CHAPTER-IX

ARID FOREST RESEARCH INSTITUTE JODHPUR

The Arid Forest Research Institute at Jodhpur was established in 1988 to address the forestry research problems of the two States of Gujarat and Rajasthan and the Union Territory of Dadra and Nagar Haveli. The main objectives of the Institute are:

Studies on silvicultural characters of tree species and shrubs of arid zone; Seed characters, germination and growth characters of arid zone trees and shrubs; Interaction of trees with agricultural crops under different agroforestry systems and tree farm economics; developing tissue culture protocols; Studies on VAM inoculations (Biofertilizers) in the nursery, plantation and irrigated plantations; Soil characteristics of arid area including site-species interaction; Exudation of gums and oleo-resins in important species.

PROJECT COMPLETED DURING 1998-99

Project 1: Woody Plant Water Relations.

Sub-Project 1(1): To develop soil moisture management practices for speedy and better plantation establishment.

Objectives: (a) To study the efficacy of different *in situ* runoff collection structures in storing soil moisture and improving water use efficiency of trees. (b) To study the economics and social implications of these techniques.

Results

A field experiment on different techniques of rain water harvesting and conservation was initiated in 1990, to find out the most efficient, method of rain water harvesting to improve the establishment and growth of forestry plantations in the Indian Desert. This study demonstrated the dramatic impact of " Micro catchment rain water harvesting treatment" on tree growth, which was 4 to 5 fold when compared with the growth on control plots. The experimental results have been published in the form of various research articles.

Encouraged by these results, a field experiment comprising different treatments of *in situ* water harvesting structures was undertaken in 1994 as the sub project (iii) of FREEP.

The structures - Ring pits, big saucers and ridges and furrows have been found beneficial. Their suitability based on growth, cost benefit analysis, employment and social conditions was studied and published.

Shooting of a film for the purpose of extension of rain water harvesting techniques is in progress.

The techniques of water harvesting have shown dramatic response in Arawali eco-restoration. It was observed that *Acacia nilotica* trees grew to 6' to 7' within a year when water harvesting was practised.

The work on neem received recognition in the form of "Award on neem research" by ICFRE in 1996 and Vishisth Vaigyanik Puraskar, in 1998 from the Ministry of Environment and Forests.

Project 2: Woody Plant Water Relations.

Sub-Project 2(2): Screening indigenous and exotic species for their tolerance to moisture stress and adverse site conditions.

Objectives: (a) To screen out the most efficient tree species under arid environment. (b) To study the physiological traits responsible for producing higher biomass per unit of water used

Results

A field experiment was initiated in an existing four year old plantation, to study the performance of different tree species on a moisture stressed arid sandy site. Mulching and no mulching treatments were also tried. The plantation initially had 3m x 3m spacing, which was subsequently thinned to 3m x 6 m. *Azadirachta indica* continued to be the best performer followed by *Acacia nilotica*, *Albizia lebbeck*, *A. planifrons*, *Prosopis cineraria* and *Tecomella undulata.* Performance of all the species was better on mulched (+M) than unmulched (-M) plots.

The leaf water potential (LWP) values varied considerably depending upon species, mulching treatment and season of growth. In general LWP was maximum (-1.32 to -2.17 MPa) during the monsoon period (August 1996) and minimum (-2.52 to -8.44 MPa) during dry deciduous season of January 1991. In the post monsoon period LWP starts falling. Normally stress will be maximum during the dry hot period of May-June. But in 1997, there were mild rains in March and again in May, with the result that the LWP remained at par with that of January. However variation in LWP from species to species was remarkable. During the period of moisture sufficiency (August 1996) highest leaf water potential (-1.32 MPa) was in khejri and lowest (-2.17 MPa) in neem. During the dry period of January'97 highest LWP (-2.67 MPa) was in siris and lowest (-8.25 MPa) in rohida. While comparing the seasonal change in LWP of fastest growing species neem and slow growing species khejri, it was seen that neem exhibited narrower variation in LWP than khejri. Maintenance of lower LWP by neem (nearly half than khejri) during the period of water sufficiency (monsoon) and higher LWP than khejri in dry season, indicates that neem exercises control over its water distribution to foliage.

Water Use Efficiency

Highest water use efficiency (WUE) was exhibited by neem (80.4 kg/cm/ha) which was more than seven times than that of Rohida (11.2 kg/cm/ha) and more than four times than that of Khejri (19.0 kg/cm/ha). Effect of mulching was appreciable on WUE of different tree species. On the average, mulching improved the WUE by 27%.

Conclusion

The study demonstrates the neem to be exceedingly faster growing species than all other tried on flat sandy soil of arid zone. This may be attributed to its being prudent in use of water (highly economical in water use). This is evident from its highest WUE (80 kg/cm/ha). From the relatively narrow seasonal variations in LWP (-2.17 MPa in monsoon to -5.28 MPa in dry deciduous season) and relatively lower LWP in the period of water sufficiency, it appears that neem exercises a strict control over water supply to foliage from where unproductive loss of water may occur. A very prolific and fast growth of root suckers indicates the possibility of water and nutrient storage in the roots of neem. This mechanism of regulated water supply may be its drought enduring mechanism as well. This hypothesis needs to be further confirmed by carrying out detailed investigations on soil-plant -water relations of neem.

Second line performers were *Acacia nilotica* (babul), *Albizia lebbeck* (siris) and *Acacia planifrons*. Biomass production of all these three species was at par. However, from utility point of view, *A. nilotica* may

be preferred as it provides good furniture and constructional timber, gum, fodder, fuel and pods. Pods are useful for fodder as well as tannin.

Prosopis cineraria (khejri) as well as *Tecomella undulata* (rohida), both are slow growing, though they have been traditionally promoted for centuries because of their high level of drought and famine tolerance.

Recommendations

On flat sandy sites with 60-80 cm soil depth in arid region of 300-400 mm rainfall, neem should be promoted and planted for higher biomass yields. Use of mulching (covering 1 m circular area by *Crotalaria burhia* shrub material) is recommended for better survival percentage and growth.

Project 3: Investigations on the morphology, bionomics, ecology and management of rohida defoliator, *Patialus tecomella* Pajni Kumar & Rose (Coleoptera: Curculionidae).

Objectives: (a) Survey, collection and identification of major insects pests of *Tecomella undulata*. (b) Study of biology and population dynamics of important insects pests i.e *P. tecomella*. (c) To evolve integrated pest management methods to control pests.

Results

Detailed morphological and bionomics studies, covering life-history and generation, effect of food and crowding on reproduction, and effect of abiotic factors on life-stages of *Patialus tecomell*a, the rohida defoliator has been completed.

Experiments on the chemical control of *P. tecomella* using various conventional insecticides were completed. Monocrotophos (0.02%) was found to be the most effective against the pest.

World-wide check lists of the insect pest spectrum of rohida (*Tecomella undulata*) (64 insect species) and *Prosopis* spp., (152 insect and one non insect pest, Acarina) have been prepared.

New pest records on *Tecomella undulata* (24 species) and *Prosopis* spp. (15 species) were created.

Project 4: Bio-ecology and management of insect pests of *Prosopis* spp. (Linn.) especially gall forming insect pests in Indian thar desert.

