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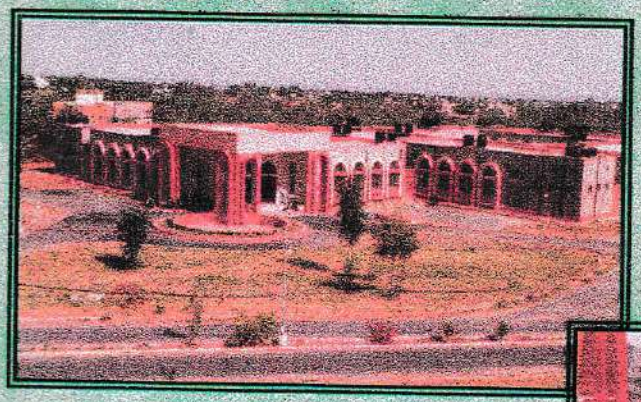

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I N D E X

Dated : 13.06.2001

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Gr. Co-ordinator (R)

1. Major- Research achievements of the Institute during the year, 2000-2001.

- Water stress level of –0.1 to –0.5 Mpa is the best treatment for better growth, biomass production and physiological function of the seedlings of *E. camaldulensis*, *A. nilotica* and *D. sissoo* considering water availability in arid zone.

- Application of sewage effluent significantly enhances nutrient concentration and uptake and quantity of application positively affect physiological functions and growth and biomass production of *E. camaldulensis*, *A. nilotica* and *D. sissoo* seedlings.

- In sand dune, combination of *Calligonum polygonoides* and *Cenchrus ciliaris* was the best for fuelwood and fodder production whereas *C. polygonoides* with *Cassia angustifolia* was best in controlling sand drift and fuel wood production as compared to the combinations with *A. tortilis* and *P. juliflora*.

- Growth and biomass production of tree/shrub species is more in bare dune plantation compared to semi-stabilized dune and the inter-dunal plain.

- *Calligonum polygonoides* provides better conditions for regeneration of *C. angustifoloia* compared to *A. tortilis* and *P. juliflora* for habitat restoration.

- Exotic shrubs of genus *Atriplex* popularly known as salt bushes perform best on degraded arid salt affected soils. *A. lentiformis* produced 4.8t/ha fresh biomass, one year after planting. *A. amnicola* did not perform well on very low soils depth (30 cm), however on reasonable soil depths (40-50 cm) it attained significant growth. *A. nummularia & Sueda nudiflora* are introduced and its initial survival and growth is encouraging. Performance of tree species was poor on degraded, low depth soils. However on better soil depths (50-75 cm); *Acacia ampliceps* and *Salvadora persica* showed significant survival and growth.

- Four gypsum levels were tried, control, half gypsum requirement, full gypsum requirement and, one and half times gypsum requirement. Out of these gypsum application at full GR produces significantly higher growth, and survival for both shrubs and tree species.

- Nitrogen application gave favorable response to growth for all the species in normal rainfall years. 27 g N/plant was the optimum dose for *A. lentiformis*. Higher doses were having detrimental effect. Among the two nitrogenous fertilizers, urea and calcium ammonium nitrate (CAN) tried for *A. lentiformis*, CAN performed slightly better in low rainfall. *Salvadora persica* also responded to nitrogen application. 27 g N/plant was significantly influencing the growth (height and crown dia.) in a normal

monsoon year. Nitrogen was not effective for *A. ampliceps* in low monsoon year. However, phosphorus application was effective. FYM application is essential for all the planted species on salt affected soils to improve the fertility and the physical condition of soil.

- Survival of planted seedling is the biggest problem in water logged salt affected areas. ***Double ridge mound technique*** appreciably increased the survival of plants on soils where water logging persists for longer duration while ***circular dished mound*** and elevated slope planting were helpful when water logging was less. Drainage is essential for individual plants on saline areas.

- Protection, ploughing and plantation activity has promoted the growth of indigenous flora and a weed growth of 86 kg/ha was recorded for the experimental area as against 0.65 t/ha from the unplanted and protected area after the monsoon season. Soil pH and EC decreased and soil organic matter increased due to plantation activity.

- At eleven years of age, height of *Khejri* was significantly higher (524 cm) due to stand density of 208 SPH (D3) as compared to 435 cm at a stand density of 277 SPH (D2) and 419 cm at a stand density of 416 SPH (D1). The collar girth was 46.3 cm, 40 cm and 35 cm respectively at three stand densities. In case of *Rohida*, height in D3 was 420 cm as compared to 381 cm in D2 and 355 cm in D1. Collar girth of *Rohida* was at par at three densities.

- Top height model/site index equation developed for *E. camaldulensis* and *D. sissoo* under irrigated conditions in IGNP area which may be used for assessing the productive capacity of the site for its plantations and accordingly suitable sites can be selected for these species. Growth and yield functions have been developed to predict the volume yield and crop diameter at a given age under varying stand densities and site qualities.

- Provenance trials of mandate species (*A. inidica* - 40 national and 35 international provenances, *Acacia nilotica* - 28 provenance, *A. excelsa* – 32 provenances *T. undulata* - 13 provenances) are being maintained and periodical measurements are being taken. The best-performing provenances in International Neem Network trials are Sunyani and Myanmar among the International Provenances and Sagar for Indian Provenance. ***The data- analyzed on periodic measurements was presented in INN Workshop- Data analysis (21st –25th March 2001) at AFRI sponsored by FAO***. The rating of the provenances varies from year to year. During the year, Shivpuri, Agra and Gurgaon were found to be the best provenances of *A. nilotica*. In case of *Ailanthus excelsa,* Pinjore, Bikaner and Kazipeth and for *Tecomella undulata* Sundarpur bir (Sikar), Nagpur and Bhainsana were found to be the best provenance.

Pilibhit was found to be the best provenance for *Dalbergia sissoo*. For Neem National trial Jaisalmer, Jhashi and Palanpur (Gujarat) were found to be the best performing provenances.

- In the experiment of developing vegetative propagation technique for *Acacia nilotica*, maximum 15% rooting was observed when cuttings from adult trees were treated with 5000 ppm IBA solution for 30 seconds and *Ailanthus excelsa*, best rooting response (50%) was obtained from 1000 ppm treatment.
- VAM inoculum containing various strains of VAM fungi *viz., Glomus microcarpum, G. fasciculatum, G. aggregatum* and mixed culture of *G. fasciculatum* and *G. aggregatum* were prepared for further experimentation and large-scale inoculation. Selective strain of VAM fungi (consortium inoculum) for neem has been prepared for nursery inoculation and field trials.

- The cause of mortality in *P. cineraria*, reported from four district of Rajasthan namely, Nagaur, Sikar, Jhunjhunu and Churu was analysed. The infection starts from the lopped portion and develops the symptoms of die back. Gradually infection spreads downward and reaches upto root system and mortality occurs in standing trees. The association of three pathogens viz., *Alternaria* sp., *Botryodiplodia theobromae* and *Phoma* sp. were isolated and identified. Association of insect borer *Derolus descicollis* was also found.

- Final Report on the seed pests of forest trees species has been completed and submitted. *Oxayrochis tarandus*-a sapsucker was recorded damaging the green pods of *Prosopis cineraria and P. juliflora* in the field conditions for the first time in India.

- Concept of Nursery Ecosystem Analysis with emphasis on cultural and quarantine control was given for better pest management in forest.

- The biocidal efficacy of *Capparis decidua, Azadirachta indica, Psoralea corylifolia, Balanites aegyptiaca* and *Dicoma tomentosa* have been studied. The anti-feedant activity of *C. decidua* has been tested against inspect pest and was the highest in seed extract.

- *Prosopis juliflora, Parkinsoina aculata, Prosopis cineraria, Acacia senegal, Dichrostychus spp.* and some herbs were selected and LPC prepared for Chroloplastic and cytoplasmic studies.

- 200 ha of Seed Production Areas, 55 ha of SSO, 5ha of VMG and 29 ha of CSO of different tree species have been established in Rajasthan and Gujarat. These areas have been handed over to concerned SFDs for future management.

2. Research Highlights of the Institute (Division-wise)

DIVISION OF FOREST ECOLOGY AND DESERT DEVELOPMENT.

(a) Project completed during the year 2000-2001.

(i)	**Sl. No:**	1
(ii)	**Project identification number:**	AFRI-1/FEDD—1 (RD)
(iii)	**Name of principal investigator:**	Dr. Ranjana Arya 'SE'
(iv)	**Title of project:**	Studies on various silvi-pastoral systems in arid zones to maximize the productivity
(v)	**Year of the start of the project:**	July 1997
(vi)	**Target year of completion:**	Dec. 2000
(vii)	**Cost of the project and expenditure made so far:**	Rs. 61,262/-

(viii) Objectives in brief :

- Improvement of productivity of degraded lands by introduction of silvi-pastoral systems.
- To introduce new tree species and study their performance vis a vis existing tree species in silvi-pastoral systems in different climatic conditions.

(ix) Scientific importance of investigations :

The arid zones of Rajasthan have a very large size of cattle population. The fodder production at present is too insufficient to meet the requirement of the livestock population. Overgrazing of conventional pasturelands has caused the deterioration bring down their productivity to very low level. The role of fodder trees and shrubs in providing highly nutritious fodder to the livestock is of great importance especially during the crucial lean period when grasses are either grazed or not available due to continuous drought. Traditional trees/ shrubs are loosing their acceptability due to their slow growing nature hence there is need to introduce new fast growing trees for better acceptability and enhance production.

(x) Results / Achievements :

Silvi-pastoral trial at Rohat

Economy of Arid zone is mainly dependent on animal husbandry, as due to frequent droughts crop failure is a recurring phenomenon. Failure of rains also affect the grass yield, thus silvi-pastoral systems are designed to save the animal population from fodder scarcity. *Prosopis cineraria* and *Zizyphus* spp. are two main tree crops of the arid India. Attempts are being made to introduce other tree species in silvi-pastoral system to find out their suitability and performance vis a vis traditional systems in vogue.

The experiment was laid out in the month of August 96 with four tree species namely *Zizyphus mauritiana* (Rhamnaceae), *Prosopis cineraria* (Fabaceae), *Ailanthus excelsa* Roxb. (Simaroubaceae) and *Dichrostachys nutans* (Mimosaceae) at a spacing of 5m x 5m in three replicates, with 24 plants in each replicate in a randomized block design. *Cenchrus ciliaris* was sown as inter-crop.

Tree survival and growth: Survival of tree species remained more than 98% for all the three species except for *D. nutans* (63%) during the experimental period, which suffered causalities due to fungal attack. After four year *Z. mauritiana* + *C. ciliaris* combination produces maximum fodder however, total biomass production was more in *A. excelsa* + *C. ciliaris* system followed by *D. nutans* + *C. ciliaris*. The year 2000 was again a drought year. In this year *Z. mauritiana* registered very poor growth increment (+8.7% height, -14% in crown dia.) as compared to (+16.7 % in height and no reduction in crown dia. for *Ailanthus excelsa*. *D. nutans* and *P. cineraria* also registered 18 and 17% height increment and +12.8 and –8% increment for crown dia respectively at the age of 50 months over their values for 38 months. However collar dia registered increase and values for *A. excelsa, Z. mauritiana, D. nutans* and *P. cineraria* were 12.4, 8.0, 5.2 and 2.6 cm respectively.

Green grass yield

Green grass yield for the year 2000 was 2333, 3183, 1316, 3316 and 3850 kg/ ha with *Z. mauritiana, A. excelsa, D. nutans, P.* cineraria and control respectively. The yield showed drastic reduction of 23%, 56% and 44% in blocks of *Z. mauritiana, D. nutans* and pure block. Here weed invasion was significantly high. Grass yield registered 20 and 50% increase with *A. excelsa* and *P. cineraria*. Here weed invasion was lesser and no of tillers / grass culms and tiller height was higher as compared to other tree species.

Biomass yield

Tree biomass was estimated for *Z. mauritiana* and *A. excelsa* total dry biomass yield was 10.52 kg/tree for *A. excelsa as* compared to 4.8 kg/ tree for *Z. mauritiana* showing 2 fold increase. However, for dry leaves biomass the trend was reverse (0.9kg/tree for *Z. mauritiana* and 0.5kg for *A. excelsa.* Wood and fuel wood yield (stem and branches) were from *A. excelsa* (10.02 kg/tree) to 3.9 kg / tree for *Z. mauritiana*. The results of the trial indicate that *A. excelsa* tree species has the potential to be introduced in silvi-pastoral system in arid zone as it showed comparable survival but better tree growth as compared to traditional tree species *Z. mauritiana* and *P. cineraria*). *D. nutans* is also a good tree but it needs better plant protection measures in the initial stages.

Silvi-pastoral trial at Nagaur

An experimental trial was laid to study the performance of different tree species in combination with a common grass spp. to find out the best performing tree in silvi-pastoral trial in arid zone conditions. Experiment was planted as replicated trial in 1996 September first week with 5 tree species namely- *Zizyphus mauritiana* (Rhamnaceae), *A. nilotica*, (Mimosaceae), *Ailanthus excelsa*, (Simorubiaceae), *Azadirachta indica*, (Meliaceae) and *Dichrostachys nutans,* (Mimosaseae) at a distance of 5m*5m in a recognized block design covering an area of 1.2 ha. However, *Cenchrus ciliaris* sown as grass species in 1997 due to no rain in 1996 after plantation.

Survival of the tree species.

Planted seedlings suffered serious frost damage in the month of Dec 96, four months after the planting, aerial part of all the plant species damaged. Causality replacement was carried out in August 1997. Plantation again suffered frost damage in January 98 however, no causality replacement was done subsequently and survival as recorded at the age of 42 months showed that *Z. mauritiana* recorded maximum survival of 91% followed by *A. nilotica* 87%, *D. nutans* 80%, *A. excelsa* 79% and *A. indica* 70%.

Growth

Despite suffering repeated frost damage and drought conditions *A. excelsa* attained maximum average height 394 cm dbh 8.7 and collar dia 13.4 followed by *Z. mauritiana* 344 cm height, 6cm dbh and 8.3 cm collar dia crown diameter values were higher for *Z. mauritiana* (299 cm) as compared to *A. excelsa* 274 cm. Continuous drought has adversely affected the crown growth and the year 2000 registered negative growth for crown dia. Among other species only *A. nilotica* attained notable growth while *Azadirachta indica* and *D. nutans* failed to grow.

