

CHAPTER-IX

ARID FOREST RESEARCH INSTITUTE JODHPUR

The Arid Forest Research Institute at Jodhpur was established in 1988 with a view to solving the forestry research problems of the 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; determining interaction of trees with agricultural crops under different agroforestry systems and tree farm economics; developing tissue culture protocols and techniques for vegetative propagation; ascertaining soil characteristics of arid area including site-species interaction; and to study the oil and protein contents of various trees and shrubs.

During the year, encouraging results were achieved in the fields of afforestation on salt affected lands, plant-water relations, tree-crop interaction, chemistry of plant parts, growth studies, management of trees for fodder, entomology, seed studies, tree improvement etc.

PROJECT COMPLETED DURING 1999-2000

Sl.No.: 1

Project identification No.: AFRI-1/FEDD-1 (WB2-II)

Name of the principal investigator: N. Bala

Title of the project: Irrigation and Water Management.

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

Year of the start of the project: 1995

Target year of completion: 1999

Cost of the project: Rs. 33,870/-

Objectives: (a) To find out the optimum water requirement of different tree species for maximizing 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.

Scientific importance of investigations: The project will lead to increase in biomass production and sustainable use of irrigation water in arid zone.

Results/Achievements: The trial was initiated in July 1995 to investigate the watering schedule and water requirement of *Eucalyptus camaldulensis*, *Acacia nilotica* and *Dalbergia sissoo* on a sandy loam soil. Six treatment combinations of quantity of water and watering frequencies were taken. Increase in growth and biomass accumulation in all the species due to irrigation were recorded. The results revealed that the quantity of water added per irrigation was more important than the total irrigation input, and more soil volume with favourable moisture condition in root zone resulted in better growth and biomass production.

Among the species, *E. camaldulensis* was found to be the most irrigation sensitive. *A. nilotica* did not show much response. *D. sissoo* registered three-fold increase in biomass because of the treatment.

S.No : 2

Project identification No. : AFRI-2/FEDD-2 (RD)

Name of the principal investigator: Dr. G. Singh.

Title of the project: Effect of different tree density and intercrops on yield and productivity of agroforestry systems.

Year of the start of the project: July 1998

Target year of completion : March 2000

Cost of the project : Rs.98.45 lakhs

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

Scientific importance of investigations: The investigation will ascertain optimum stand density and best combination of trees with agricultural crops or shrubs for maximizing yield on sustained basis.

Results/Achievements

Experiment A: Effect of different tree density and agricultural crops on yield and productivity of agroforestry systems.

In 1998 the experiment was redesigned to include some intercrop treatments of medicinal plants and water harvesting treatments. In the revised experiment main treatments are (i) no water harvesting and (ii) water harvesting. Due to total failure of monsoon during 1999, all the intercrops failed. Only the trees continued to grow at a very slow pace. No significant variations were noted in tree growth.

Experiment B: Effect of tree density on crop yield and plant growth.

The field experiment comprising three densities with *Tecomella undulata* and *Prosopis cineraria* was initiated in combination with agricultural crops to find out the effect of tree density on crop yield and tree growth in 1995 in a five year old stand. Due to failure of monsoon, intercrops failed to grow. However, the effect of density on tree growth was appreciable. At ten years of age, height of Khejri was significantly higher.

Experiment C: Maximising food, fodder and fruit yield in agroforestry system in arid region.

The experiment was started in July 1994 by planting three different species viz. *Emblica officinalis*, *Hardwickia binata* and *Colophospermum mopane* with the aim of determining total production of fruit and fodder in combination with agricultural crops. Various observations were recorded like growth data of plants, soil moisture and nutrient status of soil with distance from the tree and crop yield (grain and dry matter). Soil moisture was lower in cropped area during cropping season whereas the reverse trend was observed during fallow period. Nutrient analysis of tree leaves and the litter were carried out to determine the re-translocation of nutrients in plant system and soil nutrient enrichment through litter fall. Pruned biomass of *Colophospermum mopane* was maximum compared to *Hardwickia binata* in the fodder species.

Sl. No : 3

Project identification No. : AFRI-3/FEDD-3 (RD)

Name of the principal investigator: N. Bala

Title of the project : Effect of *ex-situ* rain water harvesting and stand density on tree growth.

Year of the start of the project: July 1998

Target year of completion : March 2000

Cost of the project : Rs.98.45 lakhs

Objectives: To find out the effect of runoff capture on the growth of standing plantations.

Scientific importance of investigations: The study will help in utilizing the runoff fruitfully in improving the growth of old plantations.

Results/Achievements: A trial on interactive effects of *ex-situ* water harvesting was laid at FE&DD field, Jodhpur. A five year old stand of *Azadirachta indica* (Neem), *Prosopis cineraria* (Khejri), *Albizia lebbek* (Siris) was thinned to two different densities 1111 SPH and 555 SPH, which were in sub plots. Two main blocks were control and *ex situ* water harvesting treatments. Due to total failure of monsoon, there were neither appreciable growth increments nor treatment effects. As such, no significant changes were observed due to various treatments because of failure of monsoon.

S.No : 4

Project identification No.: AFRI-4/FEDD-4 (RD)

Name of the principal investigator: Dr. G. Singh, Dr. Ranjana Arya and N. Bala

Title of the project: Demonstration trials in hot arid zone of Rajasthan (sanctioned by Ministry of Rural Development).

Year of the start of the project: 1995

Target year of completion: March 2000

Cost of the project: Rs. 98.45 Lakhs

Objectives: (a) To study the availability of improved fodder seeds of grasses and legumes. (b) To develop the vegetative barriers with khus and other thorny bushes or stone walls in place of costly barbed wire fencing for the plantations. (c) To develop area specific technology with regard to species content for stabilising sand dunes, control of wind erosion, shelterbelt plantations, grassland development etc. (d) To demonstrate nursery and plantation technology for important trees, shrubs and grasses of arid areas. (e) To develop and demonstrate the technology for efficient management of water through conservation of stored water and harvesting of excess rain water for utilisation in periods of moisture stress. (f) To extend the technology and train the local farmers and field level functionaries.

Scientific importance of investigations: Dissemination of proven technologies to farmers.

Results/Achievements

Nagaur Site

A total of five trials were laid, two in 1996 and three in 1997.

Silvipastoral trial: This trial was laid with five tree species *Zizyphus mauritiana*, *Ailanthus excelsa*, *Acacia nilotica*, *Azadirachta indica* and *Dichrostachys nutans* with *Cenchrus ciliaris* as intercrop. Overall *Zizyphus mauritiana* proved to be the best tree species in silvipastoral system. *Ailanthus excelsa* was next followed by

Acacia nilotica, *Azadirachta indica* was found to be frost tender species. Growth of *D. nutans* suffered severely due to frost and grazing though it survived well in small bushy form. Green grass yield was affected by drought conditions.

Silvi herbal trial: This trial was done with three tree species: *Acacia nilotica*, *Ailanthus excelsa* and *Dalbergia sissoo*. *Dalbergia sissoo* did not survive due to frost. It was replaced by *Colophospermum mopane* in 1998 to maintain the spacing in the experiment. *Cassia angustifolia* was chosen as herb. However, it was also affected by frost and was taken as annual crop subsequently. This year, a maximum leaf yield recorded was with *A. excelsa*. However, there was not much variation in yields for *A. nilotica* and *C. mopane* at the herb density of 3.8 m². *Psoralea corylifolia* was also sown this year as another important medicinal herb. However, due to no rain after sowing, seeds failed to germinate. Few plants planted from seedlings grew well yielding valuable seeds.

Agroforestry trial : This trial was laid in 1997 with two tree species: *A. nilotica* and *P. cineraria*. Due to drought conditions, the crops (guar and bajra) failed. Among the tree species, although overall survival of *P. cineraria* was greater than *A. nilotica*, its growth was relatively much lower.

Bikaner Site

Experiment 1: Effect of hedge plantation on crop production.

The experiment was started in July 1997 by planting *Zizyphus mauritiana* seedlings at an interval of 2 m in row and at two different spacing of 15 m and 20 m between rows. The objective of the trial was to raise vegetative barrier and to observe its effect on the productivity of crop sown along the hedge. *Dichrostachys nutans* was planted at the same spacing in July 1999. Growth data for the plants were recorded. Agricultural crop viz. *Vigna aconitifolia* was sown in July 1999.

Experiment 2: Studies on sand dune stabilization in Indian desert.