Objectives: (a) Survey, collection and identification of major insect pests of *Prosopis* spp. (b) Biology and population dynamics of gall forming insects. (c) To evolve integrated pest management methods to control gall forming insects.

Results

Detailed studies on the biology and population dynamics of gall forming insects of *Prosopis cineraria* (Khejri) viz., *Contarinia prosopidis, Eurytoma settitibia* and *Eriophyes prosopidis* have been completed.

Effect of lopping on the formation of mite induced inflorescence galls and resultant pod production has been worked out. It was found that the pod production is comparatively higher in the lopped trees and the mite incidence is lower.

Detailed studies on the morphology and histopathology of rachis, stem, leaf and inflorescence galls of *Prosopis cineraria* have been completed.

Studies on the natural enemies of general pest spectrum of *P. cineraria* with special emaphasis on the biology of larval parasite (*Eupelmus* sp., *Tetrastichus spirabilis*) of gall forming midge and wasp have been completed. Larval crowding was found to be the chief factor which affects the development, growth and reproduction of *Eurytoma* sp. Larval crowding also caused deformation in the newly emerged flies.

Nineteen species of parasites, 13 species of predators and three species of entomopathogens were found associated with potential pests of *P. cineraria*.

Project 5: UNDP Project.

Objectives: The main objectives of the project was poverty alleviation through enhancement of the contribution of forestry research to rural development by strengthening the capability of AFRI and its personnel to undertake forestry research. Its aim was to impart new skills and knowledge to the manpower engaged in research and also to strengthen the institute for carrying out research in specific areas of forestry. The project envisages developing mechanism for effective transfer of technology to users for sustainable development of environment.

Results

Socio-economic survey was conducted in the beginning in all ten selected villages and information on relevant parameters like human population; cattle population; literacy percentage; demand/supply of timber, fuel wood, fodder and choice of species were collected. About 50000 seedlings have been planted in the selected villages. Selected spp., are grafted ber (*Zizyphus* spp.), *A. indica, D. sissoo, A. nilotica, A. lebbeck, Moringa* spp., *Citrus* spp., *Emblica officinalis, Pomegranate, Carissa carandus* and *Cordia myxa*. Farmers did not prefer indigenous spp. like Khejri (*P. cineraria*) and Rohida (*T. undulata*). To motivate and increase technical skill of the farmers, various training cum demonstration programmes (on the spot and at institute) were organised. Local NGOs and forest officials were also imparted training. Different types of incentives like free seedlings, pitting, insecticide etc. were also provided to the farmers for motivating them to take to tree planting. It is revealed that women and children are more enthusiastic in tree planting activity and their participation in training was more than adult male folk. Sharing input benefits are helpful and instrumental in motivating local people for adopting tree planting.

The results of the intensive extension work done during project period have left a significant impact on the psyche of the local people which will go a long way in shaping their attitude towards planting locally available forest resources for bridging the gap between demand and supply of fuel, fodder and timber. Training on various aspects of forestry like planting technique, VAM innoculation, nursery raising etc. were carried out and 196 foresters, 271 farmers and 24 NGOs were trained under the project.

OLD PROJECT CONTINUED DURING 1998-99

Project 6: Woody plant water relations.

Sub-Project 6(1): Investigation of soil water plant relationship in respect of different tree species.

Objectives: (a) To find out critical limits of stress tolerance of different tree species. (b) To screen tree species for efficient water use and growth under arid conditions. (c) To study the effect of varying level of sewage water on the growth of the plants.

Achievements

A lysimeteric experiment was initiated in March 1998 with tree species *A. nilotica, D. sissoo* and *E. camaldulensis* with the aim to find out the stress tolerance limit. Initial height, collar diameter and number of branches were recorded. Soil samples were analysed for initial nutrient parameters. Soil moisture (initial) determined. Five different water stress levels imposed were 0.05 - 0.1 Mpa (W1), 0.10-0.50 Mpa (W2); 0.50-1.00 Mpa (W3); 1.00 - 1.50 Mpa (W4), till death of the plants (W5). Monthly growth parameters were recorded. At the age of seven months the best height and collar diameter were observed *E. camaldulensis* followed by *A. nilotica*. While considering the mean of the species, the plants performed best in W1 and least in W5 treatments. Number of branches were maximum in *A. nilotica* followed by *E. camaldulensis*.

An experiment was started in March 1998 by planting *E. camaldulensis, A. nilotica and D. sissoo*. Various treatments such as control (T1), Effluent @ 1/2 PET (T2), Effluent @ 1 PET (T3), Effluent @ 2 PET (T4) and good water @ 1 PET were carried out. Monthly growth parameters were recorded. At the age of seven months the best height and collar diameter were observed for *E. camaldulensis* (142 cm and 2.2 cm) followed by *A. nilotica* (122 cm and 1.7 cm). Considering the mean of the species, the plants performed best in T5 and least in T1 treatments. Number of branches were maximum in *A. nilotica* followed by *E. camaldulensis*.

Sub-Project 6(2): Screening of exotic and indigenous plants species on a salt land in arid zone.

Objectives: To find out the best exotic and indigenous species for their growth performance on arid salt land under varying management practices.

Achievements

An experiment was designed to find out the performances of *A. lentiformis,* and *Salvadora persica* under graded doses of gypsum and nitrogen on a salt affected soil (pH 9.3 and EC upto 16dsm-^{1}) at Gangani in Jodhpur district.

The trial for *Atriplex lentiformis* was laid with 3 doses of gypsum (Control G0, full GR G1, and one and half times GR G2) and six doses of nitrogen (control N0, 20 N1, 40 N2, 60 N3, 80 N4 and 100 N5 g of urea). *Atriplex lentiformis* attained good average height and crown diameter within one year of planting. The data showed that the maximum average height of 133 cm and crown diameter of 143 cm was attained in G1 treatment. All the urea treated bushes registered greater height and crown diameter as compared to control. However, treatment effects were not significant among themselves owing to monsoon failure resulting in poor nitrogen response.

The trial for *Salvadora persica* was laid with two doses of gypsum (control and full (GR) and 4 doses of nitrogen (0, 20, 40 and 60 g urea). The results were analysed after 18 months of plant growth. Analysis of variance showed application of nitrogen as well as gypsum both are significantly affecting the plant growth and application of full gypsum and 60 gm nitrogen has resulted in best height and crown diameter as compared to control.

Another experiment with *Acacia ampliceps* with two doses of gypsum (control and full GR) was laid out. Survival of gypsum treated plants is greater as compared to control in deficient rainfall year. *Acacia colei* and *Atriplex amnicola* were introduced at the site and both are giving high survival percentage and growth.

Project 7: Irrigation water management.

Sub-Project 7(1): Studies on watering schedule and water requirement of different tree species.

Objectives: (a) To find out the optimum water requirement of different tree species for maximising their growth. (b) To find out water use efficiency of different tree species. (c) To study the effect of different irrigation practices on soil characteristics.

Achievements

An experiment was started in July 1995. Plantation and irrigation schedule is being maintained based on IW/CPE ratio. Recording of data on growth parameters is being carried out regularly. A considerable variation in growth has been observed depending on different treatments. Data so far collected indicate that 2nd year plants were no more responding to different treatment of irregation. However, in the 3rd year the percent annual increment in height and girth has not shown any definite trend.