Biomass estimation

Biomass estimation was carried out for *A. excelsa* and *Z. mauritiana* only. Total biomass yield of *A. excelsa* was almost double the yield of *Z. mauritiana* in fresh as well as dry biomass yield. The yield for *A. excelsa* was 6016 kg/ha as compared to 2958 kg/ha for *Z. mauritiana*. However, while *A. excelsa* wood content was more for *Z. mauritiana* foliage and branch mass was more

Grass yield

Dry grass yield as recorded in Sept. 2000 showed that maximum yield continues to be with *A.nilotica* 2956 kg//ha followed by *Z.mauritiana* 2880kg/ha *A.excelsa* 2318 kg///ha, *A.indica*2280 kg/ha and *D.nutans* 1752 kg/ha. Despite total rainfall of 252 mm the grass yield registered 40 to 54% increase in growth with different tree species except for *D.nutans* where a 12% decline in growth was recorded. Probably shelter provided by tree species helped in lesser frost damage to grass culms which was not there in case of *D.nutans* due to very poor tree growth.

Four and half years growth of different tree species showed that although *Zizyphus* is best tree for silvipastoral systems in arid zone, *A. excelsa* has the potential to be introduced in silvi-pastoral systems surviving both frost and drought. A.nilotica and *A.indica* need protection against frost and their revival is poor. *D. nutans* is susceptible to frost and as it didn't have thorns and has palatable fodder is prone to grazing and need protection against it.

OLD PROJECTS CONTINUED

(i)	**Sl. No**	:	2
(ii)	**Project identification number**	:	AFRI-2/FEDD—2 (RD)
(iii)	**Name of principal investigator**	:	Dr. G. Singh SE
(iv)	**Title of project**	:	Effect of different tree density and inter crops on yield and productivity of agro-forestry systems
(v)	**Year of the start of the project**	:	July 1998 (However, RD project ended in March 2000, therefore the project needs to be funded from other source for continuance)

(vi) **Target year of completion** December 2003

(vii) **Cost of the project and expenditure made so far** : Rs. 94, 820.00

(viii) Objectives in brief:

- To study the influence of different tree densities on crop yield and tree growth and to find out optimum tree density.
- Effect of different tree- agricultural crop combinations on yield and productivity of agro-forestry systems.
- To study tree crop interactions in respect of soil moisture and nutrients at different age of plantation

(ix) Scientific importance of investigations :

Agro-forestry is important land use system in arid zones. The investigation has focus on finding out the optimum stand density and best combination of trees with agriculture crops for maximizing yield on sustained basis.

(x) Results / Achievements:

Experiment A. Effect of different tree density and agricultural crops on yield and productivity of agro-forestry systems

In 1998 the experiment was redesigned to include some inter crop treatments of medicinal plants and water harvesting treatments. In the revised experiment: main treatment (2) are (i.) No water harvesting (ii). Water harvesting. Sub main treatments are i.) no intercrop, ii) mungbean - mungbean, iii) mungbean- sesame, iv) sesame - sesame, v) *Cassia aungustifolia*, vi) *Capparis decidua,* and vii) *Withania sominifera* and sub - sub main treatments i.) *Prosopis cineraria* and ii.) *Tecomella undulata*. In 2000, there was total failure of monsoon therefore, all the intercrops failed. Only the trees continued to grow at a very slow pace. Due to failure of monsoon, there was no runoff, thus no significant effect of water harvesting was observed. The average height of *P.cineraria* at 11 years of age varied from 348 cm to 485 cm and collar girth from 28 cm to 40 cm. Whereas, height of *Tecomella undulata* varied from 308 cm to 430 cm and collar girth 27.60 cm to 36 cm. No significant variations were noted in tree growth as a result of intercrops and water harvesting treatments.

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

The field experiment comprised of three densities (416, 278 and 208 stems per ha) of *Tecomella undulata* and *Prosopis cineraria* 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 eleven years of age, height of Khejri was significantly higher (524 cm) due to stand density of 208 SPH (D3) as compared to 435 cm at a stand density of 277 SPH (D2) and 419 cm at a stand density of 416 SPH (D1). The collar girth was 46.3 cm , 40 cm and 35 cm respectively at three stand densities. In case of rohida, height in D3 was 420 cm as compared to 381 cm in D2 and 355 in D1. Collar girth of rohida was at par at three densities.

Experiment C. Maximising food, fodder and fruit yield in Agroforestry 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 to determine total production of fruit and fodder in combination with agricultural crops. Various observations recorded were growth data of plants, soil moisture and nutrient status of soil with distance from the tree and crop (grain and dry matter). Soil moisture was lower in cropped area during cropping season whereas the reverse trend was observed during fallow period. Data were recorded monthly observations on soil nutrient status to notice the temporal variation of nutrient pool under agroforestry system in arid areas was compiled. Availability of extractable P and N were low in cropped area compared to uncropped area whereas Cu, Zn and Mn were sufficient for the crops. Nutrient analyses 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. Growth recorded at an age of 81 month old of plantations the average of height recorded for *E.officinalis* was *C.mopane* was higher in fixed crop whereas height of *H.binata* was greater in rotational crop, collar diameter for all the species was greater in rotational crop. Total fruit production of *C.mopane* was 13.76 kg in rotational crop and 11.8 kg in fixed crop.

Experiment D - In -situ runoff agroforestry

Bunding at proper interval facilitate the *in situ* runoff collection and moisture conservation an experiment was carried out on Rohat experimental site. This is useful for agricultural activities in between the bunds and cultivation of tree for fodder and firewood beside the bunds. For such type of system the experiment comprised three tree species viz., *Azadirachta indica*, *Acacia nilotica* and *Albizia lebbeck* was started in August 1996, during the monsoon period. *Cymopsis tetragonoloba* (guar) harvested in

October 1996 produced 86 kg ha^{-1} grain was in *A. indica* plots compared to only 72 kg ha^{-1} in *A. nilotica* and 60 kg ha^{-1} in *A. lebbeck* plots. In 1997 and 1998, 99 and 2000 cropping due to irregular rainfall and long dry spell affected the crop yield. Highest pruned biomass in 1997 was recorded for *A. nilotica* (3.2 kg $plant^{-1}$), compared to only 0.48 kg $plant^{-1}$ in *A. indica* and 0.40 kg $plant^{-1}$ in case of *A. lebbeck*. Further, in 1998, the highest biomass was for *A. indica* (3.2-kg $plant^{-1}$), followed by *A. lebbeck* (0.95-kg $plant^{-1}$) and *A. indica* (0.81-kg $plant^{-1}$). Soil moisture studies suggested that the extent of soil water availability which depends on the nature of species and the root length of the plants also depends on the soil depth from which the plants is extracting soil water.

(i)	**Sl. No**	:	3
(ii)	**Project identification number**	:	AFRI-3/FEDD-3 (RD)
(iii)	**Title of project**	:	Effect of *ex –situ* rain water harvesting and stand density on tree growth
(iv)	**Name of principal investigator**	:	Dr. N. Bala
(v)	**Year of the start of the project**	:	July 1998
(vi)	**Target year of completion**		December 2002
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 22,630/-

(viii) Objectives in brief:

- To find out the effect of runoff capture on the growth of standing plantations

(ix) Scientific importance of investigations :

The study will help in utilizing the runoff fruitfully in improving the growth of old plantations and impact of runoff capture on water table.

(x) Results / Achievements :

A trial on interactive effects of *ex-situ* water harvesting was laid at FE&DD field, Jodhpur. A five year old stand (in 1998) of *A.indica (neem), P.cineraria (khejri), Albizia lebbeck* (siris) was converted into an experiment after thinning it 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. In 2000, monsoon totally failed resulting in absence of runoff to the experimental area. Therefore, there were neither appreciable growth increments nor

treatment effects. The average basal area per plot in no water-harvesting block was 2022 cm^2 for neem, 490 for *khejri* and 502 for *A.lebbeck*. The corresponding values in water harvesting block were 1941, 523 and 1350 cm^2 respectively. As such no further significant changes have been observed due to various treatments because of failure of monsoon.

(i)	**Sl. No**	:	3
(ii)	**Project identification number**	:	AFRI-3/FEDD—3 (RD)
(iii)	**Title of project**	:	Studies on sand dune stabilization in Indian Desert
(iv)	**Name of principal investigator**	:	Dr.G.Singh SE
(v)	**Year of the start of the project**	:	1996
(vi)	**Target year of completion**		March.2002
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 75,701.40/-

(viii) Objectives in brief :

- To the effect of nitrogen fixing species/ grass on the early plant establishment.
- To assess soil improvement and soil water status in duny area.
- To improve the Productivity of duny area.
- Improvement in environmental quality.

(ix) Scientific importance of investigations :

The studies carried out so far in Indian desert only include the management of soil water, plantation techniques and erection of micro windbreaks for the seedlings protection. The uses of locally available nitrogen fixing under shrubs have not been tried so far. It not only supplies the organic matter and nitrogen to the soil but also protect the seedling from the blowing sand particle.

(x) Results / Achievements :

Experiment 1: Nutrient management in sand dune for better growth and biomass production

A study was carried out at Bikaner site to find out suitable species and its combined surface vegetation for developing organic matter and nutrients to facilitate the growth of planted seedling with aim of fast stabilization of dune and production of fuel and fodder from this highly stressed site. Seedling of *A. tortilis*, *Prosopis juliflora* and *C.*

polygonoides species were planted on shifting dune and micro-windbreaks were erected to protect the seedling from the drifting sand. *Cassia angustifolia* and *Cenchrus ciliaris* were sown as treatment (vegetation type) to develop under canopy vegetation. Vegetation type had no significant ($P>0.05$) effect on the growth of the species. However, growth of species differed significantly ($P<0.001$) and *Prosopis juliflora* was the best performer. Percent height and crown diameter increment was significantly ($P<0.01$) high for *C. polygonoides* and *P. juliflora* during establishment phase indicating their efficiency in quick control of sand drift. *C. polygonoides* produced the highest biomass in form of fuelwood utilizing minimum amount of soil water compared to *P. juliflora* and *A. tortilis*. There was an increase in SOM and soil available N (NH_4-N + NO_3-N) due to plantation and vegetation type treatment. *C. polygonoides* with *C. ciliaris* was the best combination for fuel and fodder production where as *C. polygonoide*s along with *C. angustifolia* was best to control sand drift. Sowing of under shrubs and grass of local importance can also be done in advance to control the sand drift and burial of the planted seedlings. It will help in improvement of soil condition and control of sand drift particularly, in latter period when the seedlings took the shape of tree leaving bare under canopy soil, which is a common problem of semi-stabilized dune.

Experiment 2. Studies on plant growth and biomass production under the influence of habitat conditions and competitive effect of natural grasses

Competition, resource availability and biomass of existing perennial grass species, *Dactyloctinium sindicum* (Boiss) were studied in duny area at Bikaner and the effect of grass on the growth of *Acacia tortilis, Prosopis juliflora* and *Calligonum polygonoides* were examined in six topographically different habitat types. Bare dune plantation (BP), semistabilized dune plantation (SP), flat land plantation (FL), flat land with *D. sindicum* grass (FG), flatland without vegetation (FW) and bare dune (BD) were the selected habitats.

Plant growth was less and mortality was greater in FL where *D. sindicum* was abundant. Contrasting result was observed in BP habitat where the population of *D. sindicum* was zero. Percent height increment was the highest in BP plantation in 1997 and 1998 whereas it was the highest in SP in November 1999. Height increment was the highest for *C. polygonoides* in BP habitat in 1997 and in SP and FL habitats in 1998, whereas, it was the highest for *A. tortilis* in 1999. Thus, performance of *A. tortilis* was good in general, whereas *P. juliflora* performed the best only on bare dune with maximum height increment.

Differences in plant growth were apparently due to variations in soil water availability among the habitat types. Soil organic matter and available PO_4-P were higher whereas available N (NH_4-N + NO_3-N) was low in FL habitat compared to BP and SP

habitat in November 1996 and June 1999. The variations in soil resources were accounted for the variation in *D. sindicum* grass density and root biomass.

Soil water availability was always higher in FW habitats. BD followed it in October 1998 and June 1999 (after rain) whereas FG or FL followed FW in the remaining observations. The highest soil water in FW and lowest in FL indicated strong competition for soil resources between *D. sindicum* and the planted woody plant seedlings, particularly after rain. In dry period grass dried which protect surface soil water losses. Thus, lesser plant growth in FL and SP habitats was supposed to be due to low nutrient and soil water availability.

Results indicated that inter-specific competition might have limited the growth and biomass production of planted seedlings. Competition was more during higher availability of soil water. Thus, proper management of existing grass and the additional watering will be beneficial for proper growth in interdunal plane and the flat land.

Experiment 3. Studies on effect of adult neighbors on regenerative population of *Cassia angustifolia* in duny area for habitat restoration

The study was carried out to determine the effect of canopy of and distances from the adult neighbour on emergence and survival of *Cassia angustifolia* seedlings and their relations with soil water availability. Five trees of each neighbour viz. *Acacia tortilis, Prosopis juliflora* and *Calligonum polygonoides* and three-zone viz. IC zone (0-1.0 m), OC zone (1.0 -1.5 m) and OS zone (1.0–2.5 m) from the trees were selected for the study. Adult neighbour affected soil seed availability, seed germination and emergence and survival of *C. angustifolia* seedlings. Number of seeds in soil and germination and emergence was higher with *C. polygonoides* followed by *P. juliflora*. OC zone had the highest number of seedlings. The emergence was directly related to the soil seed availability. Seedling had greater survival in IC zone and subsequent performance was positively correlated with the emerging population.

Height and biomass were higher for the seedlings under the canopy of *C. polygonoides* compared to the other neighbors. Seedlings of IC zone attained greater height initially (February 2000, $P<0.01$) but did not show significant ($P>0.05$) variations with OC and OS zone in June 2000.