The experiment was initiated in September 1996 with seven species viz. *Acacia nilotica*, *A. senegal*, *A. tortilis*, *Azadirachta indica*, *Calligonum polygonoides*, *Prosopis juliflora* and *Zizyphus mauritiana*, planted at a spacing of 5 x 5 m². Micro-windbreaks were erected using locally available under shrubs viz. *Aerva pseudotomentosa* and *Leptadenia pyrotechnica*, putting them upside down in sand dune in checkerboard design. *Cassia angustifolia* was sown in 1997 for the purpose of nitrogen management in the dune. Performance of tree/ shrub species in the form of growth data was recorded annually. Height and crown diameter data indicated that growth of *P. juliflora* was best whereas *Acacia tortilis* and *C. polygonoides* were the second best species. Performance of the other species viz. *Acacia nilotica*, *Azadirachta indica* and *A. senegal* was not promising. *Zizyphus mauritiana* was medium in growth. Data on biomass indicated that *C. polygonoides* produced the highest biomass, followed by *P. juliflora*.

Experiment 3: The effect of spacing on growth and performance of different tree species.

The experiment was started in September 1996 by planting *Acacia nilotica*, *A. tortilis* and *Azadirachta indica* at different spacing. Maximum survival was recorded in *A. tortilis* followed by *A. nilotica*. The minimum survival in case of *A. indica* was believed to be due to frost and temperature below 0°C.

Experiment 4: Studies on shelterbelt and wind erosion.

The experiment was started in September 1996 by planting different combination of shelterbelt of *Acacia tortilis*, *Acacia Senegal*, *Azadirachta indica*, *Prosopis juliflora* and *Zizyphus mauritiana*.

Rohat Site

Experiment 1: Study on *in situ* run-off in agroforestry.

The experiment was laid in August, 1996, with an aim of observing the effect of in situ run-off collection on plant growth and crop production. *Acacia nilotica*, *Albizia lebbek* and *Azadirachta indica* were planted along the bund and a trench was dug to collect excess run-off water from the cropping area. Growth data were recorded. Pruned and biomass was highest for *A. nilotica* followed by *A. indica* and *A. lebbek*. Data recorded in Feb 2000 indicated that growth of *A. lebbek* was the highest followed by *A. indica*.

Experiment 2: Demonstration trial on Rain water harvesting in different tree species.

The experiment was initiated in the year 1996 with different water harvesting treatments such as control (only pitting), saucers of 2.5 m diameter, bunding in checker board design and trench-cum-mound. The tree species were *Acacia nilotica* (Babul), *Albizia lebbek* (Siris), *Dalbergia sissoo* (Shisham), *Dichrostachys nutans*, *Prosopis cineraria* (Khejri), *Eucalyptus camaldulensis* (Safeda) and *Azadirachta indica* (Neem). At four years of age the influence of water harvesting treatments was more on collar girth of the trees. In general the best treatment was trench and mound. Under this treatment, collar girth was higher in Neem, Babul, Nutans, Khejri, Siris, Shisham and Eucalyptus. The increase in height and growth at this stage was relatively low except in case of shisham.

Jasol Site

Experiment 1: Demonstration of rain water harvesting techniques.

To demonstrate effect of rain water harvesting technique on growth and establishment of tree species a trial was laid in Barmer district in 1995. *Acacia nilotica* and *Dalbergia sissoo* were planted in blocks along with different rainwater harvesting structures. Overall performance of the plants were best where trenches were dug across the land slope to harvest rainwater in between two rows. This was followed by water harvesting pockets and saucers of 1.5 m dia. More growth was registered in terms of collar girth. In case of *Dalbergia sissoo* the increase in growth was 90% and 63% in terms of height and girth respectively compared to control.

Experiment 2: Studies on integrated management of nutrient in the arid zone.

The experiment was laid with 10 treatment combinations and four species. Among the species, best growth performance was recorded in *Acacia nilotica* but no significant variation was observed among different treatments, *Azadirachta indica* responded well to different doses of fertilizers.

Experiment-3: Out planting performance of seedlings raised by different methods.

The experiment was initiated in August 1997. Seedlings of *Acacia nilotica*, *Dalbergia sissoo* and *Azadirachta indica* raised in polybags and root trainers were planted along with direct sowing to compare their growth performance. Water harvesting trenches were dug across the slope as a sub treatment. Though survival was better in case of root trainer raised seedlings, no difference was observed at later stages.

Sl. No. : 5

Project Identification No. : AFRI-8/SILVI-I (PLAN)

Name of the principal investigator: Dr. K.K. Srivastava.

Title of the project : Studies on seed borne mycoflora of selected tree species of arid zone.

Year of the start of the project : 1993.

Target year of completion : March 2000.

Cost of the project: Rs. 40,000/-

Objectives : (a) To isolate and to identify the pathogenic and non-pathogenic mycoflora of *Azadirachata indica*, *P. cineraria*, *Acacia nilotica* and *Tecomella undulata*. (b) To devise pathogenicity test. (c) To test the efficacy of fungicides/plant extracts. (d) To select best treatment in storage to enhance the viability and germination.

Scientific importance of the investigations: Suitable treatment will reduce the infection and enhance the germination percentage and viability of seeds saving cost and efforts on production of planting stock.

Results and Achievements : Pods and seed infection due to *B. theobromae*, *Fusarium solani* and *Alternaria tenuis* was recorded on *T. undulata* plantation in Rajasthan.

Pods and seed infection due to *B. theobromae* and *Colletotrichum* sp. in *A. nilotica* were recorded at canal side plantations of IGNP area.

The non-pathogenic mycoflora viz. *Aspergillus niger*, *Aspergillus flavus*, *Penicillium citrinum*, *Penicillium chrysogenum* and *Mucor* sp. were found on all the tree species.

Pods and seeds of *A. lebbek* were found attacked by *Fusarium* sp. and *Coniella* sp.

On neem, seven pathogenic mycoflora belonging to six species of *Deuteromycotina*, viz. *Curvularia* sp., *Helmithosporium* sp., *Alternaria* sp., *Aspergillus flavus* and *Chaetomium* sp. and one species of *Basidiomycotina* i.e., *Coprinus* sp. were isolated and identified.

Fungicidal treatment with Captof (0.2%) or Foltaf (0.2%) was found very effective against seed borne mycoflora. These fungicides were found very effective when seeds were treated with aqueous solution of these fungicides for 5 minutes.

The bio-efficacy of various plant products i.e. Neem Seed Kernel Power (NSKP), Karanj Seed Kernel Powder (KSKP), Neem Leaf Powder (NLP) and Neem Seed Oil (NSO) were tested against seed mycoflora of neem. Neem seed oil and Neem leaf powder (wet) performed better than other treatments.

Sl. No.: 6

Project identification No.: AFRI-13/FRME-1 (PLAN)

Name of the principal investigator: Dr. Kishan Kumar V.S.

Title of the project: Growth studies on neem in Gujarat State.

Year of start of the project: 1994

Cost of the project : Rs. 2,500/-

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

Scientific importance of investigations: Management of plantations, assessment of site productivity, yield prediction in terms of weight and volume and stand projection.

Results/achievements:

Volume equations as follows were developed:

(i) Double entry equations

$$TW_{ob} = -0.00989 + 0.0000184 * DH + 0.0000438 * D^2H$$

$$TW_{ub} = -0.00564 + 0.0000548 * DH + 0.0000360 * D^2H$$

$$TMob = -0.11512 + 0.000303 * DH + 0.0000195 * D^2 H$$

$$TMub = -0.12078 + 0.000434 * DH + 0.0000119 * D^2 H$$

(ii) Single entry equations

$$TWob = 0.07033 - 0.01387 * D + 0.0009853 * D^2$$

$$TWub = 0.05973 - 0.01176 * D + 0.0007902 * D^2$$

$$TMob = 0.33140 - 0.03578 * D + 0.0010872 * D^2$$

$$TMub = 0.24180 - 0.02716 * D + 0.0008513 * D^2$$

Where TWob and TWub are the total wood volumes over- and under-bark respectively; TM stands for timber wood volume.

Above ground biomass equations were also developed. Equations for dry weights (ob) are:

$$\text{Stem} = 5.923 + 0.017 * D^2 H$$

$$\text{Branch} = -1.394 + 0.477 * D^2 - 0.638 * DH$$

$$TW = 8.690 + 0.036 * D^2 H - 0.360 * H^2$$

$$\text{Leaves \& twigs} = -3.744 + 0.106 * D^2$$

$$\text{Total biomass} = -13.410 + 0.040 * D^2 H$$

Similar equations for under bark dry weights and green weights (both over- and under-bark) have also been developed. The bark biomass equations are:

$$\text{Green bark} = -3.601 + 0.009 * D^2 H$$

$$\text{Dry bark} = -2.719 + 0.006 * D^2 H$$

Sl.No. 7

Project identification No : AFRI-14/FRME-2 (WB3-IV)

Name of the principal investigator: Dr. Kishan Kumar, V.S.

