 1.7 cm and minimum was 0.78 ± 0.1 cm of Bilaspur provenance. The germination percentage was especially in the hot arid and semi arid region of Balaghat provenance, which was 50.7%. The next in order was Jodhpur provenance, which had 40.1% germination percentages. The poorest germination performance was displayed by Jaipur provenance (0.41%).

Project 2: Studies on post harvest technologies on non-traditional, under-exploited locally available timber species for suitability to handicraft and other small scale industries [AFRI-51/NWFP/2002-2006]

Findings: Preservative treatment and seasoning schedule has been developed for three species. *Prosopis juliflora* wood exhibits good turning, finishing and polishing properties. *Acacia tortilis* wood is moderatly hard and heavy, with fairly good grain pattern having very good turning, carving, finishing and polishing properties. This wood is highly susceptible to wood deteriorating agents. After treatment this wood resisted to insect borer and fungus attack. *P. cineraria* species having moderate to poor finishing and polishing properties as comapared to *A. tortilis* and *P. juliflora*. *P. juliflora* can be grown as clear bole tree by proper management. Quality of this wood is equal to that of *Dalbergia sissoo.*

Project 3: Survey of sandal population in Rajasthan and Gujarat states and evaluation of heartwood content and oil content [AFRI-52/NWFP/2002-2006]

Findings: Data of sandal population, heartwood and oil content collected during the survey in Rajasthan state has been compiled and analysed. The oil content in trees of Rajasthan varies between 0.9 to 3.0 %. The heartwood content is found better in naturally grown trees than trees grown on agricultural/ farmlands.

Project 4: Identification of mortality factors of *Prosopis cineraria* and development of their suitable management strategies in north-western Rajasthan [AFRI-46/FP/2001-2005]

Findings: Maximum percentage of Khejri mortality in the four north-western districts of Rajasthan has been recorded as being 36.30, 42.78, 41.00 and 37.69, respectively. Maximum mortality was observed in 71-100 cm girth class in which 2122 trees were killed followed by 1570 in 31-70 cm girth class, 850 in 101-130 cm, 700 in 21- 29 cm, 165 in 131-160 cm and only 47 in 161 cm and above girth class.

Continuous depletion of water table in Rajasthan, increasing number of tube wells or over exploitation of ground water, effect of low rainfall, change in soil properties and agricultural practices and over maturity of trees are some of the suspected causes which also play their role in mortality of Khejri in north-western zone of Rajasthan.

Project 5: Identification of key indicators and suitable strategies for sustainable Joint Forest Management in Rajasthan and Gujarat [AFRI-53/AFE/ 2002-2007]

Findings: Homogeneity of population: Homogeneous caste composition of the villages ensures greater success owing to an almost similar socio-economic status.
Dependency on nearby forest*:* JFM plantation is successful where the major proportion of villagers or JFMCs are solely or partly dependent on nearby common forest for their daily requirement of fuel wood and fodder

Availability and free collection of MFP: Non-Wood Forest Products (NWFPs) have a key role in the success of JFM. It supplements income by collection of medicinal herbs, tendu leaves, forest seeds, Mahua flowers, Aonla fruits and Acacia gum up to Rs.10,000 to 15,000 per season.

Literacy rate has positive effect on JFM: With low literacy rate.

Micro-planning and site condition: The degree of success was found to be positively linked with micro-planning and site condition.

Economic status: Lower income people were more interested in doing the activities related to JFM.

Awareness and extension: With the increase in peoples' awareness, more areas were put under plantation and previous plantation was protected.

Liaison of forest officials with villagers: The attitude of forest official plays positive role in influencing and involving people in Joint Forest Management.

Adequate and timely flow of funds: With increasing JFMC's, funding has resource crunch. Most of the new JFMC's do not have adequate funds. Timely release of fund is also a problem.

Self help Groups (SHGs) with emphasis on women: SHGs created with revolving funds for micro-credits and micro-enterprises, particularly focusing on women, brought effective change.

Motivation, recognition and capacity building of forest officials: The government officers' and field functionaries' attitudinal change through training and persuasion is necessary as it changes their ideas to adopt the participatory approach of forest management rather than policing approach.

Project 6: Studies on improving tree productivity of *Prosopis cineraria* through VAM/Biofertilizers [AFRI-47/FP/2002-2006]

Findings: The maximum number of AM fungal species was identified from Jodhpur whereas only 13 species were recorded from Jaisalmer. Maximum spore population was recorded after rain and minimum in summers. Maximum spore population was recorded from Jodhpur and minimum at Jalore. Seedlings of *P. cineraria* inoculated with VAM + rhizobium performed better as compared to other treatments in all parameters including nutrients.

The genera of AM fungi were identified as Acaulospora, Glomus, Scerocystis and Scutellospora.