Soil moisture was high under *Calligonum polygonoides* followed by *Acacia tortilis* and *P. juliflora*. The highest soil moisture was in June 1999 and at 1.5 m distance. It decreased to minimum in June 2000 with slight increase in winter and positively correlated with seedling population.

Number of branches and branching height were significantly ($P<0.01$) correlated with emergence and survival of *Cassia angustifolia* compared to total height and crown diameters. Thus higher number of branches and branching from the base was the probable reason for more number of dispersed seed, emergence and survival of *C. angustifolia* seedlings. It is concluded that *C. polygonoides* which had zero branching height and spreading canopy was found the best species providing nursing effect to the regenerated *C. angustifolia* seedlings which produce highest biomass under *C. polygonoides*. Further, *C. polygonoides* utilized lesser quantity of soil water compared to *P. juliflora* and *A. tortilis* that might be beneficial for under canopy *C. angustifolia* or other vegetation, maintenance of bio-diversity and stabilization of dune in combine.

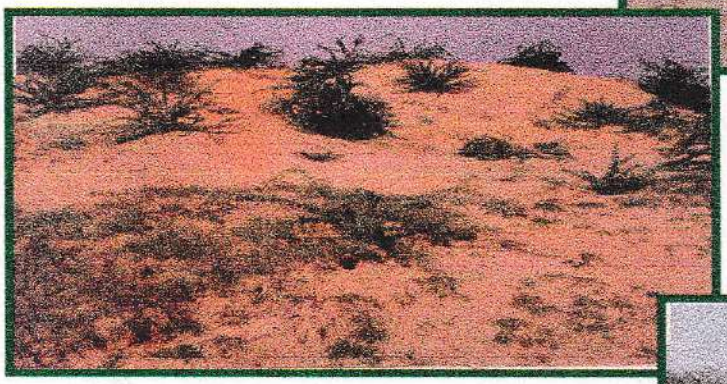
Experiment 4. To study the effect of spacing on growth and performance of *Acacia tortilis*, in Indian desert.

Competition between the plants is the most important process that determines the tree growth and size distribution. Plant spacing influences growing space of individual tree and are often used as measure of competition. Thus growing space largely dominates tree growth and yield of a stand as a whole. In view of the above, a study was started to evaluate the growth of *A. tortilis* under different stand densities for fuel wood/ biomass production under unirrigated conditions. Seedlings were planted in first week of September 1996 in 8 varying densities of 1667, 1111, 833, 667, 625, 500, 400 and 333 stems per hectare (ha) in three replications and split plot design. Growth data were recorded regularly in the month of November each year and biomass in November 2000. Growth data of the plants indicate significant difference in height, collar diameter, crown diameter and biomass of plants due to variations in tree densities. However, growth parameters did not show clear trend of increase or decrease with plant densities except collar diameter. Foliage biomass was more in lower stocking. Soil nutrient analysis data of 0-30 cm soil layer recorded in November 2000 indicates an increase in soil organic matter, available phosphorus, ammonical and nitrate nitrogen compared to the initial data of 0.154%, 3.00 mg kg^{-1}, 0.14 mg kg^{-1} and 1.81 mg kg^{-1}, respectively.

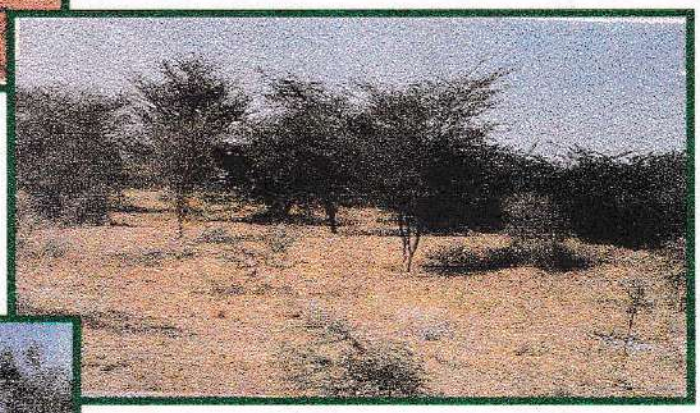
Sand Dune Stabilization

Bare Dune

Micro-wind break fixing at the planting time



12 months old *P. juliflora*



40 months old *Acacia tortilis*

40 months old *Calligonum polygonoides*

40 months old *P. juliflora*

(i)	**Sl. No**	:	5
(ii)	**Project identification number**	:	AFRI-5/FEDD-5(WB.1-I)
(iii)	**Name of principal investigator**	:	Dr G. Singh SE
(iv)	**Title of project**	:	Woody Plant Water Relations Sub Project (I):Investigation of soil water plant relationship in respect of different tree species
(v)	**Year of the start of the project**	:	July 1998
(vi)	**Target year of completion**		December 2001
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 96,752 /-

(viii) Objectives in brief:

- To find out critical limits of stress tolerance of different tree species
- To screen tree species for efficient water use and growth under arid conditions
- To study the effect of varying level of sewage water on the growth of the plants

(xi) Scientific importance of investigations :

To screen tree species for efficient water use in the arid conditions and to study the effective use of sewage water for biomass production under arid conditions.

(xii) Results / Achievements:

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

Water stress level of -0.1 to -0.5 MPa is best treatment for better growth and establishment of tree seedlings of *E camaldulensis*, *A. nilotica* and *D. sissoo* considering water availability in arid zone.

Water stress level of -0.5 to -1.0 MPa is the critical for growth, physiological, biochemical and nutrient uptake at which there is drastic reduction in all above parameters in *D. sissoo* seedlings. The decrease was also significant for the other two species.

The threshold point for survival of *D. sissoo* seedlings is -1.96 MPa which decrease to -2.02 MPa at permanent wilting point whereas the other two species are under investigation.

Availability of soil nutrients decreased with increase in water stress levels.

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

Disposal of municipal effluent by irrigating tree species is better option to get maximum biomass production in a short period. On this water scarce condition as evidenced by1.4 times higher biomass in *E. camaldulensis* and just equivalent in *D. sissoo* and *A. nilotica*, receiving sewage water at 1/2 PET (T_2) compared to that in good water application at1 PET. The quantity of sewage water may be increased even beyond 2 PET as biomass (above and root) increased with rate of sewage water application.
Multiple regression equations of the physiological parameters with environmental factors and rate of sewage water application indicate that *E. camaldulensis* and *A. nilotica* seedlings are more suitable for arid region compared to *D. sissoo* which had significant positive relation with RH.

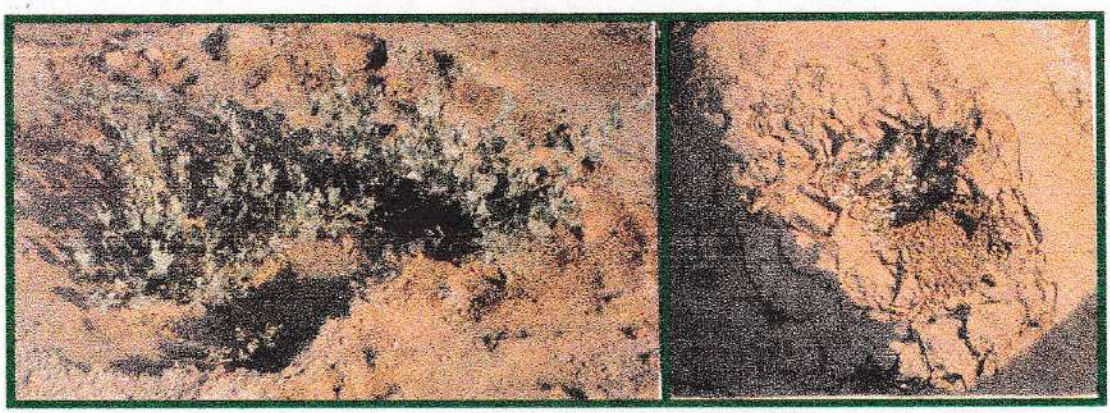
There was increase in plant nutrient concentration and nutrient uptake with increase in quantity of sewage water application, which affected positively on physiological functions and growth of the tree seedlings.

Application of sewage water did not show adverse effect on physiological function, plant growth and soil properties during two and half year of experimentation though there was increase in availability of soil organic carbon, available phosphorus and nitrogen, exchangeable cations and micro-nutrients.

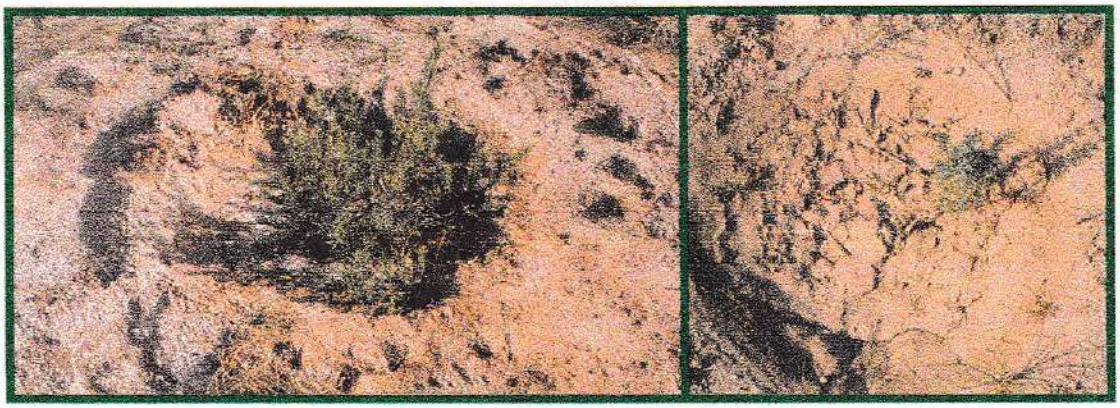
(i)	**Sl. No**	:	6
(ii)	**Project identification number**	:	AFRI-6/FEDD-6(WB.1-II)
(iii)	**Title of project**	:	Screening of exotic and indigenous plant species for their performance on salt affected soil with different management project
(iv)	**Name of Project investigator**	:	Dr. Ranjana Arya SE
(v)	**Year of the start of the project**	:	1997
(vi)	**Target year of completion**		December 2003
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 2,29,436/-

Effect of soil structures on growth of plant species on a salt affected soil

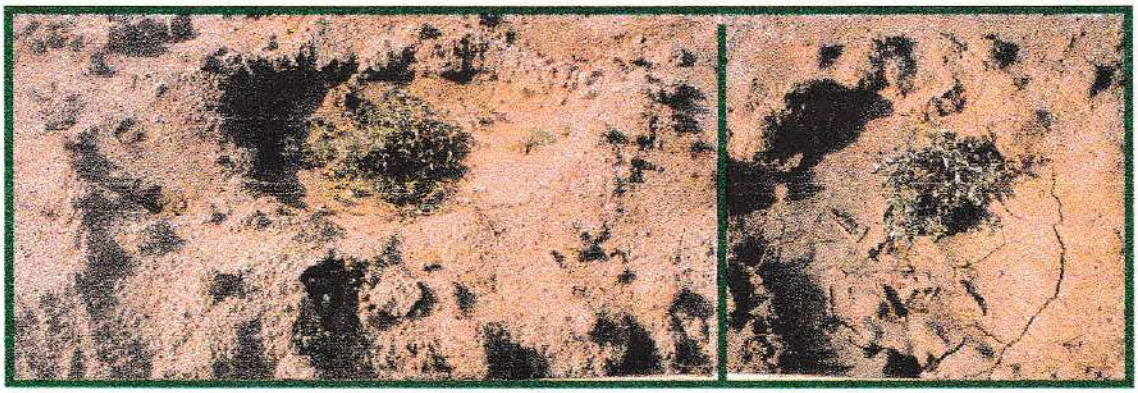
Circular Raised Plateform (CRP) **Control**



Atriplex lentiformis

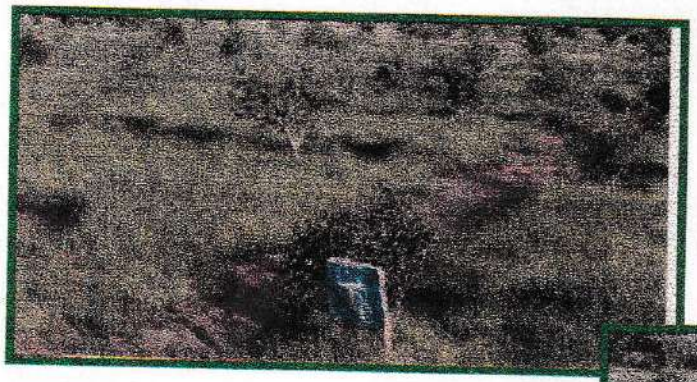


Sueda nudiflora



Atriplex nummularia

Salvadora persica **(3 yrs old) with Gypsum and Nitrogen on a salt affected**



T_1-Control

T_2-Gypsum

T_6-Gypsum + Urea (20 g)

T_8-Gypsum + Urea (60g)

(viii) Objectives in brief :

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

(ix) Scientific importance of investigations :

Utilization of salt affected areas has become necessary owing to increasing need for fodder, fuel and other minor produce increasing need for fodder, fuel and other minor produce. However, there are very few plant species, which can perform on salt affected areas. There is need to find out new species which can perform on these areas and also to find out suitable planting practice packages to increase the production from these lands. The study is an attempt in both the directions

(x) Results / Achievements :

Trials laid in 1997

Bushes if *Atriplex lentiformis* was subjected to cut in May 1999 to estimate the fodder yield. Two successive monsoon failures in 1999 and 2000 affected the recovery. Growth increment as recorded in Nov 2000, 18 months after the culling showed that height increase ranged from 52% in T12 treatment (full GR and 100 g Urea) to 17% in T1 (control), while increase in crown diameter ranged from 26 for T11 (full GR + 80g urea) to 4% in T1 control. Bush survival was also recorded. Maximum survival 100% was in T7 (full GR) where as minimum 55% in nitrogen treated bushes with or without gypsum application. Overall there was no appreciable decrease in survival of bushes as compared to survival in May 1999 despite two-failed monsoon.