Title of the project : Lopping regime of important arid zone fodder tree species.

Year of start of the project : 1995

Cost of the project : Rs. 13,500/-.

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

Scientific importance of investigations: Optimizing lopping intensities for better growth and sustained fodder yield for *P. cineraria* and *A. excelsa*.

Results/Achievements

Ailanthus excelsa

Complete lopping adversely affected the diameter increment. Lopping as such did not affect the height growth. It was seen that complete lopping is highly detrimental to increment in fodder yield compared

to other lopping intensities. It would be advisable to lop the trees moderately for better fodder yield on sustained basis.

Prosopis cineraria

The study revealed that the degree of lopping as such has no significant effects on the year to year height and dbh growth and fodder yield. Though the three lopping intensities applied did not affect significantly the fodder increment, the practice of successive lopping brought down the annual fodder yield considerably. Hence, a gap of one or two years may be advisable for sustained fodder production and recovery from injuries, if any, during lopping. Lower two third crown should be lopped leaving upper one third for producing nutrients for the trees until new leaves emerge.

Sl. No.: 8

Project identification No : AFRI-15/FRME-3 (RD)

Name of the principal investigator: Dr. Kishan Kumar V.S.

Title of the project : Sand dune stabilization and spacing/species trial at Churu.

Year of start of the project : 1996

Target year of completion : March 2000 (extension for 3 years applied under NFRP).

Cost of the project: Rs. 3,32,500/-

Objectives: (a) To study the effect of spacing on the growth of *Prosopis 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 different species on a sand dune.

Scientific importance of investigations: Technology for sand dune stabilization will be available.

Results/Achievements:

Spacing trial: *Acacia nilotica* showed maximum height increment followed by *Prosopis cineraria* and *Tecomella undulata* till Sept. 1999.

Sand dune stabilisation with a new design: This trial was laid out in July 1997. The plants attained an average height of 108.5 cm and the survival was recorded to be about 61%.

Species trial on sand dune: The trial involving *Dichrostachys nutans*, *Acacia planifrons* and *Zyziphus nummularia* laid out in July 1997. The average heights attained by these spp. were 16.8 cm., 91.1 cm and 35.1 cm respectively. Survival of *A. planifrons* was highest at 48.3%.

Sl. No.: 9

Project identification No : AFRI-18/FP-1 (PLAN)

Name of the principal investigator: Dr. S.I. Ahmad

Title of the project: Morphology, bionomics and control of Rohida defoliator, *Patialus tecomella* Pajni *et al.*, (Coleoptera: Curculionidae).

Year of start of the project: 1994

Cost of the project: Rs. 68,900/-

Objectives: (a) To ascertain the correct identity of the key pests of Rohida. (b) To prepare a checklist of insect and non-insect pests associated with Rohida. (c) To carry out detail morphology and bionomics of key defoliator *P. tecomella*. (d) To work out the most resistant rohida provenances to *P. tecomella* attack. (e) To evolve integrated pest management strategies against *P. tecomella*.

Scientific importance of investigations: The project will provide scientific and reliable database to detect and predict pest attack. Economically viable and environmentally compatible management strategies will be available.

Results/Achievements : A checklist containing 64 insect pest species on Rohida (*Tecomella undulata*) including 24 new pest records has been prepared. It was ascertained that the key defoliator, *P. tecomella* belongs to a new species *tecomella* under a new genus *Patialus* and sub-family Cioninae of the family Curculionidae. Detailed morphological studies comprising structure of head, appendages of head capsule, thorax, thoracic appendages, abdomen, its appendages and genitalia completed. Bionomical studies on *P. tecomella* comprising effect of abiotic factors and food supply on (i) life stages (ii) population dynamics (iii) larval crowding (iv) longevity and survival (v) attraction of weevil to different light colours etc. were completed. Resistance studies revealed that the Rohida provenance from Bhaislana and Osian had least preference for the larval feeding whereas Ratangarh provenance was the most favoured host for *P. tecomella*. Bioassay of 10 different conventional pesticides and 4 botanical products were carried out against *P. tecomella*. Efficacy of the pupal parasite, *Billea atkinsoni* had been worked out. Experiments on the chemical control of *P. tecomella* using various conventional insecticides were completed. Monocrotophos was found to be most effective against the pest.

Sl. No. 10

Project identification No : AFRI-19/FP-2 (PLAN)

Name of the principal investigator : Dr. S.I. Ahmad

Title of the project: Bio-ecology and management of insect pest of *Prosopis* spp., with special emphasis on gall forming insects in Indian Thar desert.

Year of start of the project : 1994

Cost of the project: Rs. 68,900/-.

Objectives: (a) To carryout the survey, collection and identification of major insect pests of *Prosopis* spp. (b) To study the biology and population dynamics of gall forming insects. (c) To study the morphology and histopathology of different types of galls in *P. cineraria* (d) To evolve integrated pest management methods to control gall forming insects.

Scientific importance of investigations: The project will result in better management of pests problems of *Prosopis* spp.

Results/Achievements : A checklist comprising 153 insect and non-insect pests of *Prosopis cineraria* and *P. juliflora* has been compiled. 15 species of new pest records belonging to 6 insect orders have been established. The gall inducing agents in *Prosopis cineraria* viz; rachis gall midge *Contarinia prosopidis* (Cecidomyiidae); stem gall wasp *Eurytoma settitibia* (Eurytomidae); and leaf and inflorescence gall mite, *Eriophyes prosopidis* (Eriophyiidae) have been confirmed. Detailed investigations on the biology and population dynamics of gall inducing insects/mites have been completed along with parasitism of larval parasites of these agents. In lopped trees the percentage of gall formation per inflorescence was minimum

and production of pod was recorded. In unlopped trees the percentage of gall formation was maximum and resultant pod production was minimum. The higher pod production and lesser formation of galls in lopped trees were because of the minimum infestation of gall mite attack.

Sl. No. 11

Project identification No.- AFRI-20/FP-3 (PLAN)

Name of the principal investigator: Smt. Seema Kumar.

Title of the project: Studies on seed pest of forest tree species in arid and semi-arid region.

Year of start of the project : 1996

Cost of the project:. Rs. 68,900/-

Objectives : (a) Taxonomic identification of important seed pests. (b) To screen the seeds for pest infestation under storage. (c) To study the host range of economically potential pests. (d) To study the population biology of important seed pests. (e) To standardize the control measures.

Scientific importance of investigations: The findings will be useful to various concerned agencies and society at large in carrying out dis-infestation and safe storage of seeds at a low cost.

Results/Achievements: Seeds of *Prosopis cineraria* were collected from selected localities and kept for emergence of insect pest species. Three species of Bruchids and one species of lepidoptera borer were found damaging the seeds. The Bruchids were identified as *Caryedon serratus*, *Caryedon prospidis* and *Bruchidius albizziae*.

Infestation upto 95% was observed in the seeds. The lepidoptera borer is yet to be identified. Sap sucker *Oxyrachis tarandus* was recorded damaging green pods of *Prosopis cineraria* and *Prosopis juliflora* in the field.

Screening of seeds in storage revealed the infestation of *Caryedon* sp. in the seed of *Acacia nilotica*, *Prosopis cineraria* and *Bruchidius albizziae* in the seeds of *Albizia lebbek*.

Sl. No. : 12

Project identification No : AFRI-23 NWFP-1 (PLAN)

Name of the principal investigator: Dr. Y.C. Tripathi

Title of the project : Studies on fatty oil of some important oil bearing plants of arid regions.

Year of start of the project: April, 1995

Cost of the project: Rs. 1,55,421/-.

Objectives: (a) To survey the oilseed potential of arid regions. (b) To identify high oil yielding provenance for collection of good quality seeds for large scale propagation of plant species. (c) To screen out arid zone flora for further sources of fatty oils. (d) To carry out qualitative studies of oil of various species to ascertain their industrial suitability.

Scientific importance of investigations: The project will identify higher oil yielding varieties and best areas for oilseeds production. New sources of fatty oils would further augment the total production of oils in the country.

Results/ Achievements: Oil extracted from *P. pinnata* seeds of different agro-climatic zones of Rajasthan were studied for their physio-chemical properties. A remarkable variation in all these characteristics of oil from seeds of different origins was recorded.

The constituent fatty acids were identified by direct comparison with authentic specimen after hydrolysis of oil samples and their percentage compositions were determined by GLC analysis of their methyl esters. The percentage composition of fatty acids showed considerable variation indicating the qualitative difference in oils from seeds of different origins.

Fungal species have been isolated and identified from infested *P. pinnata* seeds collected from three different localities namely Bikaner, Banswara and Tonk of Rajasthan State. The percentage infestation and its effect on oil content, oil quality, crude protein and carbohydrate contents were determined. Considerable weight loss, decline in content of oil, protein and carbohydrate were observed in infested seeds. Free fatty acid and saponification values of oil from infested seeds were increased whereas iodine value showed a sharp decline compared to the healthy seeds.