Sub-Project 7(2): To screen various plant species for high yield commercial forestry under irrigated conditions.

Objectives: To find out the best high yielding tree species for irrigated arid lands.

Achievements

The experiment was started in 1994-95 with six commercially important plant species namely *D. sissoo, A. nilotica, E. camaldulensis, A. lebbeck, Tectona grandis* and *Dendrocalamus strictus* with a regular water schedule and fixed quantity of irrigation (45 mm at an interval of 15 days with two treatments of VAM and without VAM. Observations of plant growth and survival have been recorded. *Dendrocalamus strictus* did not survive the experimental condition and *Albizia lebbeck* was removed due to browsing. Three years growth indicate that the performance of *Eucalyptus camaldulensis, Acacia nilotica* and *Dalbergia sissoo* is quite significant. The trends indicate that overall *E. camaldulensis* continued to attain maximum height and girth and the growth status in terms of height and girth was *E. camaldulensis> D. sissoo> A. nilotica> T. grandis* while for crown diameter it is *D. sissoo> A. nilotica> E. camaldulensis> T. grandis.* Analysis of variance showed that VAM inoculation did not affect any of the growth parameters.

In August 1998, 64 g N and 46 g P (in form of 100 g urea and 100 DAP) was applied to VAM treated trees. Analysis of variance showed that *Dalbergia sissoo* has significant effect on height growth due to fertilizer application. However, there is no effect on *A. nilotica* and *E. camaldulensis*. Similar are the trends for girth at stump height.

Project 8: Effect of different tree density and inter crops on yield and productivity of agroforestry systems.

Objectives: (a) To study the influence of different tree densities on crop yield and tree growth and find out optimum tree density. (b) To study tree crop interactions in respect of soil moisture and nutrients at different age of plantation.

Achievements

Earlier experiments indicated that crops failed during the years of prolonged dry spell or irregular rainfall. Therefore, in 1998, an experiment was designed to include some intercrop treatments of medicinal plants and water harvesting treatments. The yield of senna four months after planting was on an average,

1.15 kg in no water harvesting plot and 1.33 kg on water harvesting plot. Survival per cent of *Capparis decidua* was 80%. Other crops failed due to failure of monsoon during 1998.

The field experiment comprised three densities (416, 277 and 208 stems per ha) of *Tecomella undulata* and *Prosopis cineraria* planted in combination with agricultural crops to find out the effect of tree density on crop yield and tree growth. Due to failure of monsoon, crops failed and no grain or straw could be harvested. However, the effect of density on tree growth was appreciable. At eight and half years of age, where height and girth (collar as well as DBH) of khejri showed no significant difference in different stand density, the crown diameter declined to 380 cm from 454 cm due to increase in stand density from 277 SPH to 416 SPH. In case of rohida there was slight decline in crown diameter and DBH when stand density increased from 208 to 416 SPH. However, average height of rohida tree declined from 417 to 364 cm due to increase in stand density from 277 to 416 SPH.

Project 9: Studies on combined production system for maximising food, fodder and fruit in arid zone.

Objectives: (a) To study the tree crop interactions in various fruit and fodder tree species associated with agricultural crops for maximising production. (b) To observe the changes in soil properties and nutrient build up.

Achievements

The experiment is designed to explore the effect of fodder and fruits species (viz., *E. officinalis, H. binata* and *C. mopane* planted alongwith the annual crops) on total harvestable yield and soil productivity. The mean height and collar diameter of the plants were found to be maximum for *E. officinalis* (503 cm and 9.4 cm) followed by *H. binata* (418 cm and 7.6 cm) and *C. mopane* (362 cm and 6.5 cm).

Project 10: Effect of rain water harvesting and stand density on tree growth.

Objectives: To measure runoff collection which could be fruitfully utilised in improving the growth of wood lots.

Achievements

A trial on interactive effects of *ex-situ* water harvesting was laid at Jodhpur. A five year old stand of *A. indica* (neem), *P. cineraria* (khejri), *Albizia lebbeck* (siris) was converted into an experiment after thinning it to three different densities 1111 SPH, 555 SPH, 277 SPH. In the initial period of six months there was appreciable growth improvement due to *ex situ* water harvesting despite 1998 being a drought year.

Project 11: Demonstration trials in hot arid zone of Rajasthan.

This project with research cum demonstration trials in hot arid regions of Rajasthan and Gujarat has been sanctioned by Ministry of Rural Development.

Objectives: (a) To make availability improved seeds of grasses and legumes. (b) To develop vegetative barriers with khus and other thorny bushes or stone walls in place of costly barbed wire fencing for the plantation raised under the programme. (c) To develop area specific technology with regard to species content for stabilising of sand dunes, control of wind erosion, grassland development etc. (d) Demonstration of nursery and plantation technology for important trees, shrubs and grasses of arid areas. (e) Development and

demonstration of technology for efficient management of water. (f) Training of local farmers and field level functionaries so that results of research are effectively translated into on the field development.

Achievements

The observations on the effect of different water harvesting structures on growth so far indicate that most of the species performed best with trench cum mound structure as compared to other structures.

To demonstrate effect of rain water harvesting technique on growth and establishment of the species a trial was laid at Jasol in 1995. *Acacia nilotica* and *Dalbergia sissoo* were planted in blocks along with different rain water harvesting structures. Data were recorded for the quarter ending December 1998. Overall performance of the plants were best where trenches were dug in between two rows. This was followed by water harvesting pockets and saucers of 1.5-m diameter. In comparison to the control 48% more growth was registered in terms of height in *Acacia nilotica*. Increase was 47% in terms of girth. In case of *Dalbergia sissoo* the growth was 90% and 63% higher in terms of height and girth respectively.

Project 12: Irrigation water management for tree species.

Sub-Project 12(1): Studies on VAM association in irrigated plantations and agro-forestry systems.

Objectives: (a) Identification of different VAM fungi associated with tree species growing in irrigated plantations and agro-forestry system in arid zone of Rajasthan. (b) Determining the dependency of different arid and semi-arid tree species on VAM fungi. (c) To develop protocol for mass inoculum production. (d) Selection of efficient strains of VAMF. (f) To study the influence of VAMF with Rhizobium on leguminous tree species.

Achievements

(1) Effect of nodulation on biomass of some leguminous tree species of arid zone

Six species viz., *Acacia nilotica, D. sissoo, Pongamia pinnata, Albizia lebbeck, Delonix regia* and *Prosopis cineraria* were collected from three different nurseries i.e., Lokswel, AFRI, and Osian (Jodhpur). Highest number of nodules were noticed in *A. lebbeck* (17.78) followed by *P. pinnata, P. cineraria, D. sissoo* and *Acacia nilotica*. In *D. regia* no nodules were observed. The dry matter weight was highest in *A. lebbeck* followed *by P. cineraria, D. sissoo* and *D. regia.*

(2) Selection of efficient strains of VAM fungi.

An experiment was laid out to select efficient strains of VAM fungi for *P. cineraria, Eucalyptus camaldulensis, Acacia nilotica* and *T. undulata* at Osian nursery, Jodhpur.

(3) Comparative effect of VAM inoculation on polybags and root trainer raised seedlings.