Salvadora persica also responded to the treatments after one and a half year of growth 42 months old data (March 2001) showed that application of gypsum and nitrogen continues to affect the crown diameter in all the treatments applied, height is not influenced by the treatments. The maximum height of 186 cm and the crown diameter of 177 cm was recorded for T6 treatment (full GR with 20 g urea). Flowering and seed setting was recorded in all the treatments. Weed biomass estimation was carried out by laying quadrates and nearly 6 ton per ha yield of *S. helvolus* was recorded.

Trials laid in 1998

Acacia ampliceps was planted with and without gypsum in Sept 1998 and showed 74% survival with gypsum in Sept 1999. Failure of monsoon in 1999 affected the survival and in March 2000 the survival is 66% for gypsum treated plant as compared to 58% for control. Fertilizer application of nitrogen and phosphorus was carried out in August 2000. Percent increment in growth recorded six months after treatment application in Feb 2001 indicated that in a very poor monsoon year phosphorus application influenced the growth. Both height and crown diameter registered significantly higher growth as compared to control, while growth increment was not significant for nitrogen application treated trees as compared to control. Flowering is recorded in 60% plants.

Trials laid in 1999

A trial of *A. lentiformis* was planted in August 1999 in double ridge mound with three levels of gypsum control G0, half gypsum requirement G1 and full gypsum requirement G2. Nitrogen application was deferred due to monsoon failure. The trial was concluded in August 2000 to find out the effect of gypsum application on growth. Biomass estimation was studied and G1 treated bushes recorded maximum biomass, followed by G2 and G0. 3 doses of nitrogen 9, 18, 27 g of N from two nitrogen sources, Urea and calcium ammonium nitrate (CAN) were applied in August 2000 to the remaining bushes.

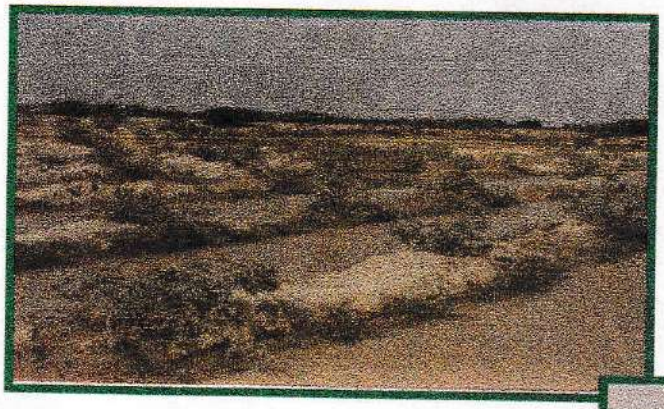
Overall survival recorded in March 2001 showed that G2 treated bushes recorded maximum survival of 97% followed by 87% for G1 and 88 for G0. However, CAN treat bushes recorded better survival as compared to urea treated bushes with or without gypsum application. Growth data also indicate the same trend.

Trials laid in 2000

A new trial of *A.amnicola* was laid out in August 2000 in place of *A.colei* trial, which recorded only 25% survival. Trial was planted with three planting treatments (double ridge mound S1, elevated slope planting S2 and simple bund planting S3) with full gypsum requirement and control, a total of six treatments. Bushes received no rainfall after planting. Survival of bushes ranged from 83% for S3, 81 for S2 and 75% for S1 treatment as compared to 74, 72 and 66% for non-gypsum treated bushes in same treatments.

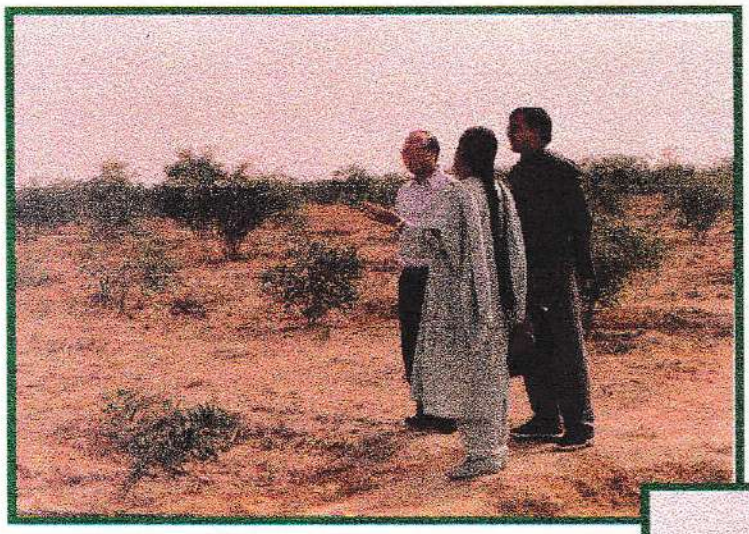
Another new trial was laid with 3 salt tolerant species namely *A.lentiformis, A.nummularia* and *Sueda nudiflora* and three treatments of planting (control, single ridge

Atriplex lentiformis **(10 months old) on double ridge mound**

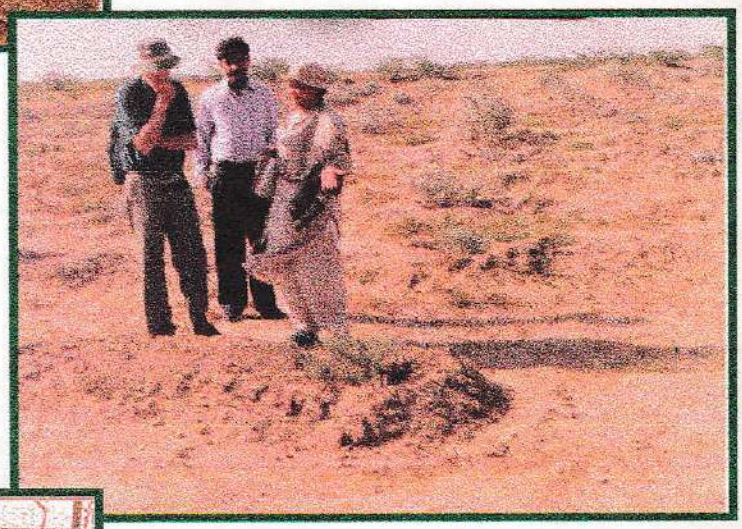


S. nudiflora **on Circular Dished Mound**

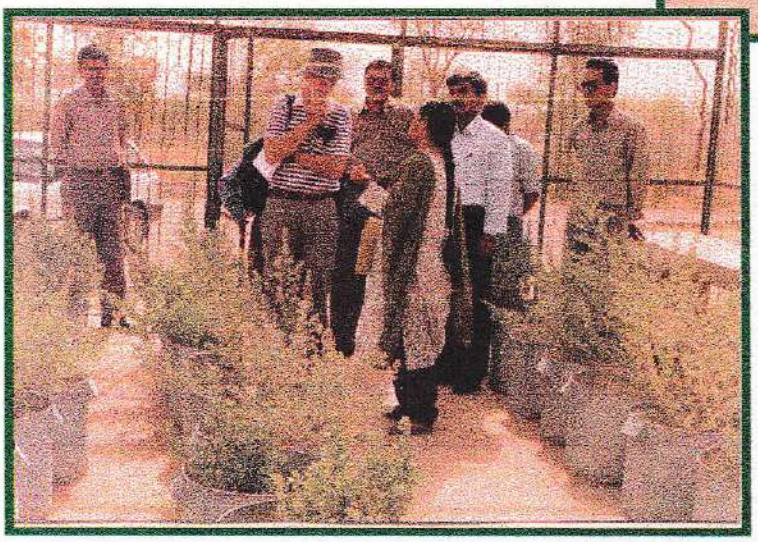
Visits of experts to different exmperimental trails on arid salt affected land



DDG Extension visits the *Acacia amplicepts* experiment



World Bank expert discussing planting techniques



World Bank expert discussing the effect of irrigated and nitrogen on salt bush in a pot culture trial

mound and double ridge mound) in a RBD in August 2000. No rainfall was received after planting. *S.nudiflora* was the best species attaining maximum height and recording nearly 100% survival in all the three planting treatments followed by *A.nummularia*. Performance of *A.lentiformis* was poorest among all the three species. Single ridge mound was the best planting practice for survival as well as growth for plant species in a drought year.

Protection, ploughing and plantation activity has promoted the growth of indigenous flora and a weed growth of 86kg/ha was recorded for the experimental area as against 0.65 t/ha from the unplanted and protected area after the monsoon season. This growth is less than last year due to monsoon failure. *S.helvolus* was the most abundant grass species, while *Sueda fruticosa* was the most abundant herb. Species variation was noticed and a maximum of 14 indigenous plant species was recorded in monsoon followed by 9 in winter as compared to two in summer. Analysis of *A.lentiformis* for ash contents has shown that percent ash content is higher in monsoon period as compared to summer.

(i)	**Sl. No**	:	7
(ii)	**Project identification number**	:	AFRI-7/FEDD-7(WB.2-II)
(iii)	**Title of project**	:	To screen various plant species for high yielding commercial forestry under irrigated condition in Indian arid zone
(iv)	**Name of Project investigator**	:	Dr.Ranjana Arya SE
(v)	**Year of the start of the project**	:	July 1995
(vi)	**Target year of completion**		December 2001
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 47,812/-

(viii) Objectives in brief :

- To find out the best performing commercially important plant species under irrigated condition in arid zone
- To study the effect of VAM biofertilizer on establishment and growth of plant species
- To study the effect of continued irrigation on the soil properties

(ix) Scientific importance of investigations :

Water is the most important factor for plant growth in arid zone. Judicious use of water is necessary. Studies are necessary to find out the most water use efficient tree species for optimum utilisation of water. Also as arid zone soils are poor in nutrition studies are needed to find the optimum doses of biofertilizer and inorganic fertilizer to increase the growth. Study aims to find answer to some of these questions.

(x) Results / Achievements :

After 63 months of growth *Eucalyptus camaldulensis* attained the maximum average height (678 cm) followed by *Acacia nilotica* (477 cm) and *D.sissoo* (423 cm) in the non fertilized plots (control). In the month of August 2000, 164g N and 184g P (P2O5) was applied to all the three tree species. Data reveal that per cent increase in height of *E. camaldulensis* and *D. sisso* was significantly influenced by fertilizer application, whereas *A.nilotica* did not respond. Average percent increment values were 12.8% for *D.sissoo*, 4.9% for *E.camaldulensis* and 8.6% for *A.nilotica* as compared to 3.9, 3.1 and 7.8 per cent for *D.sissoo*, *E.camaldulensis* and *A.nilotica* respectively in control.

Fertilizer application was effective in significantly increasing the crown diameter for *A.nilotica* registering 28% crown increment as compared to 21% for control plot whereas for *E.camaldulensis* it was 25% for fertilized plot against 21% for control. *D. sissoo* recorded lesser percent crown increment for fertilized plot as compared to control.

Biomass estimation studies were carried out in *E.camaldulensis, A.nilotica and D. sissoo* after five years of plant growth for non-fertilized plants. Maximum total dry biomass yield of 9.5 t/ha was recorded for *E.camaldulensis* followed by 9.3 t/ha for *A. nilotica* and only 3.3 t/ha for *D.sissoo*. While stem mass was 6.2 t/ha for *E. camaldulensis it* was only 5.4 t/ha for *A.nilotica* as branch mass was higher (3.4 t/ha) for *A.nilotica* as compared to (1.7 t/ha) *E.camaldulensis*. Leafmass yield recorded a three-fold increase for *E. camaldulensis* as compared to *A.nilotica*. Stem and leaf yield was almost three times less for *D.sissoo* as compared to *E.camaldulensis*.

Fresh rootmass was estimated for all the three tree species by excavating the roots in a pit of 2m dia (1m on each side of tree stem) and digging to the depth of 80 cm. Total number of roots, total root length, weight of lateral roots and total root volume was maximum for *E.camaldulensis*, followed by *A.nilotica* and *D. sissoo*. There was no clear tap root formation in any of the tree species, however, lateral roots were thick and their spread was more than 1m for *E. camaldulensis* and *A. nilotica*.

Performance of different tree species under irrigated conditions in arid zone

D. sissoo

E. camaldulensis

T. grandis

A. nilotica

Percent moisture was determined on a day before and after the irrigation and then at the interval of every four day (three measurements) for all these species. This exercise was carried out at the distances of 40 cm, 80 cm and 120 cm from tree trunk at three soil depths (0-25, 25-50 and 50-75 cm) in each month for one year. Study showed that A. nilotica withdrew maximum water in the months of February, March, August and September from all the soil depths. Withdrawal pattern was similar for the tree distances of 40 and 80 cm. However, no withdrawal was observed at the distance of 120 cm due to no drift of water from irrigation point. In all other months *E. camaldulensis* utilize the maximum water. *D. sissoo* and *T. grandis* were placed third and fourth in water withdrawal. Studies indicate that water requirement of different species vary according to their growth phase.