The seeds of various exotic Acacias (*Acacia ampliceps*, *A. victoriae*, *A. colimus* and *A. adsurgens*) and other indigenous species viz. *Acacia nilotica*, *Sesbania sesban*, *Prosopis cineraria*, *Citrullus colocynthis*, *Capparis deciduas* and *Cleome viscosa* etc. were powdered and then solvent extracted for their fatty oil. Various physico-chemical constants viz. refractive index, density, acid value, saponification value and Iodine value were determined for the extracted oils. The oils were further saponified and then esterified and the resulting methyl esters analysed by gas liquid chromatography.

Sl. No.: 13

Project identification No : AFRI-24/NWFP-2 (PLAN)

Name of the principal investigator: Dr. Y.C. Tripathi

Title of the Project : Study on the Biocidal Activity of Extractives of Arid Zone Plants.

Year of start of the project : April, 1995.

Cost of the project: Rs. 1,55,421/-

Objectives: To study the biocidal efficacy of various arid zone plant species so as to develop eco-friendly plant based pesticides.

Scientific importance of investigations : A number of plants can act as sources of pesticides and be used successfully for the eradication of diseases and against insect infestations without adding to any kind of pollution. This project will identify such plants.

Results/Achievements : The efficacy of total as well as sequential methanolic extracts of different parts of *Capparis decidua* have been tested against the aphid *Lipaphis erysimi* (Aphididae: Homoptera), an important pest of cruciferous plants. The total methanolic extracts of all the parts have shown significant activity and the order of the efficacy was found as root > seed > bark > branch > wood.

Methanolic extract of roots of *C. decidua* was studied for its antifeedant activity against *Streblote siva*, the babul defoliator. The results of the study showed promising antifeedant activity in the root extract of the plant.

100% antifeedant activity has been recorded with NSKP methanolic extract against all the stages of larvae of *Noorda blitealis*, the Moringa defoliator. The effect of Neem Seed Oil (NSO) on the growth of

Acaudaleyrodes rachipora, the babul whitefly, on *Acacia* seedlings was studied. A few concentrations were found effective in suppressing development of whitefly significantly.

Extracts of different parts of some other plants namely *Psoralea corylifolia*, *Balanites aegyptiaca* and *Dicoma tomentosa* were tested. Their biocidal efficacy was encouraging.

Sl. No : 14

Project identification No: AFRI-32/SF-1 (UNDP)

Name of the principal investigator: D.G., I.C.F.R.E. and Head, Social Forestry Division

Title of the project: UNDP project.

Year of start of the project : 1992

Cost of the project: Rs. 32.43 lakhs

Objectives: The main objective 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 impart new skills and knowledge to people.

Scientific Importance of investigations: The research results in specific area of forestry such as tree improvement programme, provenance trials, vegetative propagation, tissue culture, bio-fertilizer etc. will be of immense use for various target groups.

Results and Achievements : Most of the farmers in 10 selected villages wanted to plant trees only in courtyard/ homesteads. Socio-economic survey was conducted in the beginning in all the ten villages and information on relevant parameters like population, cattle population, literacy percentage, demand/supply of timber, fuel wood, fodder and choice of species were collected. About 51700 seedlings were planted in the selected villages. The preferred spp. are grafted ber (*Zizyphus* spp.), *A. indica*, *D. sissoo*, *A. nilotica*, *A. lebbek*, *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 institute-level) were organized. 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 was revealed that women and children were more enthusiastic in tree planting activity and their participation in training was more than adult male folk.

OLD PROJECT CONTINUED DURING 1999-2000

Sl.No : 1

Project identification No : AFRI-5/FEDD-5(WB.1-1)

Name of the principal investigator: Dr. G. Singh

Title of the project: Woody Plant Water Relations.

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

Year of start of the project: July 1998

Target year of completion : December 2001

Cost of the project : Rs. 63,621/-

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.

Scientific importance of investigations: The effective use of sewage water for biomass production under arid conditions will enhance the productivity. It will save drinking water.

Results/Achievements

Experiment 1: To screen tree species for efficient water use and growth under arid conditions.

Seedlings of *E. camaldulensis*, *D. sissoo* and *A. nilotica* were planted in July 1998 in an infilled non-weighing type of lysimeter, so that a complete water balance could be obtained for each species. Five treatments were applied. Growth and physiological parameters were recorded monthly for all the three species. Seedling growth of all the species decreased with increasing water stress level. Further, there were significant decreases in rate of photosynthesis and increase in stomatal resistance with decrease in water availability.

Experiment 2: To study the effect of varying level of sewage water on the growth of the plants.

The experiment was started with the aim of using the locked up nutrients in sewage water and to decrease water pollution due to uncontrolled discharge into the water bodies. Further, for the reuse of sewage, *Eucalyptus camaldulensis*, *Dalbergia sissoo* and *Acacia nilotica* were planted in July 1998, in the infilled non-weighing type of lysimeter, to observe nutrient balance in total through biomass production and accumulation of nutrients in soil and plants. Five treatments were applied. Growth and physiological parameters were recorded on monthly intervals. Growth of the plants increased with increasing quantity of sewage water. At the end of one year, plant and soil samples were analyzed to obtain the net accumulation of nutrients in soil as well as in plant foliage. However, the data to obtain total nutrient balance will be recorded only after harvesting/biomass recording and analyses of soil and plant samples at the end of the experiment. The foliar analysis data indicated that accumulation of Cu and Zn increased with increasing quantity of sewage water whereas that of Fe decreased.

Sl.No : 2

Project identification No: AFRI-6/FEDD-6 (WB.1-II)

Name of the principal investigator: Dr. Ranjana Arya

Title of the project: Screening of exotic and indigenous plant species for their performance on salt affected soil.

Year of start of the project : 1997

Target year of completion : December 2003

Cost of the project : Rs. 2,53,515/-

Objectives: (a) To screen different exotic and indigenous plant species for their growth performance on the salt affected soil. (b) To find out the optimum levels of gypsum and nitrogen to optimize productivity. (c) To find out the effect of plantation on soil properties in terms of physico-chemical changes and vegetation status.

Scientific importance of investigations: Utilization of salt affected areas has become necessary owing to increasing need for fodder, fuel and other minor produce. There is a need to find out new species which can

perform on these areas and also to find out suitable packages of planting practices to increase the production from these lands. The study is an attempt in both the directions.

Results/Achievements

Trial laid in 1997

Bushes of *Atriplex lentiformis* were cut to a uniform height of 60 cm to estimate the fodder yield in May 1999. However, the treatment effect was not significantly different due to deficient monsoon in 1998. The growth recovery of bushes was poor due to complete failure of monsoon in 1999. Vegetation studies were carried out. 14 species were recorded in monsoon followed by 9 in winter and 2 in summer. Ash content of leaves was significantly affected by weather and was minimum in summer compared to winter and monsoon. *Salvadora persica* attained increase in height and crown diameter with maximum value of 151 cm height and 120 cm of crown diameter. All the treatments resulted in increase in height.

Trial laid in 1998

Survival of *Acacia ampliceps* laid with two treatments of control and full gypsum requirement was recorded in March 2000 at the age of 18 months. While the gypsum treated plants recorded 67.5% survival it was 58% for control. There is decrease in survival percentage for both the treatments as compared to March 1999 due to monsoon failure.

Trial laid in 1999

Two new trials were laid in Sept 1999. First was a trial of *A. lentiformis* with three treatments of gypsum planted on double ridge mounds, a technique first time tried in India for partially water logged salt affected lands. Trial was designed with 3 gypsum and 7 nitrogen levels from two sources of nitrogen. However, nitrogen treatments were not imposed due to monsoon failure. The height and crown dia recorded at five months of plantings showed no effect of gypsum treatments. The second trials was laid with different method of plantings for *Acacia coleii* with two doses of gypsum. However, survival was only 25% due to completed drought.

Sl.No.: 3

Project identification No : AFRI-7/FEDD-7(WB.2-II).

Name of the principal investigator: Dr. Ranjana Arya

Title of the project: To screen various plant species for high yielding Commercial forestry under irrigated condition in Indian arid zone.

Year of start of the project : July 1995

Target year of completion : December 2001

Cost of the project : Rs. 36,119/-

Objectives: (a) To find out the best performing commercially important plant species under irrigated condition in arid zone. (b) To study the effect of VAM biofertilizer on establishment and growth of plant species. (c) To study the effect of commercial irrigation on the soil properties.