Project 7: Ethanomedical property of phyto pathogenic fungi: screening and isolation of therapeutic products [AFRI-48/FP/2002-2006]

Findings: Screening of *Ailanthus excelsa* leaf and stem for wound healing property against the wound caused by Fusarium in *Prosopis cineraria* has been worked out, using crude extract leaves. The partially purified fractions showed positive effect though inhibition spore germination of *Fusarium* sp.

PROJECTS CONTINUED DURING THE YEAR 2005-2006

Project 1: Multilocational trials of Eucalyptus and Dalbergia clones [AFRI-41/FGTB/2002-2006]

Status: Multilocational clonal trials of *Eucalyptus camaldulensis* and *Dalbergia sissoo* were established at four different locations namely Deesa, Kheralu, Gandhinagar, Rajpipala in Gujarat state. These clones are superior germplasm. Data was recorded in subsequent years. Initial data were recorded on growth parameters (height and girth in cm). Best clones for *Dalbergia sissoo* are G5, 20, 66, G1 and 32 and in Eucalyptus are 83,128, 99, 32 and 93.

Project 2: Micropropagation of an important medicinal plant of the arid and semi arid regions - Commiphora [AFRI-42/FGTB/2002-2006]

Status: Somatic embryogenesis has been successfully achieved in the endangered *Commiphora wightii*. It has been also observed that activated charcoal at 5% concentration gives a good response. Hardening experiments have been carried out both *in vitro* and *ex vitro* in mist chamber with 90 misting at 10 minutes interval. Twenty plants have been hardened. These plants have been produced by both somatic embryogenesis pathways as well as from cotyledonary node.

Project 3: Genetic Improvement of *Tecomella undulata* [AFRI-44/FGTB/2002-2006]

Status: Plus trees have been marked both in the canal-irrigated area and the non-irrigated farmers field. Seeds have been collected from 48 plus trees of Rohida. For the allotment of land to raise plantation in Govindpura Experimental Station, Jaipur was chosen.

Project 4: Screening of high oil and Azadirachtin in Neem [AFRI-45/FGTB/2002-2006]

Status: Two trials have been laid out from the CPTs selected for high oil and high Azadirachtin at Govindpura Experimental Station, Jaipur and maintained.

Project 5: Market survey on selected species in selected markets [AFRI-58/Silvi/1994-Continue]

Status: The data regarding prices of various forest produces viz., timber, fuelwood, bamboo were collected from the markets of Jaipur and Ahmedabad on quarterly basis. After compilation, the same were sent to the ADG (Stat.), ICFRE, Dehradun on prescribed format for publication of Timber and Bamboo Trade Bulletin.

Project 6: Stand dynamics of some important tree species of Gujarat [AFRI-57/Silvi/2001-2007]

Status: Annual measurements carried out in 30 sample plots of *E.* hybrid and 17 of *A. nilotica*. Data compilation and plot computations have been completed Basal area. Statistical distribution functions applied to define size class distribution in the stands. Johnson distribution performed better compared to Normal and Weibul distribution based on statistical tests like absolute residual, Chi-square and Kolmogorov-Smirnov test. Developed height growth and site index equations for *A. nilotica* and *E.* hybrid. Five algebraic difference equations were used to develop site index equations. Generalized non-linear least square method was used to take into account the error structure. Bias, root mean square error and Akaike's information criterion were calculated and cross validation residuals were used to evaluate the performance of the equations. Difference among the site index equations of the two species was examined using the non-linear sum of squares method. Based on the analysis, best approximating model has been recommended for both the species for site index modelling.

Project 7: Studies on seed quality improvement in respect of various tree species of arid and semi-arid areas [AFRI 59/Silvi/2002-07]

Status: Seeds of *Acacia nilotica, Prosopis cineraria* and *Azadirachta indica* were collected during the year and were graded, stored for testing. Seeds of *Dalbergia sissoo* and *Ailanthus excelsa* were stored at various moisture and temperature levels and were tested for moisture and germinability. In *Ailanthus excelsa* seeds stored at 5% moisture content gave significantly higher percent germination than seeds stored at 10% moisture level. Seeds can be stored safely up to three years without significant loss of germination. Low temperature storage is not suitable for this species. Seeds can be stored in gunny bags. Stored seeds of *Dalbergia sissoo* lost germination capacity after three years of storage at room temperature. However, when seeds were stored at low temperature, 46% germination was obtained. Three years old stored seeds of *Caparis decidua* showed lesser percent germination in all the treatments. Stored moisture content does not affect percent germination. Seeds of *Commiphora wightii* collected from six seed sources and germinated. Seeds were separated into two categories and were kept for seed germination studies. Black seeds are heavier than white and a kilogram of seed contains 35,000-40,000 seeds at moisture content of 7.5%. Black seeds collected from Kailana area showed higher germination followed by Nakoda.