The VAM inoculation experiment on *Azadirachta indica,* and *Ailanthus excelsa* was laid for comparative study of polybags and root trainers raised seedlings. The observations, on shoot height, root length, percentage of root colonization was recorded at bi-monthly intervals. Observations so far indicate that VAM inoculation is more effective in root trainer as compared to polybags.

(4) VAM inoculation experiments on arid and semi-arid tree species

Observations on VAM inoculation experiments on arid and semi-arid tree species revealed that VAM inoculated seedlings showed high percentage of root colonization and biomass of all the tree species studied.

(5) Field experiment on tree productivity in neem through VAM

An experiment was laid out to study the effect of VAM with/without chemical fertilizer (N, P, & K) in *A. indica* at AFRI, Jodhpur. The experiment consist of six different treatments and four replication and RBD design was followed. The experiment is in progress.

Project 13: Disease spectrum of arid and semi-arid tree species.

Objectives: (a) To record out break of diseases in forest nurseries and plantations. (b) To collect, isolate and identify the pathogens. (c) To assess the incidence of the diseases and their management.

Achievements

1. Nurseries and plantation diseases and their management:

Leaf blight disease on *Cordia myxa* has been reported as a serious problem in AFRI nursery, Jodhpur. The incidence of disease covered 25-30% polybags. The pathogen was identified as *Alternaria* sp. For immediate control of the disease foliar spray of Dithane M-45 (0.2%) was recommended at monthly intervals. Similar problem was also noticed in Teak plantations. The disease could be managed by adopting similar treatment.

2. Mortality in *Atriplex* sp. under W.B. Project:

The incidence of the disease was found to be between 10-15%. The pathogen was isolated and identified as *Fusarium oxysporum*. The fungus becomes active in high humid conditions and causes root rot. Soil drenching with Carbandazim (0.1%) @ 3 ltr/plant was found effective for its management.

3. Leaf spot disease on *Ailanthus excelsa*:

Sporadic incidence of leaf spot disease on *Ailanthus excelsa* was recorded in AFRI nursery and provence trial at Govind pura nursery, Jaipur. Incidence of leaf rotter was also noticed at Govind pura nursery, Jaipur. The pathogen was identified as *Cercospora* sp. A combination of Blitox (0.2%) + Monocrotophos (0.05%) was found effective for its control.

4. Studies on dieback disease in Khejri (*P. cineraria*)

About 20 (Twenty) localities Nagaur-Kuchaman area of Rajasthan were surveyed. Percentage of disease incidence was recorded. Mortality due to die back disease ranged between 1-15 percent. Lopped trees were found more susceptible to the disease. The pathogen entered through lopped portion and spreads downwards to stem and root system. Probably pathogen belongs to Fungi Imperfecti. For immediate control of the disease, recommended SFD to paste the infected part with Chaubattia paste (a fungal paste) immediately.

Project 14: Studies on seed borne mycoflora of selected tree species of arid zone.

Objectives: (a) Isolation and identification of pathogenic and non-pathogenic mycoflora of *A. indica, P. cineraria, A. nilotica* and *Tecomella undulata*. (b) Pathogenicity test. (c) To test efficacy of fungicides/plant extracts. (d) To select best treatment for storage which can enhance the viability and germination.

Achievements

1. Studies on seed borne mycoflora of neem seeds:

On neem, seven pathogenic mycoflora belonging to six species of Fungi imperfective, viz., *Curvularia lunata, Helminthosporium* sp., *Alternaria* sp. *Aspergillus flavus, Chaetomium* sp. and one species of Basidiomycetes i.e., *Coprinus* sp. were isolated and identified.

2. Biocidal effect of KSKP extracts on germination of *A. nilotica* seeds:

An experiment was laid out to seed the efficacy of Karanj Seed Kernel Powder (KSKP) extracts on germination of seeds on *A. nilotica* seeds. Fifty seeds treated under different treatments viz., **T1** 1% KSKP water extracts in 80% Methanol, **T2** - 80% Methanol, **T3** - 1% KSKP MeoH- water extract in 80% Methanol, **T4** - 1% KSKP MeoH extracts in 90% Methanol, **T5** - control were wrapped in germination paper and kept in germination box at room temperature i.e. 27°C ± 2°C. The observations on seed germination (%) showed that all the treatments were found superior to control. However among the treatments **T1** was found better then **T3** and **T2**.

3. Biocidal effect of NSKP extracts on germination of *A. nilotica* seeds:

Neem seed kernel powder (NSKP) extracts prepared in various solvents viz., **T1** - 1% NSKP Methanol extract (80%), **T2** -1% NSKP MeoH water extract in 80% Methanol, **T3** -1% NSKP water extract, **T4** - control were tested against germination (%) of *A. nilotica* seeds. There were four treatments. The percent of germination showed that all the treatments were found superior to control however, among the treatment **T2** was found best followed by **T3** and **T1**.

4. Biocidal effect of plant products on germination of *A. nilotica* seeds:

Effect of various plant extracts namely **T1** - *Jatropha curcus* (seeds) **T2** - pure Azadirachtin, **T3** - *J. curcus* seeds -water extract, **T4** - *Calotropis procera* (leaf) water extract, **T5** -control, The *A. nilotica* seeds were pelleted in above extracts for 5 minutes then percentage of germination was recorded. The data showed that all the treatments were found superior to control. The pattern of germination was recorded T4> T3> T2> T1> T5.

5. Effect of *Balanites aegyptica* extract on neem seed germination:

An experiment was laid out to study the biocidal effect of *B. aegyptica* extract on germination percentage and seed borne mycoflora of neem seeds. The percentage of germination showed that all the treatments were found superior to control however among the treatment **T4** was found best in germination as well as surface mycoflora. Other treatments i.e. **T2** and **T3** was also found effective.

Project 15: Growth and yield studies in irrigated plantations of IGNP area.

Objectives: (a) To study the growth performance of *Eucalyptus camaldulensis* and *Dalbergia sissoo* planted under irrigated conditions in IGNP area. (b) Preparation of volume/yield tables of these two species.

Achievements

Volume equations for the two species have been finalised:

The mean annual increments for *E. camaldulensis* and *D. sissoo* ranged from 1.89 to 24.09 m^3/ha/year and 2.15 to 20.65 m^3/ha/year respectively depending upon age, density and site. The average form factor also varied from 0.33 to 0.56 and 0.32 to 0.56 for *E. camaldulensis* and *D. sissoo* respectively.

Project 16: Growth studies on neem in Gujarat State.

Objectives: (a) To study the growth performance of *Azadirachta indica* in the State of Gujarat. (b) Preparation of volume/weight/yield tables of the species.

Achievements

Above-ground biomass equations developed.

Similar equations for underbark dry weights and green weights (both over- and under-bark) have also been developed.

Project 17: Lopping regime of important arid zone fodder tree species.

Objectives: (a) To study the effect of different intensities of lopping on the growth performance and fodder yield of *Prosopis cineraria* and *Ailanthus excelsa*. (b) To study the effect of pruning on the growth performance of *Prosopis cineraria*.