Scientific important of investigations: Water is the most important factor for plant growth and the soils in arid zone are poor in nutrition. Studies are essential to find the optimum doses of biofertilizer and inorganic fertilizer to increase the growth.

Results/Achievements: After 48 months of growth, *Eucalyptus camaldulensis* attain the maximum average height (658 cm) followed by *Acacia nilotica*, *Dalbergia sissoo* and *Tectona grandis*. However, crown dia was maximum for *A. nilotica* followed by *D. sissoo*, *E. camaldulensis* and *T. grandis*. DBH was nearly equal for both *A. nilotica* and *E. camaldulensis*. A study to record the per cent moisture before and after irrigation was carried out for all the four species.

Soil was analyzed for organic matter content. There was either no change or slight decrease in values, 3 years after plantation. Soil pH was also analysed and it registered an increase in all the three layers but was appreciably higher for middle layer (25-50 cm) at a distance of 40 cm from tree trunk. Complete monsoon failure has affected the overall plant growth despite increasing the irrigation quantum to 90 mm from Nov. 1999.

Sl. No. 4

Project identification No : AFRI-9/SIL/VI-2(WB-2-IV)

Name of the principal investigator: Dr. K.K. Srivastava

Title of the project : Irrigation Water Management for Tree species.

Sub-Project: Studies on VAM association in irrigated plantations and Agro-forestry systems.

Year of start of the project : 1992

Target year of completion : 2001.

Cost of the project : Rs. 55,226/-

Objectives: (a) To identify different VAM fungi associated with tree species growing in irrigated plantations and agro-forestry systems in arid zone of Rajasthan. (b) To determine the dependency of different arid and semi-arid tree species on VAM fungi. (c) To develop protocol for mass inoculum production. (d) To select efficient strains of VAM fungi. (e) To study the influence of VAM fungi with *Rhizobium* on leguminous tree species.

Scientific Importance of investigations: The soil of arid zone area is low in nutrient minerals. VAM fungi play a key role in providing nutrients like N, P, Zn & Cu from the soil in insoluble forms to soluble form to the plants. In high pH and water stress conditions, VAM inoculated plants can perform better because they have the tolerance against adverse conditions. Economically bio-fertilizers are cheaper and more feasible in forestry sector.

Result and Achievements:

Selection of efficient strains of VAM fungi : An experiment on selection of efficient strains of VAM fungi was laid out with various tree species namely *Prosopis cineraria*, *Eucalyptus camaldulensis*, *Acacia nilotica* and *T. undulata* in nursery with four treatments and four replications. The observations were recorded bimonthly. The final observations on shoot height and biomass revealed that all the treatments were effective compared to un-inoculated plants.

Selection of best host for VAM inoculum production: The experiment was laid out to select best host for mass multiplication of VAM inoculum. The rhizosphere soil collected from *P. cineraria* plantations were used for mass multiplication of VAM inoculum. The various hosts used were *Cenchrus ciliaris*, *C. setigerus*, *Zea maize*, wheat and onion. The final observations revealed that *C. ciliaris* was best host for mass multiplication followed by *C. setigerus*, *Zea maize*, Wheat and Onion.

Performance and economics of VAM, Neem shield and SPM on arid zone tree species: A new experiment was laid out to see the performance and economics of VAM fungi, neem shield and Standard Potting Mixture (SPM) on *P. cineraria* and *D. sissoo* in nursery. The experiment is in progress.

Survey of *A. nilotica* plantations for VAM population studies: Survey for VAM populations in *A. nilotica* was carried out at Himatnagar and Palanpur in South Sabarkantha Division (Gujarat). The rhizosphere soil was found rich in VAM population with the spore density of 686 & 652 spores /100 gm soil from Himatnagar and Palanpur respectively.

Sl. No: 5

Project identification No: AFRI-10/SILVI-3/(PLAN)

Name of the principal investigator: Dr. K.K.Srivastava

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

Year of start of the project: 1993.

Target year of completion: 2005

Cost of the project : Rs. 30,200/-

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 disease. (d) To find out important diseases and evolve their management.

Scientific importance of the investigations: Timely diagnosis and suitable management is (fungicidal or silvicultural) necessary to control diseases. This project will evolve suitable management practices to control diseases.

Results and Achievements: Mortality in *D. sissoo* plantation was recorded at Khatu Shyam ji roadside plantation, Sikar. The factors involved in mortality were moisture deficiency and lack of taproot development. Due to faulty irrigation, side roots developed vigorously. Sudden stoppage of irrigation and drought of previous years contributed to large-scale mortality. Few trees raised near the agricultural field were severely attacked by root rot disease due to injury caused by ploughing in agricultural field. Partially affected trees were recommended for soil drenching with Bavistin 0.1 @ 5lit/tree.

Large-scale mortality of Khejri (*P. cineraria*) trees was recorded in Nagaur-Kuchaman area. Partially affected trees were suffering from die back phenomenon. Secondary infection of insect pest, was also recorded. Prophylactic treatment with Chaubattia paste was recommended after removing diseased portion.

Recently, large-scale mortality was recorded on neem cuttings raised in mist chamber. The fungus was isolated and identified an *Nectria* species belonging to *Ascomycetes* group. For confirmation, the samples have been handed over to Forest Pathology Division, FRI, Dehra Dun. This fungus is recorded for the first time on neem cuttings.

Sl. No.: 6

Project identification No: AFRI-16/FRME-4(WB.2-III)

Name of the principal investigator: Dr.V.P. Tewari.

Title of the project: Growth and yield studies in irrigated plantations of IGNP area.

Year of start of the project : 1995

Target year of completion : March 2001

Cost of the project : Rs. 34,000/-

Objectives: (a) To study the growth performance of *Eucalyptus camaldulensis* and *Dalbergia sissoo* planted under integrated conditions in IGNP area (b) Preparation of volume tables and site-index equations for these two species.

Scientific importance of investigations: Management of plantations, assessment of site productivity, yield prediction, stand projection and growth modeling will be carried out.

Results/Achievements: Various non-linear models based on exponential function are being tried for developing allometric relationship between various growth parameters of the two species.

Sl. No.: 7

Project identification No: AFRI-21/FP-4 (PLAN)

Name of the principal investigator: Dr. S.I. Ahmad

Title of the project: Integrated Pest Management of Forest Insect pests.

Year of start of the project: 1996

Target year of completion: 2002 (Included in NFRP for further continuance).

Cost of the project : Rs. 68,000/-.

Objectives:

Component-I: Evaluation of biopesticidal efficacy of some arid zone plant species.

Component-II: Survey and evaluation of natural enemy-complex of Rohida, Babul and Khejri insect pests.

Component III : Screening and bioassay of conventional insecticides against key pests of Rohida and Babul viz. *P. tecomella* and *Taragama siva*.

Scientific importance of investigations: Utilisation of plant origin phytopesticides will help in minimising the frequent use of chemical insecticides.

Results/Achievements

I. Efficacy of Phytopesticides :

Efficacy of methanolic extracts of different parts (root/bark/wood/seed) of *Capparis decidua* have been evaluated against the aphid *Lipaphis erysimi* (Aphididae: Homoptera), an important pest of Cruciferous plants. The extracts were tested in various concentrations against the aphid (adult) and the mortality was recorded after 24 and 48 hours. The efficacy of extracts of *C. decidua* was found as root > seed > bark > wood.

Bio-efficacy of methanolic extracts of roots of *C. decidua* was tested against babul defoliator at different concentration. The suspension showed a highly significant efficacy in controlling the pest.

Extracts of different parts of *Psoralea corylifolia* were tested against *Patialus tecomella*. Preliminary studies conducted so far show encouraging results on biopesticidal activities of *P. corylifolia*.

II. Efficacy of parasites:

Efficacy of potential pupal parasite (*Billea atkinsoni*) of Rohida defoliator (*P. tecomella*) was worked out. Maximum parasitism was observed during September whereas minimum in January. Detailed biological studies on potential parasites viz; *Billeae* sp. (Diptera: Tachinidae), *Eupelmus* sp. *Tetrasticus spirabilis* (Eulophidae: Hymenoptera) have been completed. 19 species of parasites, 13 species of predators and 3 species of entomopathogens of gall forming insects of *P. cineraria* were collected and identified. *Carcelia huitenzogensis* was the most effective larval parasites of *T. siva* causing 30-40% natural parasitism.

III. Efficacy of entomopathogens

The potential of the Entomogenous fungus, *Beauveria bassiana* against the Rohida defoliator (*P. tecomella*) was worked out. 3.5×10^6 spores/ml was the most effective concentration to cause rapid kill of adult weevils.

Natural epizootics of Nuclear Polyhedrosis Virus (NPV) of *Taragama siva* caused 70-80% larval mortality.