Project 8: Development of suitable nursery technologies for arid and semiarid areas [AFRI-64/Silvi/DRDA/2002-2006]

Status: In AFRI model nursery improved planting stock for other stakeholders is being raised as per requirement. Medicinal Plants Germplasm Bank has been established. Experiment has been laid out to study effect of different potting mixtures on growth of seedlings of Mopane, Khejdi, Ardu and Ratanjot.

Project 9: Screening of exotic and indigenous plant species for their performance on salt affected soil with different management project [AFRI-49/NWFP/1997-2003]

Status: Performance of *A. amnicola* with or without gypsum on different modes of planting an experimental trial of *A. amnicola* was laid out. Survival percentage assessed for various treatments was ranging from 75 to 88.8% after 60

months of planting. Performance of exotic and indigenous tree species on different types of mounds and a trial with two tree species. *Acacia colei* and *Azadirachta indica* was laid with three treatments of planting growth, pattern recorded. Performance of *Z. mauritiana* and *C. morpane* with management practices. An experimental trial was laid with two fodder species namely *Zizyphus mauritiana* (ber) and *Colophospermum mopane*. Over all mopane recorded 64% and 8% more crown and control than ber. Nitrogen application increased both height and crown dia for both the species.

Project 10: Quantitative estimation of biologically active secondary metabolites in some of the arid zone medicinal plants to ascertain correct harvesting time [AFRI-50/NWFP/ 2002-2007]

Status: Bioactive compound viz. sterols, alkaloids and flavonoids were present in the extractives. Yield of alkaloids was highest in summer and sterols are higher in winter season in the MeOH extract. Calotropis flowers collected for the second years for study of active secondary metabolites.

Project 11: Litter dynamics and soil changes during stand development in plantation forest [AFRI-35/FED/2002-2006]

Status: Seventy six litter plots of 10 x 10 m^2 area were laid in plantations of *Eucalyptus camaldulensis, Acacia nilotica, Acacia tortilis, Tecomella undulata, Prosopis cineraria* and *Dalbergia sissoo* at Nachna, Sada and Ramgarh area along Indira Gandhi Nahar Pariyojna (IGNP). Tree height and GBH were recorded for trees inside the plot. Monthly litter collection is being made. Litters are separated into different components and dry weight is recorded. Annual litter production (kg/ha) from different trees in IGNP area indicated highest litter accumulation under *E. camaldulensis* followed by *D. sissoo*. Soil samples were collected from the plots and were analysed for organic carbon content. Soil organic carbon storage was found highest in *D. sissoo* followed by *E. camaldulensis*, *A. nilotica*, *P. cineraria*, *A. tortilis* and *T. undulata*. Analysis of soil and plant samples is in progress.

Project 12: Identification and screening of some suitable nitrogen fixing species of dry region for their utilization in improvement of soil fertility and biomass [AFRI -36/FED /2002-2006]

Status: Thirty beds of the size 5 x 5 m were prepared for seed sowing. Seeds of *Rhynchosia minima*, *Clitoria ternatea*, *Mucuna pruriense*, *Crotalaria burhia* and *Mimosa hamata* have been sown in the prepared beds. Soil samples were collected from the beds and analysed. Soil nitrogen content estimated before sowing of seeds in the beds. Standardization of buffers and substrate has been completed for *Mimosa hamata*. Highest Nitrate Reductase (HNR) activity was recorded at 0.2 m buffer (pH 7.7) and 0.2 m substrate concentration. Standardization of buffers and substrate for *Clitoria ternatea* is in progress.

Project 13: Screening different phenotypes of *Dalbergia sissoo* and *Acacia nilotica* for their tolerance to salinity and sodicity [AFRI-37/FED/2002-2006]

Status: Seeds collected from 14 selected phenotypes of *Acacia nilotica* and *Dalbergia sissoo*. Plantations were raised as per experimental design at Tharad range, Palanpur (Gujarat) with the help of State Forest Department. Growth and

survival data was recorded six months after planting. Highest survival and growth *A. nilotica* was recorded in phenotype collected from Harethar and Lakhani. The survival and growth of *Dalbergia sissoo* phenotypes was very poor because of high salinity level. Salinity of the experimental site was in the range of 8.80 to 10.88 dSm^{-1}. Soil pH and organic carbon was 7.6-8.8 and 0.23-0.28% respectively.

Project 14: Transfer of forestry technology through demonstration and training for increasing productivity and sustainable management of natural resources (Establishment of interpretation centre) [AFRI-54/AFE/2002-2006]

Status: The extension and interpretation centre is open to the visitors for technology dissemination.

Project 15: Development of suitable multi-tier farm forestry models in IGNP Command area [AFRI-55/AFE (A)/2003-2008]

Status: The survey in IGNP Command area has been conducted to select suitable site for initiating trial. But no suitable sites could be finalised. Hence, the project activities have been deferred for the next financial year.