(c) NEW PROJECTS TAKEN UP: Nil

SILVICULTURE DIVISION

(a) PROJECT COMPLETED DURING THE YEAR 2000-01 : Nil

(b) OLD PROJECT CONTINUED

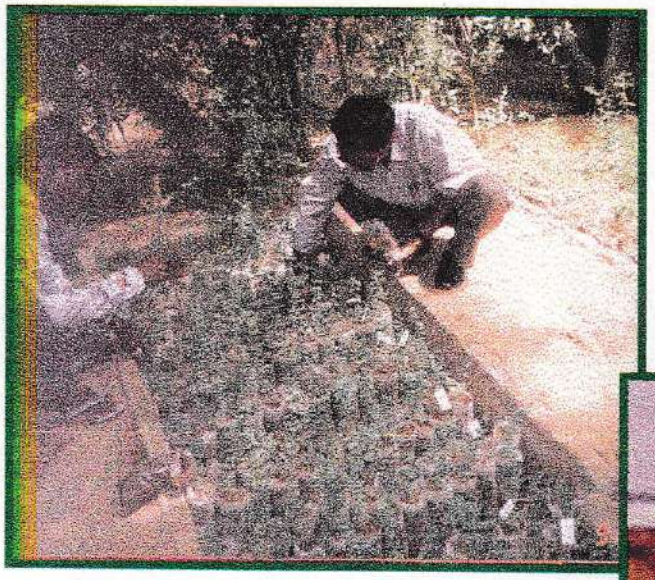
(i)	**Sl. No**	:	8
(ii)	**Project identification number**	:	AFRI-8/SILVI-1(WB.2-IV)
(iii)	**Title of project**	:	Irrigation water management for tree species Sub-Project: Studies on VAM association in Irrigated Plantations and Agro-forestry systems.
(iv)	**Name of Project investigator**	:	Dr.K.K.Srivastva SE
(v)	**Year of the start of the project**	:	1992
(vi)	**Target year of completion**	:	Dec. 2001
(vii)	**Cost of the project and expenditure made so far**	:	Rs.50,000/

(viii) Objectives in brief:

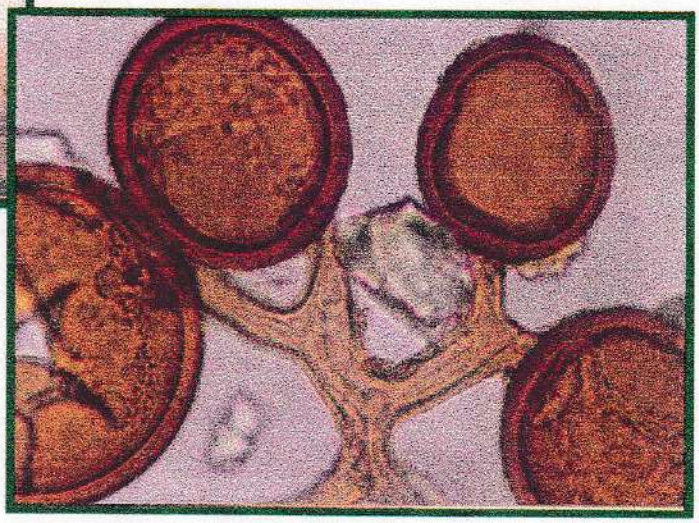
- Identification of different VAM fungi associated with tree species growing in irrigated plantations and agro-forestry system in arid zone of Rajasthan.
- Determining the dependency of different arid and semi-arid tree species on VAM fungi.
- To develop protocol for mass inoculum production.
- Selection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

(viii) Scientific Importance of investigations:

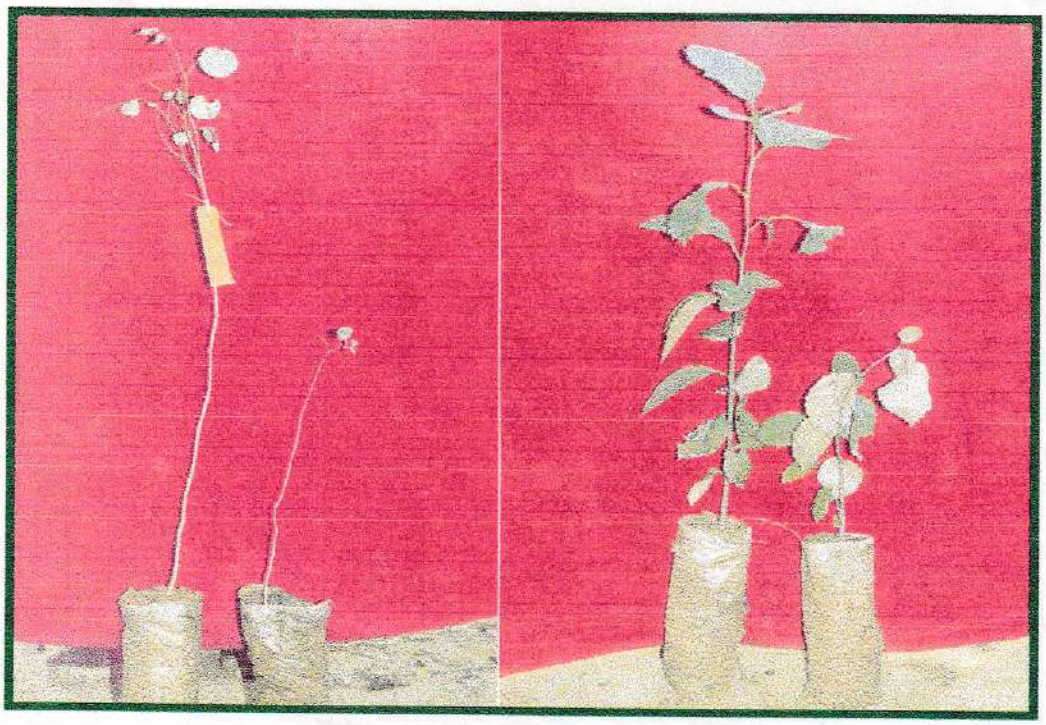
Use of bio-fertilizer has a vast importance in forestry. The soil of arid zone area is low in nutrients and minerals. VAM fungi play a key role in providing nutrients like N, P, Zn & Cu from the soil in insoluble forms to soluble form to the plants. In high pH, water stress conditions VAM inoculated plants can perform better than non-inoculated because they have the tolerance against adverse conditions. Economically bio-fertilizers are cheaper and practically possible in forestry tree species.



VAM inoculation experiment in arid zone tree species (in nursery)



G. fasciculatum



D. sissoo *C. myxa*

Effect of VAM inoculation (After 120 days)

(ix) Results and Achievements:

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 bimonthly observations were recorded on biomass, percentage of VAM colonization and spore population. The results indicated that VAM inoculated seedlings of *P. cineraria* performed better in term of biomass and percentage of infection than other treatments. The causality percentage was found least in VAM inoculated than SPM.

Survey of *A. nilotica* plantations for VAMF population studies

Survey for VAMF populations in *A. nilotica* was carried out at Himatnagar and Palanpur South Sabarkatha Division (Gujarat). The rhizosphere soil was found rich in VAMF population, whereas spore density was recorded 686 & 652 spores /100 gm soil from Himmatnagar and Palanpur respectively. The rhizosphere soil samples of *A. nilotica* reveals the presence of four genera namely *Glomus, Scutellospora, Sclerocystis* and *Acaulospora*. Among the genera *Glomus* was found predominant genera than *Acaulospora, Scutellospora and Sclerocystis.* Among the species *Glomus fasciculatum* and G aggregatum were found most common species in rhizosphere soil of *A. nilotica*.

Studies on VAM colonization and VAM propagules in *A. nilotica* and *D. sissoo* in nursery

The samples of *A. nilotica* and *D. sissoo* were collected from four SFD's nurseries Himmatnagar and Palanpur, South Sabarkatha division, Gujarat. The root samples showed the presence of VAM colonization in both tree species *i.e., A. nilotica* and *D. sissoo*. The percentage of VAM colonization varied from nursery to nursery and the species. Rhizosphere soil samples were found rich in spore population. The spore density varied between the species to species and nursery to nursery.

Mass inoculum production of VAM

About sixty pots of VAM inoculum containing various strains of VAM fungi *viz., Glomus microcarpum, G. fasciculatum, G. aggregatum* and mixed culture of *G. fasciculatum* and *G. aggregatum* were prepared for further experimentation and large-scale inoculation. Selective strain of VAM fungi (consortium inoculum) for neem has been prepared for nursery inoculation and field trials.

Standardization of dose of Neem shield biofertilizer

A new experiment was laid out to standardize the dose of Neem shield on *A. indica* .The experiment was laid out with six different treatments viz., T-1, 2.5 gm; T-2, 5.0 gm; T-3, 7.5gm, T-4, 10.0 gm, T-5, 15gm and T-6, Control. The 50 plants were taken/ treatment/ replication. The experiment is in progress.

(i)	**Sl. No**	:	9
(ii)	**Project identification number**	:	AFRI-9/SILVI-2(PLAN)
(iii)	**Title of project**	:	Disease spectrum of arid and semi-arid tree species.
(iv)	**Name of Project investigator**	:	Dr.K.K.Srivastva SE
(v)	**Year of the start of the project**	:	1993
(vi)	**Target year of completion**		Continue
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 30,000/-

(viii) Objectives in brief:

- To record out break of diseases in forest nurseries and plantations.
- To collect, isolate and identify the pathogens.
- To assess the incidence of the disease.
- To find out economically important diseases and evolve their management.

(ix) Scientific importance of the investigations:

During survey of forest nurseries and plantations a number of pathogenic diseases have been reported from arid and semi- arid areas of Rajasthan and Gujarat. In nurseries various diseases like, collar rot, wilt, damping off, charcoal root rot and other foliar diseases cause considerable losses in every year. In plantations, mortality due to *Ganoderma* root rot, wilt disease, sun scorching & bark canker and die back diseases are economically important. Timely diagnosis and suitable management (fungicidal or silvicultural) is necessary to control them. Regular survey, assessment and new out breaks of the diseases is essential to evolve suitable management.

(x) Results and achievements:

Studies on mortality in *Acacia ampliceps*

Mortality in *Acacia ampliceps* was recorded in experimental field, Gangani, FE&DD division. The plantation was found severely attacked by canker disease and mineral deficiency symptoms. For immediate treatment of the disease foliar spray of Indofil-45@ 0.2 %+ Tracel 2gm/ltr was given. The cultural work is in progress.

Survey on mortality in *P. cineraria* plantation

A preliminary survey was conducted to detect the cause of mortality in *P. cineraria* agroforestry plantation. The mortality problem was reported from four district of Rajasthan namely, Nagaur, Sikar, Jhunjhunu and Churu. The infection started from the lopped portion and develops the symptoms of dieback. Gradually infection spreads to downwards and reached upto root system and mortality occurs in standing trees. The association of three pathogens viz., *Alternaria* sp., *Botryodiplodia theobromae* and *Phoma* sp. were isolated and identified. Association of insect borer was also found. The study is in progress.

Mortality in *D. sissoo* plantation

Mortality in *D. sissoo* plantation was recorded at Khatu Shyam ji roadside plantation, Sikar. The factor involved in mortality was due to lack of moisture and taproot development. Due to faulty irrigation side roots were developed vigorously and sudden stopping of irrigation and drought of last years a large-scale mortality was noticed due to *Fusarium* root rot disease in *D. sissoo*. Few trees raised near the agricultural field were severely attacked by root rot disease due to injury caused by ploughing in agriculture field. Partially affected trees were recommended for soil drenching with Bavistin.1% @ 5ltr/tree.

Mortality in Neem plantation

An enquiry letter was received from CF, Jodhpur reg. Mortality in neem (*A. indica*) plantation. The root samples were analysed and found attacked by charcoal root rot disease. The similar problem was also noticed in International provenance trial of neem at experimental field, Forest Genetics and Tree Breeding Division, AFRI, Jodhpur. The cultural study in progress. However, soil drenching with Carbendazim (0.1%) was recommended for its immediate control.

Ganoderma* root rot in *Calotropis procera

The fruiting body of *Ganoderma* was first time collected from the base of *Calotropis procero* from AFRI Campus, Jodhpur.

(c) NEW PROJECTS TAKEN UP: Nil

FOREST RESOURCE MANAGEMNT AND ECONOMICS DIVISION

(b) PROJECT COMPLETED DURING THE YEAR 2000-2001

(i)	**Sl. No**	:	10
(ii)	**Project identification number**	:	AFRI-10/FRME-1 (WB2-III)
(iii)	**Title of project**	:	Growth and yield studies in irrigated plantations of IGNP area
(iv)	**Name of Project investigator**	:	Dr.V.P.Tiwari SE
(v)	**Year of the start of the project**	:	1995
(vi)	**Target year of completion**	:	Jan. 2001
(vii)	**Cost of the project and expenditure made so far**	:	Approximately Rs 50,000/- (excluding cost of equipment purchased)

(viii) Objectives in brief :

- *D. sissoo* planted under irrigated conditions in IGNP area
- Preparation of volume/yield tables and development of site-index equations and growth & yield functions for these two species

(ix) Scientific importance of investigations:

Management of plantations, assessment of site productivity, yield prediction, stand projection, growth modeling.

(x) Results/achievements:

The MAI for *E. camaldulensis* and *D. sissoo* ranged from 1.82 to 24.82 Cu.m./ha/year and 2.10 to 19.90 Cu.m./ha/year, respectively depending upon age, density and site. The average form factor varied from 0.33 to 0.56 and 0.32 to 0.56 for *E. camaldulensis* and *D. sissoo,* respectively. For 8-year-old plantations planted at spacing of 2mX2m, the ratio of best to worse volume yield is 8:1 and 7:1, respectively for these species. The dominant height varied from 8.2m to 31.1m for *E. camaldulensis* and from 8.7m to 22.1m for *D. sissoo* depending upon site quality and age. Annual height and diameter growths have also been estimated. Volume equations for both the species constructed and validated. Combined variable equation performed best among all the models tried for the two species. Provisional yield tables have also been prepared. Dominant height/site index equations for both the species have been developed. Payandeh and Wang model performed better for *E. camaldulensis* in comparison to Ek's,

Newnham and Goelz & Burk functions while Goelz & Burk model performed best in case of *D. sissoo* as far as relative accuracy is concerned. Growth and yield functions have also been worked out for both the species. For *E. camaldulensis*, Chapman-Richard equation performed better than the Gompertz and Schumacher models in the case of Diameter-age relationship while Schumacher model produced better results in the case of Volume-age compared to the other two models. In case of *D. sissoo*, Gompertz function produced better results for modeling both the diameter-age as well as volume-age relationships. The coefficients of all the models are taken as functions of stand densities and site classes.

(c) OLD PROJECTS CONTINUED: Nil

(d) NEW PROJECTS TAKEN UP: Nil

FOREST PROTECTION DIVISION

a) PROJECT COMPLETED DURING THE YEAR 2000-2001 : Nil

b) OLD PROJECTS CONTINUED:

(i)	**Sl. No**	:	11
(ii)	**Project identification number**	:	AFRI-11/FP-1 (PLAN)
(iii)	**Title of project**	:	Integrated Pest Management for Forest Insect Pests
(iv)	**Name of Project investigator**	:	Dr. S.I. Ahmad SF
(v)	**Year of the start of the project**	:	1996
(vi)	**Target year of completion**		2002
(vii)	**Cost of the project and expenditure made so far**	:	Rs.1,00,900/-

(viii) Objective in brief:

Component 1: **Evaluation of bio-pesticidal efficacy of some arid zone plant species.**

- To extracts the plant/parts and fractionation of crude extracts into different active compounds.
- To investigates the bioefficacy of the plant extracts/active fraction against major insect pests of arid zone.