Studies on insect virus interaction comprising i) natural incidence; ii) artificial infection; iii) estimation of PIB/larva (3.44×10^9); iv) cross infectivity test and nature of virus were carried out, completed and findings were published.

Sl. No.: 8

Project identification No -AFRI-22/FP-5 (PLAN)

Name of the principal investigator: Smt. Seema Kumar

Title of the project: Studies on the Pest Problem in forest nurseries and their management in arid and semi-arid region.

Year of start of the project:- 1994

Target year of completion – 2003 (Included in NFRP for further continuation).

Cost of the project : Rs. 68,000/-

Objectives: (a) To collect and identify important pests in forest nurseries. (b) To study the host range of economically potential pests and their management. (c) To study the population biology of important pests of nurseries. (d) To standardize the control measures.

Scientific importance of investigations: Economically viable and environmentally compatible pest management strategies will be evolved.

Results/Achievements : Surveys of selected forest nurseries were carried out and the pests of different forest tree species preserved and identified. Outbreak of *Myllocerus laetivirens* on *Acacia nilotica* and *Moringa oelifera*; *Myllocerus dalbergiae* on *Dalbergia sissoo* and leaf binder, *Laspeyresia* sp. on *Azadirachta indica* were recorded. Fourteen insect pests, two molluscs and two mites were found damaging twelve tree species.

Eco-biology and host range of *Macrochlamys indica* was studied

A checklist of insect pests of forest nurseries in arid region has been compiled. Literature updating was done and a bibliography on forest nursery pests in India with reference to arid zone was prepared.

Sl. No.: 9

Project identification No: AFRI-25/NWFP-3/(PLAN)

Name of the principal investigator: Dr. Mala Rathore

Title of the project: Studies on the proteins of arid zone shrubs and trees for their potential as food and fodder.

Year of start of the project: April 1995

Target year of completion: March 2005

Cost of the project: Rs. 1,55,421/-

Objectives: (a) To select potential plants (shrubs and trees) as protein sources. (b) To determine the protein contents of different parts viz. seeds, leaves, branches of trees, shrubs, and herbs of arid zone. (c) To prepare and investigate the leaf protein concentrates as unconventional source of fodder.

Scientific importance of investigations: The value of shrubs and tree fodder is considerable in meeting nutrient needs and maintaining the productivity of ruminant populations. The use of plant leaves as possible sources of protein is one of the possibilities. In case of non-ruminants and man, leaf protein can make a useful contribution to the diet, more so if concentrated. Leguminosae is the first largest family among the dicots found in the arid region. As legumes are the best sources of easily extractable and good quality protein, the desert flora of this family will be explored for its potential as source of food.

Results/Achievements: In continuation to the work on preparation of LPC, further plants viz. *Anogeissus pendula*, *Cassia siamensis*, *Solanum nigrum* and *Datura metel* were selected and LPC prepared. The precipitation temperatures on heating were determined. Crude protein was determined of oilseed meals of various exotic Acacias and of *Pongamia pinnata* seeds collected from various provenances of Rajasthan. The CP of oilseed meals of *Pongamia pinnata* seeds from Sirohi was highest and those from Ajmer were lowest. CP of different leaves and their LPC were also determined. *Withania somnifera* and *Solanum nigrum* proved to be good sources.

Sl. No.: 10

Project identification No : AFRI-26/FGTB-1 (WB.3-I)

Name of the principal investigator: C.J.S.K. Emmanuel

Title of the project: Provenance trials on *Acacia nilotica* and *Ailanthus excelsa*.

Year of start of the project: 1991

Target year of completion: December 2001

Cost of the project : Rs. 3,21,473/-

Objectives: (a) To screen the available geographic variation for timber yield. (b) To screen the available geographic variations for higher fodder yield.

Scientific importance of investigations: To achieve maximum gains from a plantation, it is important that the material selected should be best suited to that particular site. The selections made after conducting these trials are supposed to give maximum gains in terms of the end product.

Results/Achievements: In 1997, seeds were collected from 45 seed sources of *Acacia nilotica* from all over India. The data have been recorded on seed parameters and seedlings have been raised for laying out field

trial. The data on growth parameters on the seedlings in the nursery stage have also been recorded. Seedlings have been raised from this material and transplanted in the field at six different research stations of the State Forest Departments. Observations are going on.

Sl. No.: 11

Project identification No : AFRI-27/FGTB-2 (PLAN)

Name of the principal investigator: C.J.S.K. Emmanuel

Title of the project: International Neem Network Provenance trial.

Year of start of the project: March 1995

Target year of completion: December 2005

Cost of the project : Rs.1,18,452/-

Objectives: (a) To screen out provenances for growth. (b) To screen out provenances for azadirachtin content. (c) To screen out provenances for oil content. (d) To study isozyme patterns of different provenances. (e) To make crosses between promising provenances for higher oil and adaptability purposes. (f) To select Plus Trees and establish Seedling Seed Orchards. (g) To improve the genetic quality and adaptability of Neem and to improve its utilisation.

Scientific importance of investigations: Planting stock with improved qualities will be available.

Results/Achievements: The International provenance trial on neem was initiated by the FAO Neem Network and the seeds were exchanged between the participating countries during 1995. The field trials have been laid out during July - August 1996 at Jodhpur, Jaipur, Jabalpur and Coimbatore, with 18 provenances including control. The International trial at Jodhpur is progressing well and the maximum height is up to 4.54 metres from Sunyani and collar diameter is 28.7 cms from Tibbi Laran. The best performers are Sunyani and Myanmar. Among the Indian provenances Sagar is the best with a height of 2 metres and the girth is best for Jodhpur 14.16 cms. The performance at Jaipur is also good and the mean height varies from 1.60 metres to 2.72 metres and collar dia. from 8.0 cms to 17.50 cms.

Sl. No. : 12

Project identification No : AFRI-28/FGTB-3/(PLAN)

Name of the principal investigator: C.J.S.K. Emmanuel

Title of the project: Provenance trial on Arid Zone species.

Year of start of the project: March 1992

Target year of completion: March 2002

Cost of the project : Rs. 28,432/-

Objectives: (a) To find out the promising provenance for growth. (b) To find out the promising provenance for adaptability. (c) To utilize the best provenance for Plant Improvement work.

Scientific importance of investigations: The selections made after conducting these trials will result in easy availability of better planting stock.

Results/Achievements:

NEEM: The provenance trial of *Azadirachta indica* with 39 seed sources from all over India was laid out in 1992. The growth data collected so far indicates that no single provenance has given good result consistently. This year the Kanpur provenance is superior in growth followed by Gandhinagar (Gujarat) and Ravinagar (Maharashtra). Controlled crosses were made between *A. indica* and *A. siamensis*.

ROHIDA: The provenance trial of *Tecomella undulata* was planned in the year 1992 with 13 seed sources from Rajasthan. The growth data collected so far indicates that the Sunderpur bir (Sikar) is superior in growth followed by Nagaur and Bhaislana (Jaipur).

SHISHAM: Provenance trial for *Dalbergia sissoo* has been laid out in August 1995 with the seeds sent by FRI, Dehra Dun in the year 1994. The trial consists of 13 provenances with 3 replications and 6 plants in each line at a spacing of 4 x 3 metres. The line design was chosen considering low number of plants in each provenance. Thirteen provenances were used in the trial viz. Agra, Kasganj, Rudrapur, Lalitpur, Etawah, Raikhera, Rampur, Pratapgarh, Allahabad, Lakhimpur Kheri, Mohangarh, Jodhpur and Pilibhit. Pilibhit provenance has shown best result followed by Rudrapur and Mohangarh. The local provenance has not given good result.

Sl. No.: 13

Project identification No : AFRI-29/FGTB-4 (WB.3-II)

Name of the principal investigator: Dr. U.K. Tomar

Title of the project: To develop vegetative propagation technique for *Acacia nilotica* and *Ailanthus excelsa*.

Year of start of the project : 1994

Target year of completion: Dec. 2001

Cost of the project : Rs. 23,000/-

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

Scientific importance of investigations: *A. nilotica* and *A. excelsa* are two species which are difficult to be propagated through vegetative means. In the case of *A. excelsa*, there is not even a single report available on this subject. While some reports are available on vegetative propagation of *A. nilotica*, success in rooting is reported very poor and hence these techniques are not useful for propagation purposes. Therefore, clonal propagation techniques developed for both the species will be very useful in vegetative propagation.

Results and Achievements

Acacia nilotica:

Different durations of IBA treatments were given to stem cuttings. Maximum of 15% rooting was observed when cuttings from adult trees were treated with 5000 ppm IBA solution for 30 seconds (Just dip). Stem cuttings of different thickness were raised in the month of October. Maximum rooting (20%) was observed in the 3-5 cm thickness class. Effect of cut at different places was also studied in stem cuttings but no significant differences were observed in rooting percentages. Plants raised through cuttings were shifted to poly bags for hardening. After three months of hardening, vegetatively raised plants were transferred to field. Further observations are being made.