Project 16: Development of economically viable and integrated agroforestry models for arid region [AFRI-55/AFE (B)/2003-2008]

Status: Field visit was conducted at village Harsh, Bilara, Jodhpur to find out the modalities for implementation of the project on the site selected earlier. Choices of horticulture and silviculture species with interaction of agricultural crops had been finalized with the farmer. The activities for raising seedlings of silviculture and horticultural species have been initiated in AFRI nursery. All the actives are under progress.

PROJECTS COMPLETED DURING THE YEAR 2005-2006 (Externally Aided)

Project 1: Survey and silvicultural management practices for commercially exploitable medicinal plants of arid and semi-arid areas of Rajasthan [AFRI 35/Silvi 8/MPB/2002-2005]

Status: Surveyed 435 units/ traders involved in the trading of medicinal plants in 26 districts of Rajasthan. The total requirement of surveyed districts revealed that 9,36,110 kg of various medicinal plants is traded annually. Jaipur tops among the surveyed districts with 27.24% trading of medicinal plants followed by Jodhpur, Ajmer, Bhilwara, Udaipur and Sri Ganga Nagar. The trade share of Banaswara is only 0.002% of the total trade.

Cultivation practices for *Aloe vera* (L.) Webb. & Berth. (Gauwar patha), *Asparagus racemosus* Willd. (Satavari), *Catharanthus roseus* (L) G. Don. (Sadabahar, *Ocimum sanctum* Linn. Tulsi) and *Withania somnifera* (Linn.) Dunal (Ashwagandha) and senna in arid areas under rainfed and irrigated conditions have been developed.

Our observation indicated that *Ocimum sanctum*, *Catharanthus roseus* and *Asparagus racemosus* have 96-98% survival and *Withania somnifera* and *Aloe vera* suffered maximum causality. The initial percent survival of *Aloe vera* was 70% and for *Withania somnifera*, it was 74 percent. All species responded to irrigation and fertilizer application. Cultivation trial of guggal indicated that plants raised either through seed or cuttings performed better at Kayalana (good soil) site than at Karwad (saline soil) site. The growth was higher at Kayalana (mean height 48.37cm) against mean height of 28.89cm at Karwad site. A germplasm bank with 150 medicinal plants has been established at Jodhpur.

Project 2: Development of silvipasture model for rehabilitation of Oran/Gauchers [AFRI-275/Silvi-3/UNICEF/2001-2003]

Status: The rehabilitation model was developed at Tulesar and Ostran villages of Jodhpur district. The indigenous and fodder species like *P. cineraria, Tecomella undulata, Zizyphus* spp., *Colophospermum morpane, Hardwickia binnata* and *Alilanthus excelsa* were planted along with seed sowing of local grasses.

PROJECTS CONTINUED DURING THE YEAR 2005-2006 (Externally Aided)

Project 1: Capacity building and eco-sensitization of farmers and rural poor for development and sustainable management of life supporting systems [AFRI/56/ AFE/2002-2007]

Status: Field training programmes were successfully conducted in phase II with financial collaboration of the Rajasthan Forest Department at three different places of Forest Divisions' Range Headquarters which comprised all the Panchayat Samitis in each of the remaining nine Desert Districts of Rajasthan i.e. Sikar, Jhunjhunu, Jaisalmer, Bikaner, Barmer, Churu, Jalore, Nagaur and Pali Districts to educate and uplift the socio-economic status of

Director, A.F.R.I. addressing the participants

Practical Demonstration at nursery

stakeholders, especially, the farmers, Forest field staff, Gram Sevaks, Panchayat Functionaries, NGOs, SHGs, women and children on the latest forestry technology and other allied ecofriendly value addition activities. A total number of 1963 participants including 185 women participated in these 27 practical-cum-demonstrative training programmes.

Project 2: Study of characteristic features pertaining to bio-drainage potential of some selected tree species [AFRI-38/FED/2004-2008]

Status: Three sites have been selected for the experiment. One is near Masitawali head of IGNP. This site is having extremely high salinity ranging from 37 dSm^{-1} to 42 dSm^{-1}. The other sites are located at 1357 RD and Anupgarh branch of IGNP having low salinity regime.

Sample plots have been laid out at Anupgarh branch of Indira Gandhi Nahar Pariyojna (IGNP) and 1357 RD, IGNP main canal. Plantation of *E. camaldulensis* was raised by the State Forest Department, Rajasthan. Arid Forest Research Institute, Jodhpur, raised experimental plantation of *Eucalyptus* sp. in 2003 (seed source CSIRO, Australia) at 1357 RD, IGNP. Growth and Physiological parameters recorded for three quarters. At 1357 RD experimental site height of the plats was highest in *E. camaldulensis*. However, crown spread and collar girth was high in *E. rudis*.