Achievements

Lopping was not found to have any significant effect on the height and DBH growth of *P. cineraria* while the effect is highly significant (99.9%) on its crown width. Height growth of *A. excelsa* is shown to be affected by lopping at 94% confidence level while effects on the growth of DBH and crown width are significant at 98% and 99.9% respectively. Mean % increments in fodder yield and crown width of both the species are adversely affected by heavy lopping. However analysis show that lopping intensity as such does not have any significant effect on the fodder increment in the case of *P. cineraria* while it is highly significant (99.9%) in the case of *A. excelsa*. Effect of pruning on growth parameters *of P. cineraria* are found to be significant at P-0.05 level and above.

Project 18: Sand dune stabilization and spacing/species trial at Churu.

Objectives: (a) To study the effect of spacing on the growth of *P. cineraria, Acacia nilotica* and *Tecomella undulata* on an interdunal plain. (b) To study the effect of an arrow shaped plantation in arresting sand movement. (c) To study the relative growth performance of *Acacia planifrons, Dichrostachys nutans* and *Zizyphus nummularia* on a sand dune.

Achievements

A. nilotica has outgrown the other two species as far as height is concerned. The effect of spacing was insignificant on the height growth of all the three species in the first year. *Acacia tortilis* planted in the SDS experiment (arrow shape) has survived well *A. planifrons* showed the best survival (55%) followed by *Z. nummularia* (33%) and *D. Nutans* (30%) respectively on a sand dune.

Project 19: Market survey on timber/fuelwood and bamboos.

Objectives: To collect data on the market prices of selected timber species, fuelwood and bamboos from Jaipur and Ahmedabad markets on a quarterly basis for publication of timber and trade bulletin.

Achievements

Prices of selected timber species, fuelwood and bamboos have been collected from the markets of Jaipur and Ahmedabad. The data have been compiled in the prescribed format and forwarded to ICFRE HQ.

Project 20: Integrated pest management of forest insect pests.

Objective: (a) Development of biopesticides for the management of forest tree species in arid and semi-arid regions. (b) Survey and evaluation of natural enemy complex of rohida, babul and neem defoliators. (c) Screening and bioassay of conventional insecticides.

Achievements

Investigation on the biological control of rohida defoliator, *P. tecomella*, covering efficacy of its pupal parasite (*Billae* sp.), entomopathogenic fungus (*Beauveria bassiana*) and phytopesticides (NSKP, plant extract of neem, aak, dhatura and others) were carried out. The final work report has been submitted.

Detailed bio-ecology of pupal parasite, *Billeae* sp., was completed.

Methanol extract of neem seed kernel powder (NSKP) at 0.05% concentration showed 100% antifeedent activity against the moringa defoliator, *Noorda blitealis*.

Project 21: Studies on the pest problem in forest nurseries and their management in arid and semi-arid region.

Objectives: (a) Collection, identification, host range and population biology of important nursery pests. (b) Standardization of control measures.

Achievements

Six insect pest were identified as important insect pests of nurseries. *Pulvinaria* sp. was found infesting neem. *Brachymeria nephantiasis* (Hymenoptera: Chalcidae) was identified as the most destructive parasite of *Ailanthus* web worm.

Project 22: Studies on Seed Pest of forest tree species in arid and semi-arid region.

Objectives: (a) Collection, preservation and taxonomic identification of important seed pests. (b) Screening of seeds for pest infestation under storage conditions. (c) Study on host range of economically potentail pests. (d) Study on population biology of important seed pest. (e) Standardization of control measures.

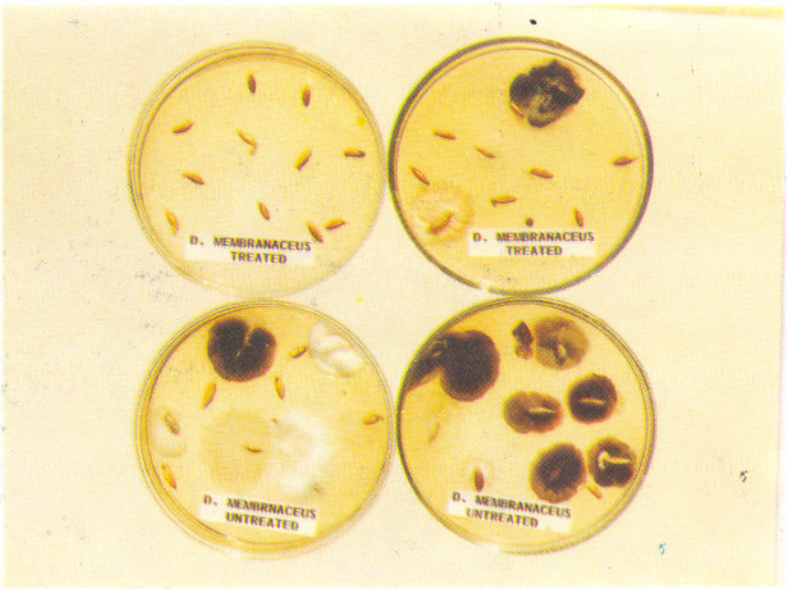
Achievements

Seeds of various tree species were collected from Jodhpur. At temperatures 29°-32°C and relative humidity ranging from 70-75 percent, maximum development of *Caryedon serratus* was observed. Ovipositional response was observed on fifteen seed hosts.

Project 23: Studies on fatty oil of some important plants having oil bearing seeds of arid regions.

Objectives: (a) To study the variation in oil content of important oilseeds from different localities of arid and semi-arid zones for finding out higher oil yielding varieties. (b) To select best areas for oilseeds production. (c) To screen the arid and semi-arid zone species for identification of newer sources of fatty oils so as to further augment the total production of oils in the country.

Folior blight attack in ***Dipterocarpus retusus*** *nursery in Digboi, Assam*

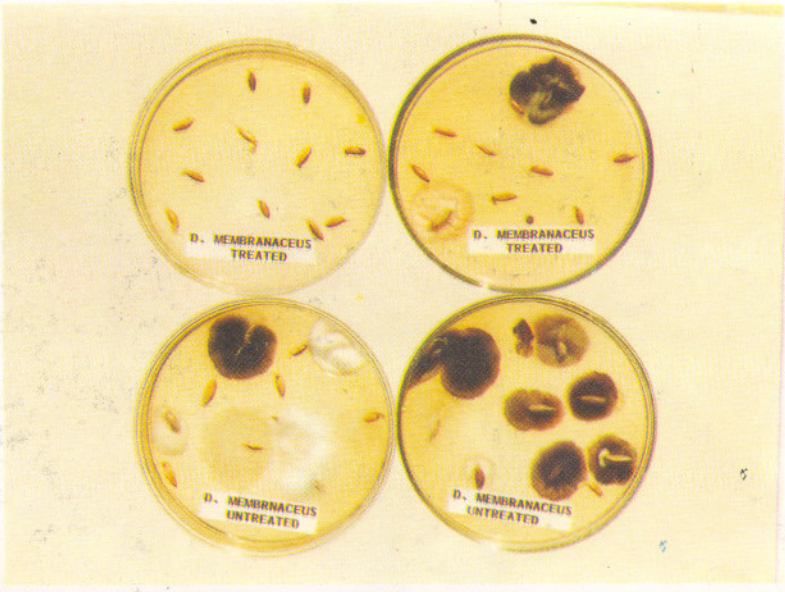


Seed mycloflora of ***Dendrocalamus membranaceus*** *and its control*

Adult of ***Patialus recomella***

Heavily skeletonized leaves of ***Tecomella undulata***

Folior blight attack in ***Dipterocarpus retusus*** *nursery in Digboi, Assam*



Seed mycloflora of ***Dendrocalamus membranaceus*** *and its control*

Adult of ***Patialus recomella***

Heavily skeletonized leaves of ***Tecomella undulata***

Achievements

Screening of seeds of arid zone species for fatty oils has been carried out and physico-chemical evaluation of oils is in progress. Effect of fungal infestation on content and quality of oils as well as content of some other chemical constituents has been studied.