Ailanthus excelsa:

Stem cuttings were prepared from seedlings (1 and 2 years old), and 5- 8 years old tree and treated with 1000 ppm IBA. Maximum 80% rooting was achieved from one-year-old and 40% from two-year-old seedlings after 30 days of growth in mist chamber conditions. Branch cuttings did not root. Stem of the saplings (2-year-old) was divided in to three parts i.e. upper part (UP), middle part (MP) and basal part (BP). In this experiment each type of cuttings were treated with various IBA, ppm concentration 500, 1000, 1500 only and 2000 ppm IBA. Maximum 40% rooting was recorded in cuttings from middle. Sprouting was observed only from cuttings of lateral branches of mature tree. Cuttings prepared from coppice shoots rooted with very low frequency on 1000 ppm IBA treatment.

Sl. No.: 14

Project identification No : AFRI-30/FGTB-5 (WB.3-III)

Name of the principal investigator: Dr. U.K. Tomar

Title of the project: To develop tissue culture technique for *Acacia nilotica* and *Ailanthus excelsa*.

Year of start of the project : 1994

Target year of completion : Dec. 2001

Cost of the project: Rs. 24,000/-

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

Scientific importance of investigations: Tissue culture techniques are powerful tools not only for clonal forestry but also for genetic engineering. In case of *A. excelsa*, there is not even a single research publication available on micropropagation. Whereas some publications are available on tissue culture of *A. nilotica*, success is reported only from seedling explants. Micropropagation of mature trees is still difficult. Therefore, in both the species micropropagation techniques are required to be developed.

Results and Achievements:

Acacia nilotica

Shoot multiplication rate remained very poor. Addition of glutamine increases the multiplication rate up to 3 fold. Cultures are being maintained for the last one and half years by repeated subculturing on shoot multiplication medium. Various rooting media with different auxins were tried. MS 1/2 with IBA proved best for rooting (70%). *In vitro* rooted plants of *A. nilotica* were transferred to polybags in mist chamber for hardening. These plants survived up to two weeks only.

Ailanthus excelsa

With a view to reducing the cost of the medium, different grades of sucrose were added individually in MS medium. Sugar cubes, a cheaper source of sucrose was found equally good as HiMedia sucrose. Single stem nodal segments were placed on MS medium in two orientations, horizontally and vertically. The vertical orientation was found favorable for shoot multiplication and shoot elongation. Maximum 15-fold shoot multiplication and 1.6 cm shoot elongation was observed on MS + 2 mg/l BA medium. Among the auxins tried, rooting (50%) occurred on MS + 1.5 mg/l NAA medium. Addition of 18.4 mg/l Mannitol in the MS medium caused early rooting. Rooted plantlets were transferred in plastic cups containing soilrite and kept in growth

chamber. Initially humidity was maintained at 90% and it was reduced after every week to 60% within one month. After one month the plantlets were transferred in polybags containing compost as potting mixture and kept in polyhouse. A poor survival (10%) was recorded during the hardening stage. Plants grew rapidly in polyhouse conditions and in compost soil mixture. After 2 weeks plants were shifted to shade house where they grew well.

Sl.No : 15

Project identification No: AFRI-33/SF-2 (NABARD)

Name of the principal investigator: D.G., ICFRE and Head Social Forestry Division

Title of the project: NABARD Project.

Year of start of the project : 1995

Target year of completion: 2000-2001

Cost of the project : Rs. 31.5 lakhs

Objectives: (a) To study the performance of different silviculture and horticulture species with different spacings, 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 and pastoral (grasses) with different spacing in silvi-pastoral model. (d) To study the growth and productivity in agri-silvi model. (e) To introduce bio-fertilizers 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.

Scientific importance of investigations: Best/most suitable model will be given wide publicity for adoption by user agencies such as farmers, NGOs, Forest Departments etc. It is expected to bring more area under tree cover which will not only give employment to the rural poor but also improve the productivity of the land in arid areas.

Results and Achievements/progress made: Under NABARD project, 21335 seedlings have been planted in different -agroforestry models in the selected microwatersheds. However, the survival of these seedlings on the farmer's fields is poor in some of the models due to monsoon failure in two consecutive years (1998 and 1999), uncontrolled grazing and severe blue bull menace. But in some of the models like agri-silvi-horti in Kudi, agri-silvi and silvi-pastoral in Sangariya and silvipastoral in Jaleli, the survival percentage is fairly high (50-60%). These models will be utilized for data generation and drawing inferences regarding suitability of agroforestry models. Casualty replacements have been carried out. Periodic data such as growth of tree species (height & girth), yield of crop and grain yield are being recorded from time to time.

Bund planting is the most preferred planting model in all the watershed areas. Data based on this pattern of planting are also being generated for inferences about most successful tree species in 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.

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

A study has been conducted to assess per hectare yield for agricultural crop component and the additional income that a farmer can get from tree component in selected micro watersheds of arid region of Rajasthan. Facts emerging from the study can be summarized as below :

A 30 to 50 trees per ha. of the species of farmer's choice is the best land use socially accepted by majority of farmers (about 80%) at a spacing of 10m x 10m in both silvi-pastoral and agri-silvi-management systems. For quick economic returns, horticulture component should be included in agri-silvi models. If a farmer plants 100 trees per ha of *Punica granatum*, *Zizyphus mauritiana*, *Carissa carrandus*, *Cordia myxa* and *Embllica officinalis*, (20 each) on his farm land, he is expected to get Rs. 55000 or more from the fifth year onwards.

A major proportion of fuel wood requirement of landless and medium farmers is met by *P. juliflora* that is abundantly available in the vicinity of farmer's field. Average tree density on farmer's field is 25-35 trees/ha and these trees provide fuel, fodder, timber etc. *Prosopis juliflora* alone accounts for nearly 50 percent population of the total existing tree species.

NEW PROJECTS TAKEN UP DURING 1999-2000

Sl. No: 1

Project identification No.: AFRI-12/SILVI-4/(NOVOD)

Name of the principal investigator: Dr. U.K. Tomar and Dr. D.K. Mishra

Title of the project : Development of neem in various agro-ecological zones of India.

Component (i): Studies on the storage of seeds collected from sample trees of *Azadirachta indica*.

Component ii): Selection of sample trees of *Azadirachta indica* in Gujarat state.

Year of start of the project: 1999

Target year of completion: 2003

Cost of the project: Rs. 32.27 lakhs

Objectives: (a) To fabricate the seed germination/storage facilities. (b) To carry out survey and selection of sample trees. (c) To test the seeds for seed parameters. (d) To evaluate the seed lots for germinability and storability. (e) To test the seeds for quality.

Scientific importance of the investigations: The project will suggest methods to increase viability of neem seeds in storage.

Results/Achievements: The project started from October 1999. Seed lab has been fabricated. Forms required for the collection of fruits from sample trees have been prepared. 150 sample trees of neem have been marked. Data collected from these 150 trees have been entered in the computer for documentation and analysis.

Sl. No.: 2

Project identification No: AFRI-17/FRME-5 (NOVOD)

Name of the principal investigator: Dr. U.K. Tomar and Dr. Kishan Kumar V.S.

Title of the project: Development of neem (Components - Selection of CPT/sample trees, phenological observations, development of model plantation, model villages).

Target year of completion: March 2002

Cost of the project : Rs. 2.00 lakhs

Objectives: (a) To select 600 samples of neem trees in Gujarat to find out CPTs with maximum oil content. (b) To study the phenological aspects, especially the seed yield of neem, of the selected trees. (c) To raise 5 ha. of experimental model plantation of neem in Gujarat State. (d) To execute developmental works on neem in 5 selected villages in Gujarat.

Scientific importance of investigations: The project will result in production of better quality planting stock of neem.

Results/Achievements: 150 sample trees were selected; total height, clear bole height, dbh and crown width was measured. Methodology for the quantitative and qualitative phenological study has been developed and phenological observations were recorded about these trees. 5 ha of land was selected at Hathrol and fencing and advance action works were initiated. Five villages were selected in Himmatnagar district.

Sl.No.: 3

Project identification No : AFRI-31/FGTB-6 (NOVOD)

Name of the principal investigator: Dr. U.K. Tomar

Title of the project: Integrated development of Neem in different agroclimatic zones - Gujarat.

Year of start of the project-1999

Target year of completion : 2000

Cost of the project : Rs. 32.27 lakhs

Objectives: (a) To screen the neem germplasm for oil and azadirachtin contents and establish superior germplasm. (b) To distribute the superior stock to end-users. (c) To provide training to the user groups.