Plantation of four species viz. *Eucalyptus camaldulensis*, *Acacia nilotica*, *Tamarix aphylla* and *Casuarina junghuhniana* has been done. Average height of the seedlings at the time of plantation was 75 cm, 65 cm, 50 cm and 75 cm in *Acacia nilotica*, *Eucalyptus camaldulensis*, *Tamarix aphylla* and *Casuarina junghuhniana* respectively. Soil samples have been collected for analysis. Ground water level was recorded from the observation pits.

Soil and water samples have been collected and analysed. Fencing of the site has been completed. The mean soil pH was found to be 8.8, 8.6 and 8.5 at 0-25 cm, 25-50 cm and 50-75 cm soil depth. Electrical conductivity was very high in the topsoil layer. Organic carbon was also found to be high in the 0-25 cm soil layer. Soil ammonical nitrogen (NH_4 - N) and phosphorous was 12.2 and 22.73 ppm respectively.

Project 3: Development of suitable models for urban aesthetic forestry suitable for arid and semi arid region of Rajasthan [AFRI-63/Silvi/UIT/2001-2006]

Status: Growth and survival data in respect of the plants raised under the experimental roadside plantations at seven different locations have been recorded. Average height and diameter growth of various ornamental tree species raised under the experimental plantations have been observed in the order of *Dalbergia sissoo* > *Azadirachta indica* > *Cassia siamia* > *Tecomella undulata* >*Pongamia pinnata* > *Alistonia scholaris* > *Casia fistula* > *Delonix regia.*

Project 4: Raising of Arboretum-cum-botanical garden for native flora of Rajasthan [AFRI-61/Silvi/2002-2006]

Status: Plants belonging to 84 native tree species of Rajasthan and Gujarat have been maintained. Complete boundary wall construction has been accomplished to provide protection to the Arboretum-cum-botanical garden.

NEW PROJECTS INITIATED DURING THE YEAR 2005-2006 (Externally Aided)

Project 1: Integrated management for qualitative improvement and increased production of Rohida (*Tecomella undulata*) in Rajasthan [AFRI-65/FP/SFD/2005-2007]

Status: Three species of wood boring insects and two species of wood decaying fungi have encountered so far. Further study on the identification of these factors is in progress. It was observed that no hollowness problem was seen in the Rohida plantations raised in the IGNP area except in a few trees.

The preliminary observations revealed that the tree deformity pertaining to hollowness might initiate with the formation of cankers in the main trunks of the trees. The percentage of canker formation was found in trees having girth range from 80 cm onwards irrespective of age and girth class. The maximum percentage of cankers has been noticed in the trees with girth range above 121 cm.

Stem cuttings collected from three differently managed trees were raised in mist polyhouse under intermittent misting. Observations collected on sprouting at two weeks interval. After two months final observations were recorded on sprouting, relative growth of callus at basal cut ends and root primordia formations. Root primordia were also recorded in cutting showing callus formation.

Stem cuttings were also raised in mist polyhouse after giving 1000 ppm IBA treatment along with a control (with out IBA treatment). No significance difference was recorded in sprouting and root primordia formation between treated cutting and control. Stem cuttings were raised in sand and vermiculite for each class. Percentages of cuttings producing callus were just double when raised in sand as compared to cuttings raised in vermiculite.

The summary results indicated that depending upon age, site and density, average height in the stands varied from 3.35 to 6.47 m, mean quadratic diameter from 6.12 to 12.24 cm, dominant height from 4.24 to 9.30 m, basal area from 1.84 to 13.88 m^2/ha, volume yield from 3.90 to 47.78 m^3/ha, height increment from 0.20 to 0.36 m/yr, dbh increment 0.36 to 0.65 cm/yr and MAI from 0.22 to 2.65 m^3/ha/yr. Total wood volume equations constructed and validated. A total of 8 equations were compared and best model selected based on the bias, relative error of prediction, coefficient of determination and Akaike's information criteria differences.

Rainwater harvesting devices (top), run-off measuring devices (lower four left) and plantation activity at the site (lower four right)

Project 2: Studies on prediction of NTFP availability and potential for extraction in Aravalli region of Rajasthan [AFRI-67/Silvi/SFD/2006-2008]

Status: Preliminary survey for selection of villages has been undertaken.

Project 3: Efficacy and economics of water harvesting devices in controlling run-off losses and enhancing biomass productivity in Aravalli ranges [AFRI-39/FED/SFD/2005-2008]

Status: A hilly site was selected in Banswara forest division covering slopes of 0-10%, 10-20% and >20%. Rainwater harvesting devices are Contour Trench (CT), Gradonie (G), Box Trench (BT), V-ditches (V) along with a control plot. Seventy five plots (three slopes x five treatments x five replicates) of 700-m^2 area in completely randomised block design were laid. Seventy five number of run-off measuring devices along with flow control wall fitted with pipes were constructed to control water flow and collect run-off.