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

- To prepare checklist of potential natural enemy complex of each of the key pests.
- To study the efficacy of each of the potential bio-control agents.

Component: III: Screening and Bioassay of conventional insecticides against key pests of Neem.

- To study the bioassay of conventional insecticides against key pests of Neem.

(viii) Scientific importance of investigations:

- Utilisation of plant origin phytopesticides will help in minimising the frequent use of chemical pesticides.
- Similarly, the use of bio-control agents such as parasites, predators and pathogens will replace the use of conventional insecticides against key insect pest
- Bioassay of chemical pesticides will be useful in standardising the optimal dose for their emergent use in forest nurseries.

(ix) Results / achievements:

Efficacy of phytopesticides

Investigation of the bioefficacy of plant extracts of *Psorolea corylifilia* and *Balanites aegypticea* against major insect pests is in progress.

The extract of *Psorolea corylifolia* has been prepared for testing it in different concentrations in order to find out its effective biocidal dose. The different concentrations against *Myllocerus tenuicornis* prepared were 0.1, 0.5, 0.05, 0.005 and 1%. The experiment was replicated thrice. It has been observed that the extract worked as repellent rather than acting as effective biopesticide. However, an insignificant mortality measuring 9.0 to 10% per replication was recorded in 48 hours. Moreover, 0.5% concentration was found to be most effective as repellent and an antifeedent. The data will be subjected to analysis of variance in order to study the exact antifeedent activity.

The ecological observations revealed that after treatment the beetles become restless and start moving away from treated leaves. The repellent activity of the extract of *Psorolea corylifolia* has been confined. Further investigation by using higher concentration of the extract is being worked out against *Myllocerus tenuicornis*.

- Relevant literature on biopesticidal aspects of *Psorolea corylifolia* and *Balanites aegypticea* have been screened out from various sources. The same have viewed while carrying out the experimental works.

- The extract of *Balanites aegypticea* (fruit coat and fruit pulp) is being prepared for testing against *Patialus tecomella* in different concentrations to find out the effective biocidal dose. The experiment was replicated thrice. The data were collected and recorded. The major insect pests of Rohida and Neem viz. *Patialus tecomella* and *Myllocerus tenuicornis* were collected from experimental fields of AFRI.

- The biopesticidal studies show a positive response of *Balanites aegypticea* against *Patialus tecomella*. Amongst the different concentrations viz. 0.1, 0.01, 0.001% listed, the 0.1% was found to be the most effective.

II. Efficacy of parasites

- *Euplelmid* sp. (Eupelmidae : Chalcidae) and effective egg parasitoid was found to parasites the eggs of *Halys dentalus*, *Eurybrachus tomentosa* and *Homoecerus prominulus*.

- *Acaudaleurodes rachipora* was attacked by three species of parasites and six species of spiders namely *Encarsia acaudaleyrodis*, *Encarsia sp.*, and *Eretmocerus rajasthanicus* and *Neoscona theis, Theridon sp, Peucetia sp, Cyrtarachne sp, Parawixia sp, Cheiracanthim sp.* Respectively.

- *Eupelmus* species is the chief larval ectoparasite of *Contarinia prosopidis* (rachis gall inducer). Biological observations on this parasite have been studied in detail recorded as:

- The eggs of *Eupelmus* species generally laid in the close vicinity of the host larvae inside the gall tissue. Each egg is oval and measures 0.40±0.007 m.m., in length and 0.21±0.01 m.m., in width with smooth eggshell. The incubation period range from one to three days with an average of 2.35 ±0.01 days.

- There are three larval instar. In about five days the maggots becomes mature and by this time it is able to suck the complete body fluid of the host larva. The colour of the larva is creamy white. The size of the different instars maggots varies from 0.73±0.02 mm., to 1.50± 0.03mm., in length and 0.36±0.02 to 0.81±0.04 mm., in width pupation takes place in gall.

- The adult of *Eupelmus* clears its way out of the gall surface alongwith the midge. The act of emergence from the gall takes a few seconds. Average lengths of newly emerged male and female individuals measure 0.95±0.04 mm and 1.35±0.06 mm respectively. Mature parasites are capable of strong flight and were often seen flying over the *Prosopis cineraria* trees on warm sunny days.

III. Efficacy of chemical insecticides

- The ten different conventional chemical insecticides viz.; 1)Chloropyriphos, 2)Monocrotophos, 3)Endosulphan,4) Quinalphos, 5)Fenvalerate, 6)Dimethoate,7) Malathion, 8)Cypermethrin, 9)Phasmidon and 10)Dimecron in different levels of concentration are being tested against *Myllocerus tenuicornis*. The data on the different effectiveness of various chemical insecticides against *Myllocerus tenuicornis* have been recorded and the same are being analysed by using the probit analysis method.

(i)	**Sl. No**	:	12
(ii)	**Project identification number**	:	AFRI-12/FP-2 (PLAN)
(iii)	**Title of project**	:	Studies on the pest problems in forest nurseries and their management in arid and semi-arid region
(iv)	**Name of Project investigator**	:	Smt. Seema Kumar SD
(v)	**Year of the start of the project**	:	1994
(vi)	**Target year of completion**		2003
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 38,900/-

(viii) Objective in brief :

- To record outbreak if any.
- To survey, collect and identify pests of economic forestry importance and develop a reference collection of the same.
- To study the eco-biology and host range of important pests.
- To evolve eco-friendly integrated pest management strategies.
- To bring all the scattered information on pest problem in forest nurseries in a single document.

(ix) Scientific importance of investigation:

Conservation of faunal diversity, generation of data on bio-ecology and economically viable and environmentally compatible pest management strategies will be involved.

(x) Results/achievements:

- A comprehensive list of forty-two species of insect pest causing damage to eighteen forest trees in Rajasthan and Gujarat was prepared. Bibliography of pests of forest nurseries with special reference to arid regions was prepared.

- Regular surveys were conducted to forest nurseries in and around Jodhpur for surveillance and collection of pests.

- No outbreak was recorded in this year.

- Seven species of *Myllocerus* were recorded on different hosts viz. *Myllocerus undecimpustulatus* on *Azadirachta indica, Dalbergia, Pongamia pinnata, Albizzia lebbeck, Acacia nilotica* and Cassia siamea, *Myllocerus tenuicornis* on *Azadirachta indica, Acacia nilotica, Dalbergia sissoo, Myllocerus laetivirens* on *Dalbergia, A. indica, Acacia nilotica* & *Moringa* sp., *Myllocerus dorsatus* on *Dalbergia sissoo* and *Myllocerus dalbergiae* on *Dalbergia sissoo.*

- Two species of *Myllocerus* are still yet to be identified.

- Two species of Diptera belonging to family Agromyzidae were recorded as new hosts of *Ailanthus excelsa*. They fall into the category of leaf miners.

- Other frequently occurring insect pests were- *Patialus tecomella* on *Tecomella undulata, Noorda blitealis* on *Moringa oleifera, Acaudaleyrodes rachipora* on *Acacia nilotica, Acacia ampliceps, Acacia senegal, Cassia siamea, Prosopis* cineraria, *Prosopis juliflora*, *Bombax* sp., *Lasperyresia koenigana* on *Azadirachta indica, Calotis amata* on *Salvadora, Microtermes mycophagus* on *Azadirachta indica, Leucoptera sphenograpta* on *Dalbergia sissoo.*

Non-Insect Pests recorded were:

- Mites- *Aceria pongamiae* on *Pongamia pinnata,* Nematodes- Meilodogyne sp. on *Acacia nilotica and*
- Mollusc- *Laevicaulis alte* on *Azadirachta indica.*
- The pests were preserved as future reference collection.
- Eco-biology of *Calotis amata* was studied.
- Concept of Nursery Ecosystem Analysis with emphasis on cultural and quarantine control was given for better pest management in forest nurseries.

- The preserved specimens are being maintained as reference collection for further studies.

(c) NEW PROJECTS TAKEN UP : Nil

NON-WOOD FOREST PRODUCTS

(a) PROJECT COMPLETED DURING THE YEAR 2000-2001

(i)	**Sl. No**	:	13
(ii)	**Project identification number**	:	AFRI-13/NWFP-1 (PLAN)
(iii)	**Title of project**	:	Studies on fatty oil of some important oil bearing plants of arid regions.
(iv)	**Name of Project investigator**	:	Dr. Y.C.Tripathi SE
(v)	**Year of the start of the project**	:	April 1995
(vi)	**Target year of completion**		March 2000
(vii)	**Cost of the project and expenditure made so far**	:	:Rs. 1,55,421/- (Approx.)

(viii) Objectives in brief:

- To survey the oilseed potential of arid regions
- To identify high oil yielding provenance for collection of good quality seeds and for large scale propagation of oilseeds plant species
- To screen out arid zone flora for further sources of fatty oils
- To carry out qualitative studies of oil of various species to ascertain their industrial suitability

(ix) Scientific importance of investigations:

Tree borne oilseeds are the potential source of fatty oil, which constitute the major industrial raw material for the manufacture of many value-added products. In view of the wide applicability and great industrial demand, research work was initiated 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 and to select best areas for oilseeds production. It was also envisaged to screen the arid and semi-arid zone species for identification of newer sources of fatty oils, which would further augment the total production of oils in the country.

(x) Results/achievements:

Oil extracted from *P. pinnata* seeds of different agro-climatic zones of Rajasthan were studied for their physio-chemical properties viz., refractive index, acid value,

saponification value, iodine value and percentage of unsaponifiable matter. 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 work of determination of oil content of species was continued. The seeds of various exotic Acacias (*Acacia ampliceps, A. victorae, A. colimus, A.adsurgens*) and other indigenous species viz. *Acacia nilotica, Sesbania sesban, Prosopis cineraria, Citrullus colocynthis, Capparis decidua, 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.

(i)	**Sl. No**	:	14
(ii)	**Project identification number**	:	AFRI-14/NWFP-2 (PLAN)
(iii)	**Title of project**	:	Study on the Biocidal Activity of Extractives of Arid Zone Plants.
(iv)	**Name of Project investigator**	:	Dr. Y.C.Tripathi SE
(v)	**Year of the start of the project**	:	April 1995
(vi)	**Target year of completion**		March 2000
(vii)	**Cost of the project and expenditure made so far**	:	: Rs. 1,55,421/- (Approx.)

(viii) Objectives in brief:

- To study the biocidal efficacy of various arid zone plant species to explore their pesticidal potential so as to develop eco-friendly plant based pesticides.

(ix) Scientific importance of investigations :

- The use of botanical pesticides is gaining much importance over the more hazardous chemical insecticides and fungicides. 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. Generally plants rich in bitter principles are found to have this activity. On this basis *Capparis decidua, A. indica* (Neem) and other plants were selected for testing their biocidal activities.

(x) Results/achievements :

The efficacy of total as well as sequential methanolic extracts of different parts of *Capparis decidua* have been tested against the aphid Lipapis 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 at 0.5% concentration against all the stages of larvae of *Noorda blitealis,* the Moringa defoliator. The effect of Neem Seed Oil (NSO) on the growth of *Acaudaleyrodes rachiora,* 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 development of whitefly significantly.

Extracts of different parts of some other plants namely *Psoralea corylifolia, Balanites aegyptiaca* and *Dicoma tomentosa* were prepared. Percentage yield of extract of different parts of the plant has been worked out. Fractionation of various extracts of all the plants was done for separating their active fractions. Preliminary results of the evaluation of their biocidal efficacy were encouraging.

(b) **OLD PROJECTS CONTINUED**

(i)	**Sl. No**	:	15
(ii)	**Project identification number**	:	AFRI-15/NWFP-3/(PLAN)
(iii)	**Title of project**	:	Studies on the proteins of arid zone shrubs and trees for their potential as food and fodder
(iv)	**Name of Project investigator**	:	Dr. Mala Rathore SD
(v)	**Year of the start of the project**	:	Apirl 1995
(vi)	**Target year of completion**		March 2005
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 1,75,421/- (Approx.)

(viii) Objectives in brief :

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

(ix) Scientific importance of Investigations :

There is limited availability of land for increased food and forage production for the ever-growing population. To maintain the nutritional standards, unconventional sources of proteins have to be explored. In arid and semi-arid regions, browsing of shrubs and trees has become increasingly severe because of harsh environment and limited, fluctuating feed supplies.

The values of shrubs and tree fodder are 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.

(x) Results/Achievements:

Crude protein content studies on the species taken up last year were continued. During the current year, *Prosopis juliflora, Parkinsoina aculata, Prosopis cineraria, Acacia senegal, Dichrostychus cineraria* and some herbs were selected and LPC prepared. Chroloplastic and cytoplasmic studies are in progress.

(C) NEW PROJECT TAKEN UP- Nil

DIVISION OF FOREST GENETICS AND TREE BREEDING

(a) PROJECTS COMPLETED DURING 2000-2001: Nil

(b) OLD PROJECTS CONTINUED

(i)	**Sl. No**	:	16
(ii)	**Project identification number**	:	AFRI-16/FGTB-1 (WB.3-I)
(iii)	**Title of project**	:	Provenance trials on *Acacia nilotica* and *Ailanthus excelsa.*
(iv)	**Name of Project investigator**	:	Sh. C.J.S.K. Emmanuel SE
(v)	**Year of the start of the project**	:	1991
(vi)	**Target year of completion**	:	2001
(vii)	**Cost of the project and expenditure made so far**	:	: Rs. 4,12,371/- (Approx.)

(viii) Objectives in brief :

- To screen the available geographic variation for timber yield.
- To screen the available geographic variations for higher fodder yield.

(ix) Scientific importance of investigation :

To achieve maximum gains from a plantation, it is important that the material selected should be best suited to that particular site. Provenance trials are laid out with this aim. The selections made after conducting these trials are supposed to give maximum gains in terms of the end product.

(x) Results/achievements :

The data on growth parameters have been recorded for the provenance trials of *Acacia nilotica* laid out with 28 seed sources during 1992. The rating of the provenances varies from year to year, in this year it is Shivpuri, Agra and Gurgaon.