Scientific importance of investigations: The project will result is abundant availability of superior planting stock of neem.

Results and Achievements : 232 CPTs of Neem have been selected and required information on CPTS has also been collected. Some samples have been sent to IBPGR (for cryo preservation) and TERI (for chemical evaluation). Two farmers' training courses were conducted in selected five villages of Gujarat. 5 ha area has been identified for model plantation and fencing is in progress. Vegetative propagation and phenological studies are also in progress.

Sl.No.: 4

Project identification No : AFRI-34/(WB-PSIP)

Name of the principal investigator: C.J.S.K. Emmanuel

Title of the project: Planting Stock Improvement Programme.

Year of start of the project : 1994

Target year of completion: 2000-2001

Cost of the project : Rs. 192.20 lakhs.

Scientific importance of the investigations: Knowledge of the genetic parameters within a species is helpful in developing effective tree improvement/breeding strategies. A great variability, exists in the growth and stem form of tropical tree species. This variation indicates the possibility of improving these species by selection, breeding out cloning. The project will develop species planting stock.

COMPONENT: DEVELOPMENT OF SEED PRODUCTION AREA

Objectives: (a) To develop seed production area of target species. (b) To compare the performance of seeds collected from the SPAs. (c) To prepare management plan for SPAs.

Results/ Achievements: The project on Planting Stock Improvement Programme was started in September 1994. Sample plots were laid out in both selected as well as rejected stands to assess them on the basis of growth and form of the population. Sample plots laid out in selected and rejected stands have been analysed and based on the analysis, culling operations were carried out in 40ha of seed stands of *Acacia nilotica* and 55ha of seed stands of teak in Gujarat. 10 ha of seed stands of *D. sissoo* were selected under rainfed conditions and 15ha of seed stands of *Acacia nilotica* at Mandera beed, Bharatpur have also been selected for conversion into SPA. Culling operation is being carryout in both these stands. Moisture conservation work have been implemented.

COMPONENT: DEVELOPMENT OF SEEDLING SEED ORCHARDS

Objectives: (a) To develop seedling seed orchards of target species for quality seed. (b) To select CPTs.

Results/ Achievements: The target for this activity was 20 ha of *Acacia nilotica*, 20 ha of *D. sissoo* and 10 ha of *E. camaldulensis*. 7ha of provenance trial cum SSPA of *E. camaldulensis* has been raised at Jodhpur from seeds obtained from CSIRO, Australia. The seedling seed orchards of target species i.e. 10 ha of *A. nilotica*, 5ha of *D. sissoo* and 2 ha of *E. camaldulensis* have been raised at Anupgarh and Sangeeta distributory, Rajasthan. 50 CPTs of *A. nilotica*, 50 of *D. sissoo*, 30 of *E. camaldulensis*, 13 CPT of *Tectona grandis* and 25 CPTs of *A. nilotica* in Rajasthan and 50 CPT of *Tectona grandis* and 20 CPTs of *A. nilotica* in Gujarat have been re-screened. All the selected CPT's 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. Seeds from these CPTs were collected and seedlings from these have been raised in the nursery of AFRI. Seedlings are also being raised from seeds of 216 CPTs of *E. camaldulensis* procured from CSIRO, Australia in AFRI nursery.

COMPONENT: VEGETATIVE MULTIPLICATION GARDEN

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

Results/Achievements: Base population of 72 clones of *D. sissoo* and 26 clones of *E. camaldulensis* have been planted in 5 ha area (1ha at AFRI nursery and 4 ha in AFRI campus) for the purpose of establishment of Vegetative Multiplication Garden. Green House civil construction work has been completed and procurement and installation of equipment such as humidity controls, cooling and heating system are in progress. The polyhouse installed at AFRI is working very satisfactorily for rooting of the cuttings in this arid environment.

Fresh cuttings of 20,000 *D. sissoo* clones have been raised in mist chamber. Out of these cuttings, 6000 plants of *D. sissoo* are in hardening stage. 1000 plants of *Eucalyptus camaldulensis* clones have already been hardened and are ready for casualty replacements in CSOs.

COMPONENT: DEVELOPMENT OF CLONAL SEED ORCHARD

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

Results/Achievements : 29.0 ha of CSO has been established. Out of this, 10 ha of *T. grandis* and 4 ha of *D. sissoo* have been established in Gujarat. 10 ha CSO of *D. sissoo* and 4.0 ha of *Eucalyptus camaldulensis* have been established in Rajasthan.

Fresh ramets of *D. sissoo* and *Eucalyptus camaldulensis* clones have been raised in mist chamber for casualty replacements in CSOs.

COMPONENT: DEVELOPMENT OF SEED BANK FACILITIES

Objectives: (a) To establish seed bank facilities. (b) To procure seed testing equipments. (c) To test the seeds of important tree species for various seed parameters. (d) To evaluate seedlots for germinability and storability. (e) To test seed for qualities. (f) To develop testing protocols of various species for pre-treatment.

Results/Achievements: Equipments like microwave oven, oven, spectrophotometer, digital water bath, tabletop centrifuge have been procured and installed. Seeds of *A. nilotica* collected during previous years have been tested and it was found that even seeds older than six years showed about 67% germination capacity.

Seeds of *A. nilotica*, *D. sissoo* and *P. cineraria* were used for pre-treatment studies. MS showed best treatment in all the tested species. Effect of seed size and pre-treatments were studied on the vigour index of *A. nilotica* and *P. cineraria* seeds. TTC test has been perfected for *A. nilotica*, *D. sissoo*, *P. cineraria* and *A. excelsa* seeds. Seed from 50 CPTs of *D. sissoo* have been collected, cleaned and distributed for raising nursery. Pod length/pod width, number of seeds/pod, pod weight, moisture content and germinative capacity of seeds collected from CPTs of *D. sissoo* have been recorded.

COMPONENT: 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.

Results/Achievements : The existing nursery in AFRI has been 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. Chaff cutter to facilitate cutting of organic materials into small pieces for composting has been procured. 3500 root-trainers of 150 cc and 1500 RT of 250 cc are being utilised for raising nursery stock.

1,20,000 seedlings of different tree species are being raised in root trainers and polythene bags for research plantations for NOVOD project and SSO casualty replacement.

The right kind of potting media for root trainer has been worked out. The ratio of 3:1 of compost and sand, soil proved best.

EXTENSION

Media

Video films :

A film, "Wonders of Water" demonstrating the technology of rain water harvesting has been prepared for users.

Transfer of technology

Training:

Farmers training was organized in 5 villages in Himmatnagar (Gujarat) under NOVOD funded project.

Exhibition, Kisan Mela etc. :

A kisan mela was held on 25-26 March 2000. 59 farmers and 41 NGOs/SFD officials participated from 15 villages of 5 districts in Marwar region of Rajasthan.

Field demonstration :

A group of farmers (20 number) from the villages adopted under UNDP programme were taken on tour to demonstrate various agroforestry and plantations work at Dausa, Karnal, Dehra Dun and Roorki during 13-19 March 2000. The tour helped in creating awareness and interest in growing plants. Farmers were shown different agroforestry models of tree - crop combination such as poplar with sugarcane, wheat, potato and Berseem etc. Farmers were also shown various forestry plantations on farmers' field as well as on Government land.

Demonstration plantations :

Demonstration of water harvesting technology was continued at different sites.

Seminars, workshops etc. :

Peer review workshops on Acacia and Neem projects were held in November 1999.

Publication and extension literature brought by the institute

Brochures with title and author if any :

AFRI - Forestry research in the new millennium-by Sh. R.L.Meena, IFS, GCR, Smt. Seema Kumar-Sci-SD and Sh. A.K.Sinha-Sci-SD.

Folders, pamphlets with titles

- *Jal bachao vriksh badhao*, Dr. G.N. Gupta, Dr. G.Singh & Sh. N. Bala
- *Vrikshon ki Vridhi evam Chare ki utpadadakata par changai ka prabhav*, Dr. V.P. Tewari & Dr. Kishan Kumar V.S.

- *Vaniki main achhey beejon ka Mahatwa*, Sh. Vedpal Singh & Dr. D.K. Mishra
- *Babul ki latt*, Dr. S.I. Ahmed
- *Bahu upayogi jaiv urvarak - VAM*, Dr. K.K. Srivastava & Neelam Verma
- *Lavaneeya bhoomi par vriksharopan*, Dr. Ranjana Arya
- *Keetnashak ke roop mein neem ka upayog*, Dr. Y.C. Tripathi
- *Mrida evam nami sanrakshan*, Dr. Rajendra Prasad
- *Krishi bhoomi mein vriksh ka mahatwa (krishi vaniki)*, Dr. G.Singh & Dr. G.N. Gupta.