Observations in the first year indicated that slope gradient had significant effect on soil nutrients, vegetation status and their biomass, soil water content and surface run-off losses. Treatment effect was not significant on water loss and Soil Water Content (SWC) except in 0-20 cm soil layer of lower reach sampling points in a plot, in which SWC was significantly ($P<0.05$) greater in contour trench plots as compared to Gradonie and V-ditch plots. Steep slopes resulted in higher water and PO_4-P loss.

Project 4: Implementation of Bamboo Locational Trials (BLT) project [AFRI-43/ FGTB/NMBA//2005-2007]

Status: Three trials namely species, Water Management and Spacing Trails are established at Bhapore Nursery at Gaupara in Banswara District. Casualty is lesser in the species in which the plants have grown well at the time of planting viz. *B. balcooa, D. hamiltonii, D. strictus* and *B. tulda.* Whereas, casuality is more (50% and above) in plants which are smaller at the time of planting viz. *D. asper* and *B. bambos* (they are tissue culture raised also). Probably the absence of well-grown rhizome may be the reason for their poor survivability. In case of *B. nutans*, in which the plants are medium sized, the survival is better than *D. asper* and *B. bambos* (Mortality is 11%). In case of *B. giganteus*, the rhizomes could not produce new shoots.

Project 5: Multiplication and field trial of Bamboos through tissue culture in Rajasthan and Gujarat [AFRI-68/FGTB/DBT/2005-2007]

Status: Site identified in both states viz. Rajasthan and Gujarat. The identified sites in Rajasthan are Kushalgarh, Banswara and Saira, Udaipur. Only one site i.e. Chakhalia, Dahod is identified in Gujarat. Planting material (8000 TC Plants) of *Bambusa bambos* procured from TERI and *Dendrocalamus strictus* are being raised at AFRI, Jodhpur. Advance work of pitting as per field design is in progress.

Project 6: Coordinated Project: Genetic improvement of *Jatropha curcas* for adaptability and oil yield (Component: Performance of *Jatropha curcas* accessions under arid environment) [AFRI-69/Silvi/CSIR/2005-2010].

Status: Twenty two accessions have been collected/received against target of 27 accessions. Two new accessions from Haryana have been identified and seed has been collected from them. Twenty accessions from Tamil Nadu (10) and Kerala (10) have been collected and are under the process of propagation. Seeds of Udaipur and Banswara area have also been collected and sent to FRI for provenance trial. Seeds were also collected from one-year-old irrigated trial. Total fruit yield/tree, seed/fruit ratio, seed/kernel ratio and optimum solvent extraction time for oil estimation and type of solvent has been worked out for Jatropha. Performance trial has been laid out with 17 accessions. Design for all new trials to be laid out under this project has been finalized.

Abstract: No. of Projects

	No. of projects completed in 2005-2006	No. of ongoing projects in 2005-2006	No. of projects initiated in 2005-2006
Plan Projects	7	16	-
External Projects	2	4	6
Total	9	20	6

EDUCATION AND TRAINING

Education

Mr. Ranjeet Singh Yadav under the supervision of Dr. G. Singh, Head, Division of Forest Ecology was awarded Ph. D. degree from FRI Deemed University.

Trainings

Attended

International

1. Dr. Tarun Kant, Scientist C successfully completed one year Post Doctoral Fellowship from 16th August 2004 to 15th August, 2005 under Biotechnology Overseas associateship 2003-2004, Govt. of India, Dept. of Biotechnology at the Department of Plant Sciences, University of Cambridge, U.K.
2. Dr. V.P. Tewari, Scientist-E successfully completed two months study-cum-research visit from 15th December 2005 to 15th February 2006 at the Institut für Waldinventur und Waldwachstum, Georg-August Universität, Göttingen (Germany) under the German Academic Exchange Programme (DAAD) and worked on the project "Modelling Growth and Yield in Forestry Tree Species".

National

1. Shri Balbir Singh, IFS attended the five days compulsory training programme for IFS officers on "Management of Tropical forests- Issues and challenges" held at Kerala Forest Research Institute, Peechi.
2. Dr. G. Singh, Scientist-E attended six days training programme on 'Participatory management of natural resources for sustainable livelihood' at National Institute of Rural Development, Hyderabad from 11th to 16th April 2005.
3. Km. Sarita Mutha, R.A. I of Forest Ecology Division attended two days training/workshop on 'Essentials of achieving forest certification: the process and the requirement' on 4th and 5th April 2005 organised by SGS, India Private, Ltd. at New Delhi.