Project 24: Study on the biocidal activity of extractives of arid zone plants.

Objectives: To test the biocidal activities of *Capparis decidua, Azadirachta indica* (Neem) and other plants.

Achievements

1. Biocidal efficacy of *Capparis decidua*

Extractives of root, seed, wood, bark and branches of *Capparis decidua* were tested against the aphid, *Myzus persicae* and were found to exhibit promising activity. The order of efficacy was shown as root > seed > bark > branch > wood.

2. Biocidal efficacy of neem

a) 100% antifeedant activity has been recorded with NSKP methanolic extract at 0.5% concentration against all the stages of larvae of *Noorda blitealis*, the Moringa defoliator.

b) The effect of Neem Seed Oil (NSO) on the growth of *Acaudaleyrodes rachipora*, the babul whitefly on Acacia seedlings was studied. NSO at 0.5, 0.3 and even at 0.1 % concentration were found effective in suppressing the development of whitefly significantly.

Project 25: Studies on the proteins of arid zone species.

Objectives: (a) To select the potential plants as protein sources. (b) To prepare LPC for the plant species of desert area was taken up.

Achievements

1. Crude Protein content determination

Seed meals and seeds, leaves/branches of various arid zone plants have been investigated for their protein content. These meals have reasonably good amount of nitrogen viz. *Moringa oleifera, Tephrosia purpurea, Cordia gharaf, Cassia fistula, Capparis decidua, Ziziphus mauritiana, Calligonum polygonoides, Pithecellobium dulce, Parkinsonia aculeata*. The crude protein content of *Dalbergia sisso* pods from forty three regions has been determined. The study of its dependence on other seed parameters is in progress. The weight per unit area of neem leaves and its the protein content is being studied.

2. LPC Preparation

The extraction of protein from fresh leaves and preparation of LPC was carried out for following species viz. *Aerva persica, Dalbergia sissoo, Withania somnifera, Anogeissus pendula, Salvadora persica, Salvadora oleoides, Pithecellobium dulce* and *Ziziphus nummularia*.

Project 26: International provenance trial on neem.

Objectives: To improve the genetic quality of neem and its utilisation.

Achievements

The data recorded this year show that maximum survival was from Sagar (99%) followed by Kulapachra (97%) and Mandore (96%) of Indian provenances and Chamwino (100%; Tanzania) followed by Doi Tao (96%; Thailand) and Tuang Luang (95%; Thailand) of international provenances. The highest mean height of the plants was in case of Kulapachra (186 cm) followed by Ramanguda (169 cm) and Sagar (179 cm) in case of Indian provenances. In the case of international provenance it was Sunyani (380 cm, Ghana) followed by Tibbi Lasan (3.7 m Pakistan and 3.6 m Myanmar).

Project 27: Provenance trials and propagation of fodder tree species.

Objectives: To screen geographical variations for adaptability and higher fodder yield.

Achievements

(a) *Acacia nilotica*:

In order to identify and develop genotypes having fast growth rate, better stem form, improved wood properties, good quantity of fodder and resistance to disease and insect pests, provenance trials of *Acacia nilotica* were undertaken at AFRI, Jodhpur during 1991. The tree height attained by different provenances varied from 250 to 380 cm in the year 1998-99. The ranking of height varies from year to year.

A fresh provenance trial was started and seeds were collected from 45 different locations in 1997. During 1997-98 data have been recorded on seed parameters and seeds have been sown in the nursery to raise seedlings for field trial. Observations are in progress.

It is proposed to have multilocational trial for *Acacia nilotica* provenances. For this purpose, seeds have been supplied to FRI, Dehradun, IFGTB, Coimbatore, TFRI, Jabalpur, IWST Bangalore, CF Research of Haryana, Andhra Pradesh, Uttar Pradesh and State Silviculturists of Gujarat.

(b) *Ailanthus excelsa:*

The seeds of *Ailanthus excelsa* were collected from thirty two seed sources and studies were conducted on seed parameters. Seeds were sown in the nursery for field trial and observations were recorded on the seedling growth parameters in nursery. Observations are in progress.

Project 28: Provenance trial of arid zone species.

Objectives: To map the geographical variability for adaptation and growth of arid zone species.

Achievements

Azadirachta indica, Tecomella undulata and *Dalbergia sissoo* trials were laid out in the early nineties. The annual growth data are being recorded for theses species. In case of *Azadirachta indica* where thirty nine seed sources were used, Rajkot, Palampur and Jhansi have shown good growth. In case of *Tecomella undulata* the trial was laid out with thirteen seed sources and Sundarpur bir is the best so far, whereas in case of *Dalbergia sissoo* out of twelve provenances, Pilibhit gave the best result.

Project 29: To develop vegetative propagation technique for *Acacia nilotica and Ailanthus excelsa.*

Objectives: To develop a cost effective method/technology for cloning the superior genotypes of *Acacia nilotica* and *Ailanthus excelsa.*

Achievements

(1) *Acacia nilotica*:

Stem cuttings of *Acacia nilotica* were raised in the mist chamber. So far only shoot regeneration was observed in spite of giving IBA treatment from 500 to 2500 ppm concentrations. Seasonal variation was also observed and sprouting response was recorded only during the period from March to September. However, low frequency (>10%) of rooting was observed when cuttings from adult trees were raised in the month of March, 1999 after treating them with 5000 ppm IBA solution.

To conduct grafting experiments for rejuvenation and easy vegetative propagation, 200 seedlings were raised as root stock. Different types of grafts were tried. However, grafted scion survived only for a couple of weeks. Further work is in progress.

(2) *Ailanthus excelsa:*

To standardize the macropropagation techniques, stem cuttings of different types were tried. Different concentrations of IBA were tried to induce rooting from stem cuttings. Only bud break was observed from these stem cuttings. Rooting was observed in the stem cuttings collected from 1-2 year old seedlings.

For grafting experiments, 200 seedlings were raised in nursery. Early success has been achieved in some of the grafts. Experiments are in progress to refine this technique further.

Project 30: To develop tissue culture technique for *Acacia nilotica* and *Ailanthus excelsa.*

Objectives: To develop the technology for faster multiplication and cloning of superior planting stock material.

Achievements

(1) *Acacia nilotica*:

Annual response of nodal segments were studied throughout the year by establishing nodal explants in each month. Best response (95%) in terms of bud break was recorded from nodal explants raised in the month of March. A combination of IAA and BAP proved better for shoot initiation without producing callus. Callusing was observed in NAA and BAP containing medium.