In 1997, seeds have been collected from 45 seed sources of *Acacia nilotica* from all over India. The data has 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. The seeds have been supplied for raising provenance trials to Forest Research Institute, Dehradun, Institute of Forest Genetics and tree Breeding, Coimbatore, Tropical Forest Research Institute, Jabalpur, Institute of Wood Science and

technology, Bangalore, Silviculturist, Gujarat Forest Department, Rajpipla, Arid Forest Research Institute, Jodhpur, Conservator of Forests (Research), Haryana Forest Department, Panchkula, Conservator of Forests (Research), Andhra Pradesh Forest Department, Hyderabad, Conservator of Forests (Research), U.P. Forest Department, Lucknow, Conservator of Forests (Research), Maharashtra Forest Department, Pune.

Seedlings have been raised from this material and transplanted in the field at six different research stations of the State Forest Departments. Seeds have not been received by FRI, Dehradun and TFRI, Jabalpur whereas the seeds have not been sown by IFGTB, Coimbatore and IWST, Bangalore. The seedlings raised at AFRI, Jodhpur have been planted in the field at the JNV University campus.

The *ailanthus excelsa* provenance trial was laid out from the seeds collected from 13 different seed sources were sown in the nursery and transplantable seedlings could be obtained from 8 provenance only. The provenance trial was laid out at two different sites Jaipur and Jodhpur. The data collected shows that the Pinjore (Haryana) was the best followed by Bikaner (Rajasthan) and Kazipeth (Andhra Pradesh).

In the year 1997 as per the MTR of WB fresh collection of the *Ailanthus excelsa* provenances was done and seeds could be collected from 35 provenances. The seedling could be raised from 32 provenances and were transplanted in the field during 1998. Due to drought conditions the mortality rate was very high and seeds were again sown and mortality replacement was done in 2000.

(i)	**Sl. No**	:	17
(ii)	**Project identification number**	:	AFRI-17/FGTB-2 (PLAN)
(iii)	**Title of project**	:	International Neem Network Provenance trial
(iv)	**Name of Project investigator**	:	Sh.C.J.S.K. Emmanuel SE
(v)	**Year of the start of the project**	:	March 1995
(vi)	**Target year of completion**		December 2005
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 1,48,612/- (Approx.)

(viii) Objectives in brief

- To screen out provenances for growth.
- To screen out provenances for azadirachtin content.
- To screen out provenances for oil content.

- To study isozyme patterns of different provenances.
- To make crosses between promising provenances for higher oil and adaptability purposes.
- To select Plus Trees and establish Seedling Seed Orchards.
- To improve the genetic quality and adaptability of Neem and to improve its utilisation.

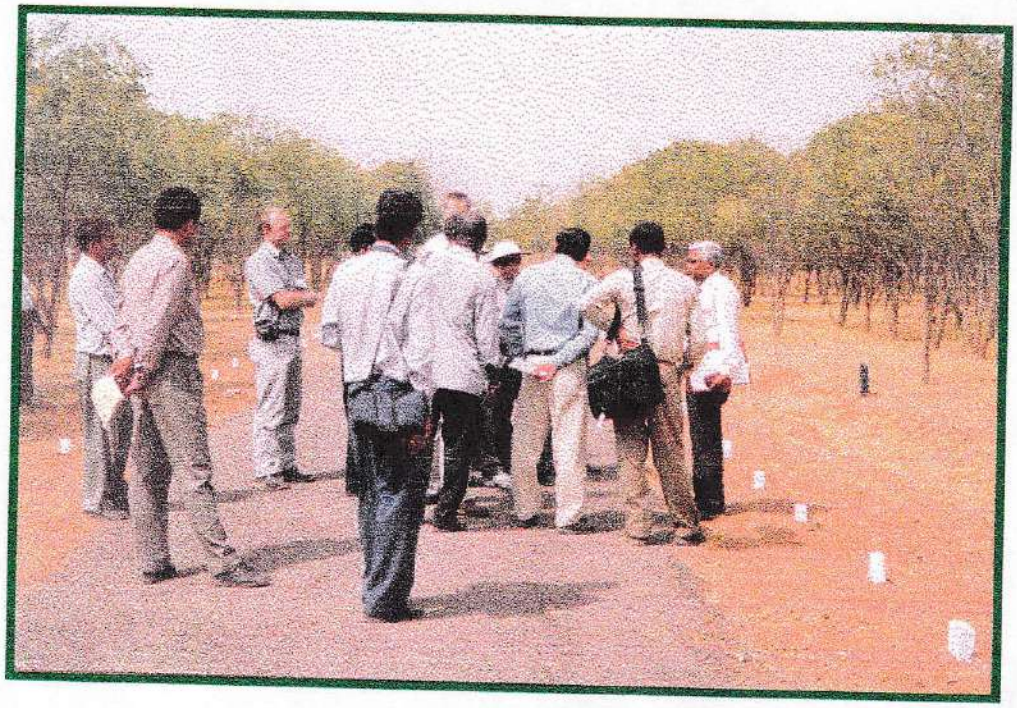
(ix) Scientific importance of investigation :

To achieve maximum gains from a plantation it is important that the material selected should be best suited to that particular site; with this aim only the provenance trials are laid out. The selections made after conducting these trials are supposed to give maximum gains in terms of the end product.

(x) Results/achievements :

The International provenance trial on neem was initiated by the FAO 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 4.58 meters and collar diameter is 37.49 cms from Myne of Myanamar. The best performers are Sunyani and Myanmar. Among the Indian provenances Sagar is the best with a height of 2.32 meters ffollowed by Ramanaguda and Jodhpur. ***The AFRI, Jodhpur has successfully organised an International Neem Network Workshop on the Data analysis from 21st -25th March 2001 sponsored by the FAO.*** The participants of eight countries besides experts from FAO and DANIDA attended the workshop.

(i)	**Sl. No**	:	18
(ii)	**Project identification number**	:	AFRI-18/FGTB-3/(PLAN)
(iii)	**Title of project**	:	Provenance trial on Arid Zone species
(iv)	**Name of Project investigator**	:	Sh.C.J.S.K.Emmanuel SE
(v)	**Year of the start of the project**	:	March 1992
(vi)	**Target year of completion**		March 2002
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 45,456/- (Approx.)



Visit of INN Participants to National Neem Provenance Trial

International Neem Network Provenance Trial

(viii) Objectives in brief :

- To find out the promising provenance for growth.
- To find out the promising provenance for adaptability.
- Utilize the best provenance for Plant Improvement work.

(ix) Scientific importance of investigation :

To achieve maximum gains from a plantation it is important that the material selected should be best suited to that particular site; with this aim only the provenance trials are laid out. The selections made after conducting these trials are supposed to give maximum gains in terms of the end product.

(x) 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 Jaisalmer (Rajasthan) provenance is superior in growth followed by Jhansi(Mashya Pradesh) and Palanpur(Gujarat).

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, from the seeds sent by FRI, Dehradun 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 meters. 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 7.16 meters of height followed by Lalitpur 5.85 meters and Mohan Nagar 5.53 meters. The local provenance has not given good result.

(i)	**Sl. No**	:	19
(ii)	**Project identification number**	:	: AFRI-19/FGTB-4 (WB.3-II)
(iii)	**Title of project**	:	To develop vegetative propagation technique for *Acacia nilotica* and *Ailanthus excelsa*
(iv)	**Name of Project investigator**	:	Dr. U.K.Tomar SE
(v)	**Year of the start of the project**	:	1994
(vi)	**Target year of completion**		Dec. 2001
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 58,664/- (Approx)

(viii) Objectives in brief :

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

(ix) Scientific importance of investigations:

Clonal propagation techniques are essential for tree improvement programme through clonal forestry or clonal seed orchards. *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 in both the species, clonal propagation techniques are required to be developed.

(x) Results and Achievements:

Acacia nilotica

- Experiments with 3.5-cm thickness stem cuttings were tried out with *different* level of IBA treatments. Maximum of 15% rooting was observed when cuttings from adult trees were treated with 5000 ppm IBA solution for 30 seconds. The rooted plants were kept in the green house for hardening. These were transferred to the field.

Ailanthus excelsa:

Cuttings from coppice shoots were taken and dip treatments of 500, 1000,2000 and 5000 ppm of IBA were given. Best rooting response (50%) was obtained from 1000 ppm treatment. There was a high mortality rate during the hardening phase. The

surviving plants were planted in the field and are doing well. An experiment was conducted in May. Stem cuttings were prepared from seedlings (1 and 2 year 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 seedling after 30 days of growth in mist chamber conditions, whereas, 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 500, 1000, 1500 and 2000ppm IBA. Maximum 40% rooting was recorded in cuttings from middle portion at 1000 ppm IBA. Only sprouting was observed from cuttings of lateral branches of mature tree. Cuttings prepared from coppice shoots rooted with very low frequency (5.3%) on 1000 ppm IBA treatment. An experiment was conducted in May. 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, whereas, 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 500, 1000, 1500 and 2000 ppm IBA. Maximum 40% rooting was recorded in cuttings from middle portion at 1000 ppm IBA. Only sprouting was observed from cuttings of lateral branches of mature tree. Cuttings prepared from coppice shoots rooted with very low frequency (5.3%) on 1000 ppm IBA treatment.

(i)	**Sl. No**	:	20
(ii)	**Project identification number**	:	AFRI-20/FGTB-5 (WB.3-III)
(iii)	**Title of project**	:	To develop tissue culture technique for *Acacia nilotica* and *Ailanthus excelsa*
(iv)	**Name of Principal investigator**	:	Dr. U.K.Tomar SE
(v)	**Year of the start of the project**	:	1994
(vi)	**Target year of completion**		December 2001
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 45,086/- (Approx.)

(viii) Objectives in brief :

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

(ix) Scientific importance of investigations :

Tissue culture techniques are additional powerful tools not only for clonal forestry but are also prerequisite 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.

(x) Results and Achievements :

Result and Achievements:

Acacia nilotica

- Cultures are being maintained for the last one and half years by repeated sub culturing on shoot multiplication medium. However shoot multiplication medium. However shoot multiplication rate is not very fast.
- Rooting experiments were undertaken routinely and it was found that hormone free ½ MS medium or ½ MS with IBA gave high rooting percentage (70%), though not cent percent.
- The survival rate of these regenerated plants was not very high in the previous year so experiments were laid out (which are still in progress) to improve the hardening phase by increasing the time kept in the mist chamber.

Ailanthus excelsa

- Nodal segments with vertical orientation were used further to standardize the stem multiplication efficiency and eliminate the intermittent callus formation. Shoot multiplication was found to marginally increase by the use of 200-mg/l tryptophan in the earlier used MS medium supplemented with 2 mg/ 1BA.
- With the view of decreasing the mortality rate of the rooted plantlets, efforts are still being continued for increasing the survival rate by increasing the time period for which the plantlet were initially kept at 90% humidity in the mist chamber.
- Experiments were also laid out for initiating the callus cultures from nodal explants. Good callus was found to initiate on MS medium supplemented with 30-g/1 sucrose, 2.0 mg/1 2, 4 D and 0.5 mg/1 BA at a pH of 5.8. Highly embryogenic looking, compact, nodular calli resulted. This will be now utilized to develop regeneration system based on somatic embryogenesis and organogensis, whichever feasible.

(i)	**Sl. No**	:	21
(ii)	**Project identification number**	:	AFRI-21/FGTB-6 (NOVOD)
(iii)	**Title of project**	:	Integrated development of Neem in different agroclimatic zones – Gujarat (i) Selection of CPT/sample trees, Phenological observations, Development of model plantation, Model villages. (ii)Studies on the storage of seeds collected from sample trees.
(iv)	**Name of Principal investigator**	:	Dr. U.K.Tomar SE
(v)	**Year of the start of the project**	:	1999
(vi)	**Target year of completion**		2004
(vii)	**Cost of the project and expenditure made so far**	:	Rs. 32.27 Lakhs/-

(viii) Objectives in brief :

- Screening the neem germplasm for oil and Azadirachtin contents and establishment of selected superior germplasm in research plantations. Distribution of the superior stock to end-users (SFDs, NGOs and Farmers). Providing training to the user groups.
- To select 600 samples of neem trees in Gujarat to screen out high seed yielding trees.
- To study the phenological aspects, especially the seed yield of neem, on the selected trees.
- To raise 5 ha of experimental model plantation of neem in Gujarat State.
- To test the seeds for seed parameters.
- To evaluate the seed lots for germinability and storability.
- To test the seeds for quality.

(ix) Scientific importance of the investigations :

Azadirachta indica A Juss. (neem) is grown throughout the tropics for its multiple utility. Selected superior germplasm for oil and Azadirachtin contents will further facilitate its economical uses.

The viability of neem seeds is very short. Attempts were also made to store the seeds in wet conditions, to retain high moisture content of seeds (Ponnuswamy *et al*, 1989; Surendran *et al.*, 1993). On the other hand seeds having 10% moisture content can be stored safely upto 3-months (Ezumah, 1986). It has also been reported that the seeds from Cameroon were available after 5-years of storage at 4°C. From the above it can be concluded that much variability exist in the neem seeds and it can be tapped for better utilization and productivity of neem.

(x) Results and achievements/progress made:

- In first year of the project 234 sample trees selected and in the second year 350 trees were selected; total height, clear bole height, DBH and crown width measured and observations on general morphological characteristics have also been recorded. Some samples have been sent to IBPGR for cryo-preservation and TERI for chemical evaluation.

- For ensuring active participation and involvement of farmers in integrated development of Neem in Gujarat on pilot basis five villages have been selected in Raigarh range of Himmatnagar Forest division of Gujarat State. The basic objective of selecting these village is to develop them as model Neem villages.

- An experiment in 5 ha of land has been laid out at Hathrol for studying the performance of three types of seedlings (summer, winter and coppice seedlings)

- So far four training on *"Krishkon Ke Liye Neem Vraksharopan Tatha Iske Bahuupyogi Utpadon Par Prashikshan"* (training for farmers on Neem plantation and its important useful product) have been organized (March 3-4, March 5-6, 2000 and March 13-16, 2001) for farmers of selected villages.