Organized

1. Organized ten nos. of three days training programmes on "Capacity building and eco-sensitization of farmers and rural poor for development and sustainable management of life supporting systems" in desert districts of Rajasthan.
2. As a multidisciplinary approach of watershed management, inputs on nursery and plantation techniques, biofertilizers, agroforestry models, soil and water conservation techniques, horticulture, pasture

management, disease and pest management etc. were given by the resource persons from both within and outside the institute in above training programmes.

3. Technical staff of the institute delivered lectures/talks on various forestry topics at Nehru Yuva Kendra, Maru Van Prashikshan Kendra, Jodhpur for the benefits of students, NGOs and foresters from time to time during the year.
4. Training on VAM technology was imparted to 25 participants, which include ACFs, RFOs JRF and Field Supervisors, at TRC, Gandhinagar (Gujarat). Training on Isolation of VAM and identification techniques were given to JRF time to time at AFRI, Jodhpur.

LINKAGES AND COLLABORATION

National

1. Tata Energy Research Institute, New Delhi
2. Central Arid Zone Research Institute, Jodhpur
3. Jai Narayan Vyas University, Jodhpur
4. Council of Scientific and Industrial Research, New Delhi
5. National Bureau of Plant Genetic Resources, New Delhi
6. National Mission on Bamboo, New Delhi
7. Department of Biotechnology, Govt. of India, New Delhi
8. Ministry of Water Resources, New Delhi
9. Rajasthan Forest Department
10. Gujarat Forest Department

International

1. Institute of Forest Inventory and Forest Growth, George-August University, Goettingen, Germany.
2. Department of Plant Sciences, University of Cambridge, U. K.

PUBLICATIONS

Brochure/Pamphlets

1 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Giloe, *Tinospora cordifolia* (Willd.) Miers: The Climber of Longevity. Extension brochure.

2 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Sarpgandha, *Rauvolfia serpentina* Benth. Ex. Kurz: Bitter root to better high blood pressure. Extension brochure.

3 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Isabgol, *Plantago ovata* (Forsk.) Natural defence to digestive disorders. Extension brochure.

4 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Bhui Amla, *Phyllanthus amarus* Schum & Thonn.: The wonder herb. Extension brochure.

5 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Tulsi, *Ocimum santum* Linn: The sacred plant. Extension brochure.

6 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Ratanjot, *Jatropha curcas* L: The bio-diesel plant. Extension brochure.

7 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Mulhatti, *Glycyrrhiza glabra* Linn: Sweet Root sweeter than sugar. Extension brochure.

8 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Shatavari, *Asparagus racemosus* Willd. Extension brochure.

9 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Kalmegh, *Andrographis paniculata* (Wall.) Nees. The king of bitters. Extension brochure.

10 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Guar Patha, *Aloe vera* (Linn.) Burm.f., Lily of the Desert. Extension brochure.

11 K.K. Chaudhuri, D.K. Mishra and J.K. Shukla (2005). Ratanjot, *Jatropha curcas* L. Biodiesel Plant. Extension brochure.

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CONSULTANCY

Consultancy was taken up for "Landscaping and arboriculture job" at two housing construction sites of Air force station, Jodhpur, for M/s National Building Construction Corporation Ltd. (NBCCL), a Govt. of India Enterprise, under Ministry of Urban Development and Poverty Alleviation, New Delhi, who has been appointed executing agency for Defence Housing Project for armed forces at different locations in Rajasthan.

CONFERENCES/MEETINGS/WORKSHOPS/SEMINARS/SYMPOSIA/ EXHIBITIONS

Organized

1. One day Workshop on "Combating Desertification Programme" was held on 6th September 2005.
2. Research Advisory Group Meeting was organized on 20th September 2005.
3. A two days Regional workshop on "Challenges in Forestry Research Extension" was organised on 18th and 19th October 2005.
4. A three day workshop on "okfudh 'kCnkoyh" was held at AFRI, Jodhpur from 28th to 30th September 2005, which was sponsored by Commission for Scientific and Technical Terminology, Ministry of Human Resource Development, Govt. of India, New Delhi.
5. A one day workshop on "Strategies for meaningful implementation of Desert Development Programme

Inaugural session

Excursion to Eco park at Tinwari

(DDP), Drought Prone Area Programme (DPAP) and Integrated Watershed Development Programme (IWDP) in desert areas" on 7th December 2005.