Multiplication of cultures:

At higher concentrations of BAP dwarf shoots were developed. Horizontally placed shoots multiplied better than vertically placed shoots. Addition of auxins higher than 0.1 mgl^{-1}, developed callusing from the portion of the explant which is in contact with the media. Yellowing of leaves and leaf shedding was checked by adding silver nitrate (0.1mgl^{-1}).

Experiment was also conducted to observe the effect of reduced nitrogen (amino acids) on bud break and multiplication of shoots from nodal explants collected from lopped tree. No significant differences were recorded in terms of bud break percentage. However, amino acids favour healthy growth of shoots.

Rooting:

The shoots (size 2-3 cm long) were isolated and kept in half MS media containing IBA of varying concentration and kept at 35°C in growth chamber. Roots sprouted after 21 days. Full and half strength MS basal agar gelled media were tried along with auxins (IBA and NAA, 0.1 - 1.0 mgl^{-1}) for root induction from the regenerated shoots. The isolated shoots best rooted in 1/2 strength MS medium containig 0.25 mgl^{-1} IBA. At lower concentration of IBA the roots were fibrous and small. Higher concentration of IBA and NAA developed callus from the basal portion of the explant.

(2) *Ailanthus excelsa:*

Shoot initiation multiplication from *in vitro* raised seedling

After complete surface sterilization of viable seeds with 0.1 to 0.2 $HgCl_2$, seeds were germinated in MS medium without hormones. Various explants viz. hypocotyl, epicotyl, cotyledons and cotyledonary nodal segment were used for initiation of shoots. Cotyledonary nodal shoot segments proved best for establishing multiple shoot cultures.

Coppice from field plant shoots were collected from adult trees and after removing the larger leaves, the material was cut into small (3-4 cm long) pieces along with single node. After surface sterilization, explants were kept vertically in MS medium with various combinations of plant growth regulators. Multiple shoots were observed after 2 weeks. 3-4 shoot were observed in a single explant. Multiple shoot cultures are being maintained for the last one and half year.

Root induction:

Different hormones at varying concentration were tried with MS medium or MS1/2 strength medium. Observations are in progress.

Project 31: Macropropagation and micropropagation of some arid zone tree species.

Objectives: To develop clonal propagation technique through macropropagation and micropropagation methods for some arid zone tree species.

Achievements

***Azadirachta indica*:**

Macropropagation:

Stem branch cuttings were treated with Auxin (IBA) powder (3%) at lower end and upper end was pasted with chopatia paste to prevent the infection. These were but in Mist Chambers where RH was maintained at 90%. Shoot formation was observed within a week and 85% of the stem cuttings sprouted in four weeks.

Micropropagation:

Multiple shoot cultures are being maintained for the last three years by timely subculturing them on fresh medium. No abnormalities were recorded due to long term subculturing. A trial on tissue culture raised and macropropagated plants of *A. indica* was laid down in field. The plants are growing well for the last two and half years. Another trial of 14 tissue culture raised plants of Neem is also progressing well and now it is almost three year old. Cultures have also been raised from a four years old unique genotype of *Azadirachta indica* growing in experimental field. However the multiplication rate is very poor in this genotype as compared to normal neem plants.

Project 32: NABARD Project.

Objectives: The objectives of the NABARD project are: (a) To study the performance of different silviculture and horticulture species with different spacement, in agri-silvi and agri-silvi-horti model. (b) To study the suitability of different trees, fruit plants and crop combinations in agri-silvi and agri-silvi-horti model. (c) To study the performance of different silvi-pastoral model. (d) To study the growth and productivity in agri-silvi model. (e) To introduce biofertilizers in agroforestry plantations. (f) To seek improvement of crop productivity through introduction of suitable tree species. (g) To develop appropriate land use/management plans for the three watershed areas.

Achievements

Bund planting is the most preferred in all the watershed areas. Data based on this pattern of planting is also generated for inferences about most successful tree species in arid region. So far in all three watersheds 20935 seedlings have been planted on farmers fields including 8555 seedlings which have been planted in 1998.

Periodic data from all the planted models regarding growth (height and girth), yield (crop yield) and grass yield are being recorded for future analysis and conclusive recommendation on most suitable model for arid region. To assess the impact of agroforestry plantation on soil fertility, soil samples from all the planted sites were analyzed before planting for pH, O.M., EC, N, P and K contents.

From the initial experience of project implementation, it has been observed that spp. like *Eucalyptus, P. cineraria, A. nilotica, A. indica, Ailanthus excelsa, Cordia, Zizyphus* and *Aonla* are performing well in different agri-sivli, silvi-horti and silvi-pastoral models. The grasses like *C. ciliaris* and *C. setigerus* are giving high fodder yield.

Project 33: Planting stock improvement programme (World Bank Project).

Objectives: (a) Mass multiplication of selected clones. (b) Multilocational clonal testing selected clones.

Achievements

Base population of 28 clones of *D. sissoo* and 25 clones of *E. camaldulensis* have been planted in 1.00 ha area in AFRI nursery for the purpose of establishment of Multiplication Garden.

One mist polyhouse has been commissioned and is being used for mass multiplication of selected clones for raising CSO under PSIP. It has the capacity to raise 25,000 cuttings at one time.

Project 34: Development of clonal seed orchard.

Objectives: (a) To produce quality seeds. (b) To improve the productivity.

Achievements

Till now 13.0 ha of CSO has been established. Out of this 4 Hectares CSO of *T. grandis* and 2 Hectares CSO of *D. sissoo* has been established in Gujrat. 5.0 ha CSO of *D. sissoo* and 2.0 ha of *Eucalyptus camaldulensis* has been established in Rajasthan.

Fresh cuttings of 40 *D. sissoo* clones have been raised in mist chamber and 600 plants of *D. sissoo* and 600 plants of *Eucalyptus camaldulensis* clones have already been hardened and are ready for plantation.

Project 35: To develop model nursery.

Objectives: (a) Production of superior quality of seedlings. (b) Standardization of potting mixtures and containers (root trainers) for various arid zone tree species.

Achievements

The existing nursery in AFRI is being upgraded into a model root trainer nursery. Two low-cost shade-cum-mist chambers have been fabricated and are being utilised for rooting of cuttings of different species. Shade house covering space of nearly 420 sq.m. has been created. Experiment on potting mixture incorporating locally available organic materials is in progress. Composting is in progress and compost is being utilised as a component in potting medium in root trainers. 3500 root-trainers of 150 cc and 1500 RT of 250 cc have been received and are being utilised for raising nursery stock. 1000 root-trainer stands have been procured.

40,000 seedlings of different tree species have been raised in root trainers and 10,000 seedlings in polythene bags for research plantations.

Project 36: Development of seed bank facilities.

Objectives: To procure seed testing equipments. (b) To develop seed lab. (c) To collect the seeds of target species. (d) To develop seed testing and storage protocols.

Achievements

Seed Collection

Seeds have been collected from selected seed stands and candidate plus trees of *Acacia nilotica*, *Dalbergia sissoo* and *Eucalyptus camaldulensis* and given to AFRI nursery and the nursery of the SFD, Rajasthan for raising seedlings. Seeds of other species has also been collected for research work.

Selection of a Substratum

Studies showed that top of filter paper method give maximum percentage germination, energy period and germination energy than seeds incubated in vermiculite and sand in the case of *Azadirachta indica* and *Eucalyptus camaldulensis* seeds. However, seeds of *Acacia nilotica*, *Dalbergia sissoo* and *Prosopis cineraria* showed higher percentage of germination in vermiculite than the filter paper or sand incubation methods.

Germination Studies

Neem seeds collected from dryer parts of the country were found to have smaller length, breadth and weight than those from other sources. The viability and germination capacity starts decreasing after the second week of collection. However, seeds stored at low temperature (4±1°C) retained viability up to six months though with very poor germination (10%). Storage of neem seeds collected from Jodhpur and stored in various containers at low and high temperature showed remarkably enhanced viability at low temperature in cotton bag. Variation of oil content of neem seeds stored in different containers was also studied. Germ plasm variability has been observed in neem. Germination studies in the stored seeds of *Acacia nilotica* and *D. sissoo* have been carried out.

Storage Studies:

Studies showed that initial moisture content has no effect on the long-term storage capability of neem seeds. Comparison of neem seeds collected from both the flowering periods indicated that the seeds collected in winter season had higher seed weight, larger size and had less moisture content than the seeds of summer season.

Effect of Pre-treatments on Seed Germination and Seed Vigour:

Mechanical scarification followed by 24 hrs soaking in ordinary water gave the highest (95%) germination in *A. indica* seeds and the method was recommended for large-scale seedling production. Seeds of *Prosopis cineraria* also showed better germination percentage in mechanically scarified seeds (70%). *Dalbergia sissoo* required no or cold water (48 h) pre-treatments. Cold water pre-treatment of 48 hrs. and 72 hrs. had similar results. Removal of pod covering facilitates early germination of *Dalbergia* seeds.

Effects of seed size and pre-treatments (hot water, sulphuric acid and mechanical scarification) were studied in *Acacia nilotica,* and *Prosopis cineraria.* Seed size and pre-treatments affected the percentage germination and seedling vigour of both the seed types. Mechanically scarified seeds of both the species showed higher germination and seedling vigour followed by acid and hot water pre-treatments.

Project 37: Development of seed production areas.

Objectives: (a) To develop seed production area of target species in Rajasthan and Gujarat state. (b) To produce quality seeds.

Achievements

The list of potential seed stands obtained from SFDs was compiled. Teams were formed to survey the listed and other areas for the development of seed production areas (SPAs).

In Gujarat, culling operations in 30 ha. SPAs of *Tectona grandis* has been completed. 40 ha seed stands of *Acacia nilotica* has been selected for conversion into seed production areas. Marking of superior/ inferior trees has also been completed for retension/culling. 40 ha seed stands of *Tectona grandis* have been selected for conversion into seed production areas.

Project 38: Development of seedling seed orchards.

Objectives: (a) To develop seedling seed orchards of target species in Rajasthan state. (b) To select candidate plus trees. (c) To produce quality seeds

Achievements

31 ha SSO of *D. sissoo, A. nilotica* and *E. camaldulensis* has been created at Govindpura Jaipur. Seedlings were raised from the seeds received from CPTs of target species.

Candidate plus trees of targeted species have been re-screened in Rajasthan State. 50 CPTs of *A. nilotica*, 50 of *D. sissoo*, 30 of *E. camaldulensis* and 13 CPT of *Tectona grandis* have been re-screened. All the selected CPTis of targeted species have been analysed as per the DANIDA format for the selection of plus trees with few modifications for the traits to be assessed.

Also selected 50 CPTs of *Tectona grandis* and 20 CPTs of *Acacia nilotica* in Gujarat State.

EXTENSION

(a) Facilities generated and services rendered

(i) Consultancy to various agencies

Rajasthan Forest Department has been guided and helped in the selection of Seed Production Area of *Acacia catechu, Ailanthus excelsa, Prosopis cineraria, Salvadora persica* and *Acacia senegal.*

(ii) Library and documentation - computer facilities

Four pentium I computers were installed.

(iii) Video films

Shooting of a film for the purpose of extension on "Rain water harvesting" is in progress.

(b) Transfer of Technology

Under NABARD Project about 8000 seedlings of forestry trees/horticultural plants were planted under different agroforestry models in farmars field and in three selected microwatershed areas in and Jodhpur district.

Under NABARD Project, on the spot training was provided to the farmers on various aspects of agroforestry ie. Tree planting techniques, soil moisture conservation and rain water harvesting measures.

(i) Teaching support- e.g. to various organisation

The IT Cell of the institute provided teaching support in computers for the AFRI centre of FRI Deemed University.

(ii) Exhibition, Kisan Mela etc.

Under RD Project six demonstration centres viz. Jodhpur, Bikaner, Churu, Rohat, Jasol and Palanpur have been established and maintained.

Under NABARD Project, different demonstration plots on agroforestry models (silvi-agri, silvi-horti & silvi-pastoral) are being established on farmers field in three watershed areas.

Demonstration plantations

Under world bank project, demonstration plantations on salt affected land at Gangani, Jodhpur has been established.

(iii) Seminars, Workshops

Workshops were conducted on *Acacia nilotica* and *Azadirachta indica* for peer review.

Workshop for setting of research priorities for AFRI and linkage with other organisations/ Institutes/States etc.- e.g. collaborative ventures etc. was conducted.

(c) **Publication and extension literature brought out by the Institute**

Brochures with title and authors:

- Selection criteria and Candidate Plus Tree Selection of *Acacia nilotica* at farmers field in Rajasthan- Author: C.J.S.K. Emmanuel and D.K. Mishra.
- Selection criteria and Candidate Plus Tree Selection of *Tectona grandis* in Gujarat- Author: D.K. Mishra and C.J.S.K. Emmanuel.
- Selection criteria and Candidate Plus Tree Selection of *E. camaldulensis* in Punjab - Author: D.K. Mishra and C.J.S.K. Emmanuel.

FINANCIAL STATEMENT

I. PLAN			
Sl.No.		SUB-HEAD	Expenditure (Rs. in lakh)
1.	A.	**REVENUE EXPENDITURE**	
		(a) Research	126.71
		(b) Administrative Support	42.60
		Total for Revenue Expenditure 'A'	**169.31**
	B.	**LOAN AND ADVANCES**	
		(a) Loan Advances (Conveyance)	-
		(b) House Building Advance	-
		Total for 'B'	-
	C.	**CAPITAL EXPENDITURE**	
		(a) Building & Roads	73.64
		(b) Equipments, Library Books	0.52
		(c) Vehicles	-
		Total for 'C'	**74.16**
		GRAND TOTAL FOR A+B+C(PLAN)	**243.47**
II. NON-PLAN			
1.	A.	**REVENUE EXPENDITURE**	
		(a) Research	-
		(b) Administrative Support (Salary)	-
		Total Non-Plan	-
		TOTAL FOR PLAN + NON-PLAN	**243.47**
III. FUNDED PROJECT			
	A.	World Bank Project	66.52
	B.	UNDP Project	4.91
	C.	NABARD Project	2.66
	D.	Rural Development Project	3.58
		GRAND TOTAL for (A+B+C+D) FUNDED PROJECT	**77.67**