Attended

1. Dr. R.L. Srivastava, Director attended 4th meeting of the Reconstituted Programme Steering Committee on Bioengineering for Biofuels and Bioenergy at New Delhi organized by Dept. of Biotechnology, New Delhi on 7th and 8th April 2005.
2. Dr. R.L. Srivastava, Director attended IRG-36 Annual Conference on "Protection and efficient utilization of plantation grown lesser-known timbers of arid region in India- *Acacia tortilis*, *Prosopis juliflora* and *Prosopis cineraria*" at IWST Bangalore from 24th to 28th April 2005.
3. Dr. G. Singh, Shri N. Bala and Dr. P.K. Aggarwal attended two days workshop on 'Dry Land Organic Farming in Rajasthan' organized by the Jodhpur chapter of the Indian Society of Soil Science at CAZRI, Jodhpur on 10th and 11th May 2005**.**
4. Dr. G. Singh attended one day meeting at UNDP office New Delhi on 12th May 2005 for presentation of project 'Integrated ecosystem approach to mitigate land degradation, enhance productivity and reduce poverty in arid and semi- arid lands of western India.
5. Dr. Ranjana Arya participated in two days workshop on Organic Agriculture in arid zone on 10th and 11th May 2005 in CAZRI, Jodhpur.
6. Shri R.L. Srivastava, Director AFRI, visited BITS, Pilani for delivering lecture on Desert Development Technologies from 8th to 10th May 2005.
7. Shri R.L. Srivastava, Director AFRI, attended a meeting at UNDP Office, New Delhi in connection with GEF Project from 11th to 13th May 2005.
8. Dr. R.L. Srivastava attended two days workshop on Agri Conclave 2005 at Jaipur on 11th and 12th August 2005 organized by CII, Rajasthan and delivered a talk on "Wasteland and their management with special emphasis on problem soils of Rajasthan".
9. Dr. R.L. Srivastava, Director and Dr. G. Singh, Scientist E participated in the workshop on 'Grassland Ecology and Gene Pool Conservation' organized by State Forest Department, Rajasthan from 26th to 28th September 2005 at Jaipur.
10. Dr. R.L. Srivastava, Director, AFRI attended the workshop on "Challenging Poverty by Enhancing Rural Livelihoods" organized by IFFDC & MKD, IFFCO from 27th to 29th September 2005 at Udaipur and chaired one session.
11. Dr. R.L. Srivastava, Director, AFRI attended "Immersion programme on institution building and livelihood promotion - Learning from the experiences of Andhra Pradesh" held at CRIDLA, Hydrabad and visited collaborative institutes/partners at CRIDA, Hyderabad and PAP Ltd. Bangalore under CSIR, Jatropha Project from 4th to 10th December 2005.
12. Dr. R.L. Srivastava, Director, AFRI attended International Workshop on Biofuels at New Delhi on 18th and 19th January 2006.

13. Dr. G. Singh and Dr. Sunil Kumar, Scientist-D participated in Regional level Workshop on the theme "Desert and Desertification for the Western Region" held at GCERT, Gandhi Nagar (Gujarat) on 19th and 20th January 2006 organized by the Gujarat Forest Department.
14. Dr. R.L. Srivastava, Director and Dr. U.K. Tomar Scientist-E, AFRI participated in National Conference on "Tree Biotechnology: Indian Scenario" held at TFRI, Jabalpur on 9th and 10th February 2006.
15. Shri C.J.S.K. Emmanuel attended workshop on "Medicinal and aromatic plants development" at Mandore Agriculture Station, Jodhpur organized by the State Agricultural Department.
16. Shri Arvind Apte, DCF attended National workshop on 'Conservation and cultivation of medicinal plants' at Pinjore, Haryana on 15th and 16th February 2006 and presented a paper on ' Market Potential of medicinal plants in Rajasthan'.
17. Dr. G. Singh, Head, Division of Forest Ecology, participated in national seminar on 'Recent Advances in Forestry Sciences' held at Guru Ghasi Das University, Bilaspur on 30th and 31st December 2005.
18. Dr. R.L. Srivastava, Director, AFRI participated and addressed a Technical Workshop in Hindi on National resource conservation as chief guest organized by Oil India Ltd. at Hotel Chandra Inn, Jodhpur on 22nd February 2006.

Exhibition

AFRI participated in the Paschimi Rajasthan Hast Shilp Utsav-2006 at Jodhpur to disseminate the research highlights and achievements of AFRI to the masses from 2nd to 11th January 2006.

DISTINGUISHED VISITORS

1. Dr. J.S.P. Yadav, Former Chairman, Agriculture Scientist Recruitment Board, visited the Institute on 15th April 2005.
2. Hon'ble Minister of Environment and Forests, Rajasthan visited the institute on 16th July 2005 on the occasion of Van Mahotsava and inaugurated *Aloe vera* Demonstration trial in AFRI campus.
3. Shri B.L. Arya, IAS, Commissioner, Jodhpur Division visited the institute and inaugurated the Regional Workshop on "Challenges in Forestry Research Extension" on 18th October 2005.
4. Smt. Veena Upadhyay, IAS, Joint Secretary, Ministry of Environment and Forests visited institute on 25th February 2006 and interacted with the Scientists/Officers on different aspects of research, computerization, administration etc.

MISCELLANEOUS

56th Van mahotsava was celebrated on 16th July 2005 in collaboration with Rajasthan Forest Department Jodhpur.