- Root trainers and root trainer stands have been procured for establishing advance nursery for raising Neem seedlings. Shade house has also been fabricated for keeping seedlings in summer.

- Seedling seed orchard SSO of 4 ha has been raised at AFRI, Jodhpur. Some seedlings were raised from winter flowering trees for establishing a seed orchard. Eight different winter flowering progenies have been raised in this SSO.

❖ Standardisation of vegetative propagation & storage etc.:

A. Macropropagation: It was found that coppice shoots can be rooted without any hormonal treatment under high humidity (above 80%) and at 30±5^{0}C. However, branch cuttings can be best rooted when treated with 1000 ppm IBA for 30 seconds under similar conditions.

B. Micropropagation: Experiments on shoot proliferation from nodal shoot segments and on callus induction from various explants are underway. Rooting has been achieved from proliferated shoots obtained *in vitro* on half strength MS medium. Furhter experiments are underway.

- Phenological observations (quantitatively) recorded regarding leafing, flowering and fruiting on the sample trees of neem selected in Gujarat State using the procedure/format prepared for the purpose and data thus collected were compiled and analyzed.
- Seeds have been collected from 100 seed trees during the month of July 2000 and analyzed for various seed -parameters.
- Collected seed have been stored under two-moisture levels and at two temperatures. Moisture content and germinative capacity of collected seed varied from 1% to 23% and 2% to 96%. Low-temperature storage of neem seed prolonged the seed germinative capability.Neem seed collected during winter, 99 showed 30% germination even after 10-months of low-temperature storage. However, seeds collected during July 2000 showed only 5% germination.

NEW PROJECTS TAKEN UP IN HAND DURING THE YEAR 2000-2001:
Nil

SOCIAL FORESTRY DIVISION

(a) PROJECT COMPLETED DURING THE YEAR 2000-01

(i)	**Sl. No**	:	22
(ii)	**Project identification number**	:	AFRI-22/SF-1 (NABARD)
(iii)	**Title of project**	:	NABARD Project : Development of Agroforestry models for hot arid region of India
(iv)	**Name of Principal investigator**	:	Head, Social Forestry Division.
(v)	**Year of the start of the project**	:	1995
(vi)	**Target year of completion**		Dec.2000.
(vii)	**Cost of the project and expenditure made so far**	:	Total Cost Rs. 31.5 lakhs, Total Exp. Rs. 9,74,673/-, Exp. During 2000-01 Rs. 74,921/-

(viii) Objective in brief :

- To study the performance of different silviculture and horticulture species with different espacement, in agri-silvi and agri-silvi-horti model.
- To study the suitability of different trees, fruit plants and crop combinations in agri-silvi and agri-silvi-horti model.
- To study the performance of different silvi and pastoral (grasses) with different spacement in silvi-pastoral model.
- To study the growth and productivity in agri-silvi model.
- To introduce biofertilizer in agroforestry plantations
- To seek improvement of crop productivity through introduction of suitable tree species.
- To develop appropriate land use/management plans for the three watershed areas
- Results and achievements

(ix) Scientific importance of investigation :

Agroforestry is a tool for sustainable agricultural production and supply of essential goods such as food, fodder, firewood, timber, oilseeds, industrial material etc. In India, the agroforestry assumes great significance in view of the fact that about 50% of its area suffer

from one or the other type of land degradation and is not suited to intensive agricultural production system. In arid region where harsh and unfavorable climatic conditions coupled with poor soils make agricultural production system a gamble due to high risk and uncertainties, the system of agroforestry holds further significance in producing food, fodder, fuel etc.

With the advent of scientific knowledge the status of agroforestry has been elevated from traditional practices to a commercially viable efficient production system. This has necessitated development of area specific suitable agroforestry models to obtain higher productivity. The scientific data on different agroforestry models viz. agri-silvi, silvi horti and silvi pastoral raised with integrated packages of rain water harvesting and soil moisture conservation will facilitate farmers in deciding tree-crop combination, stand density, tree-crop interaction, planting geometry, etc. for obtaining maximum biomass productivity in agroforestry systems.

(x) Results /achievements:

The main recommendations emerged from the various research activities of this project are detailed as below.

- At the out set as most of the area is rainfed and soil being sandy remains prone to wind & water erosion, there exist good possibility and scope for establishing trees in agroforestry systems with the use of different rainwater harvesting and soil moisture conservation techniques.

- Design and diagnostic survey has revealed that most of the land area is of degraded nature and falls in class IV category of land use capability classification, hence, suited most for silvi pastoral system. The irrigation facility is negligible, as the availability of ground water is poor. In few pockets of Kudi and Sangariya where the availability of ground water is poor to moderate, the quality of water is highly saline rendering it unfit for irrigation or drinking purposes. In general, single monsoon crop is grown in all the project area except in few pockets of Kudi and Sangariya where irrigation facility is available to the limited extent.

- Analysis of existing agroforestry systems has revealed that mainly *Kherji* (*P.cineraria*) based agroforestry practices are followed. In Jaleli watershed *Prosopis-Zizyphus* based multi-storey system is more common. The other important trees and bushes which farmer retain in fields are *A. nilotica, T. undulata* and *Capparis decidua. Prosopis juliflora* is grown on field boundaries for vegetative fence and cut every two or three years for firewood. The main kharif crops grown in rainfed fields are bajra, moong, guar, moth & til. In irrigated fields wheat or mustard is grown as rabi crop in winter.

Evaluation of economic return from traditional agroforestry has indicated that in rainfed conditions from khejri-bordi based agroforestry about 50% of the total income comes from tree component whereas, in irrigated area the share of trees get reduced to 30% in total income. The main reasons for low productivity in existing agroforestry system are poor tree density, scarcity of water, soil salinity, unscientific package of crop production, uncontrolled grazing and poor soil fertility status.

- Survey and analysis of rhizosphere soils for VAM infection in trees occurring in agroforestry systems has revealed that the VAM infection was higher, (63-75%) in rainfed than irrigated conditions (52-65%). Among the trees the VAM infection was in the order of *A. nilotica* = *A. indica*> *T. undulata* = *P. cineraria*> *A. tortilis*> *Eucalyptus.* The dehydrogenase activity in rhizosphere soil was maximum for *A. nilotica* in rainfed and *T. undulata* in irrigated condition. Among the VAM fungi *Glomus sp.* was dominant followed by *Gigaspora sp.* and *A. caulospora*. Field trials have shown that use of VAM is having high potential in enhancing growth and productivity in agroforestry system.

- Different agroforestry research trials were conducted to find out suitability of tree- crop combinations, crop rotations, above and under ground interaction, stand density, planting geometry etc. It has been found that the highest crop yield was recorded with Khejri (*Prosopis cineraria*) having density of 278 stem/ ha. The growth of tree was directly related with its stand density. Studies on crop sequence revealed that biomass yield of Khejri were highest with mothbean-mothbean and pearlmillet-pearlmillet followed by moongbean -moongbean sequence. Biomass of Rohida was highest (30.26 t/ha) when planted along with moongbean- moongbean crop sequence, which was almost double of the biomass yield in its pure stand (16.65 t/ha). It has also been established that biomass production of Khejri was 25-28% higher in agroforestry plot than its pure stand. For raising Agri-silvi model by in-situ rainwater harvesting, rows of trees planted at 6 m apart are found better. The plant to plant distance in row can be 4 m. In Agri-silvi model it is better to grow trees-crops combination of legume species. *Acacia nilotica* proves to be better than *Prosopis cineraria* in terms of growth. For Silvi-pasture model 5 x 5 m spacing is found suitable. *A. excelsa* produced highest biomass followed by *Z. mauritiana* in Silvi-pasture system. However, maximum green grass yield was obtained in association of *Z. mauritiana*. Further grass yield is directly influenced by pattern of rain in monsoon.

- For raising different agroforestry models in arid zone following trees/crops combinations are suggested for maximum biomass production

Recommended species for different agroforestry models in arid zone

Agroforestry model	**Silvi species**	**Horti species**	**Crops/ grasses**
Agri-silvi	*P.cineraria* *A. nilotica* *T.undulata* *A. indica*	-	Moong, Guar, Moth, Til, Bajra etc.
Silvi-horti	*P.cineraria* *T. undulata* A. *Indica*	*E. officinalis* *Z. mauritiana* *Punica granatum* C. *Myxa* *Carissa carandus*	-
Agri-silvi-horti	-do-	-do-	Moong, Guar, til and wheat & Mustard in irrigated conditions.
Silvi-pasture	*P. cineraria* *A. indica* *A. nilotica* *A. tortilis* *H. binnata* *C. mopane* *Z. mauritiana*	-	*Cenchrus ciliaris, Cenchrus setigerus, Lasiurus sindicus*

Establishment of agroforestry plantation in fields is dependent on pattern of rain in monsoon season. Few life saving irrigation are essential in first year particularly in silvi-horti models. There should not be deficiency of moisture in soil at the time of planting. Regular maintenance and silvi operations are essential for better growth and yield.

- Economic analysis of models raised on experimental area could not be done as the silvi species are only 3-4 years old, the horti species have not started fruiting and regular crop yield could not be harvested due to three consecutive droughts. However, based on yield tables the projected returns from different species are given below.

Projection of Returns From the Planted Species (Per Hectare/ year)

S.No.	Species	Spacing		Returns in Rs. For irrigated plantation in IGNP area			
1.	*Zizyphus mauritiana* (Ber)	6m 6m	X	Returns upto 4th year – Nil			
					Fodder	Fruit	Total
				5th-6th year	834	16,680	17,514
				7th-15th year	834	33,360	34,194
2.	*Punica granatum* (Anar)	4m 4m	X	Return up to 3 year – Nil			
				4th-6th year		15,625	15,625
				7th-12th year		31,250	31,250
				13th-15 year		46,875	46,875
3.	Prosopis cineraria (Khejri)	4m 4m	X	Return upto 7th year – Nil			
				8th year	2735	1,54,688	1,57,423
				9th year	4297	2,10,938	2,15,235
				10th-15th year	5859	2,53,155	2,58,984
4.	*Acacia nilotica*	3m 3m	X	Return upto 14th year – Nil		Timber	
				15th year		8,03,000	8,03,000
5.	*Ailanthus excelsa* (Ardu)	5m 5m	X	Return upto 3rd year – Nil		Fodder	
				4th-6th year		10,000	10,000
				7th-11th year		40,000	40,000
6.	*Azadirachta indica* (Neem)	5m 5m	X	Return upto 4th year – Nil		Seed Fruit	
				5th-10th year		20,000	20,000
				11th-15th year		24,000	24,000

Conclusively, it is felt that though sufficient scientific data has been generated to suggest agroforestry models for arid zone, further research is needed for better

understanding and to optimize sharing of above/ underground resources in agroforestry systems. Tree-crop interactions particularly allelopathic effect of trees on crop and vice versa need to be evaluated. For calculating economics of different models it is necessary to maintain research trial established in AFRI experimental area for evaluation of yield from crops in good monsoon, silvicultural species when they complete at least half the rotation and horti plants when they start fruiting.

(b) OLD PROJECTS CONTINUED : NIL

(c) NEW PROJECTS TAKEN UP IN HAND DURING THE YEAR 2000-01 :
NIL

PLANTING STOCK IMPROVEMENT PROGRAMME

(i) Sl.No.23

(ii) Project identification number : AFRI-23/(WB-PSIP)

(iii) Title of the project: Planting Stock Improvement Program

(iv) PSIP Team Leader : Sh C.J.S.K. Emmanuel SE

(v) Year of start of the project : 1994

(vi) Target year of completion: March, 2001.

(vii) Cost of the project and expenditures made so far :

SPA : Rs. 60.00 lakhs, **CSO** : Rs. 10.60 lakhs, **SSO**: Rs. 20.78 lakhs, **VMG:** Rs. 4.25 lakhs, **Model nursery:** Rs. 33.22 lakhs

COMPONENT: DEVELOPMENT OF SEED PRODUCTION AREA

(viii) Objectives:

- To develop seed production area of target species
- To compare the performance of seeds collected from the SPAs
- To prepare the management plan of SPAs

(ix) Scientific importance of the investigations:

Knowledge of the genetic parameters within a species is helpful for developing effective tree improvement/breeding strategies. The significance of genetic variation studies and provenance testing in forest tree improvement is well known. A great variability, however, exists in the growth and stem form of tropical tree species. This variation indicates the possibility of improving these species by selection and breeding.

In broad sense, tree improvement covers both the selection of population (species, provenance, seed stands) and the selection and breeding of individuals. It comprises the identification of superior phenotypes; testing of their offspring in progeny trials to confirm genetic superiority of the parents, and bringing together tested superior genotypes for seed production in which both male and female parents contribute their superior genes.

The use of appropriate germplasm is fundamentally important for the entire tree planting activities. Although it is widely understood that tree species differ in site requirement and uses, the extent of genetic variability within species has been less appreciated. The vast natural genetic variation found within most trees is a resource to be wisely used. Investment in tree improvement programmes has proven to be one of the most cost-effective trees planting activities in temperate countries. Tropical field trials have demonstrated that yields can be increased between 10 and 45 percent by simply choosing the best-adapted seed source for a particular site. Further gains are possible from individual selection and breeding.

(x) Results/ achievements

The project on Planting Stock Improvement Program 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 unselected stands have been analysed as per the proforma received from ICFRE 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. 10ha of seed stands of *D. sissoo* 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 the stands. Moisture conservation work has been implemented. Management plan of SPAs has been prepared and discussed with the concerned SFDs. These areas have been handed over to State Forest Departments for future management

COMPONENT: DEVELOPMENT OF SEEDLING SEED ORCHARDS

(viii) Objectives:

- To develop seedling seed orchards of target species for quality seed
- To select CPTs

(ix) Scientific importance of the investigations:

The techniques used in tree improvement to select superior trees depend on the types of stands and species in which selections are to be made. The determination of best selection techniques depends on species characteristics, past history, present condition of the forest, variability and inheritance pattern of the desired traits. Selection can be made either in even-aged natural stands or plantations or in uneven-aged scattered stands where check trees are not available. The comparison tree system does not work when trees are growing in all aged stands or scattered. Since growth curves within a species vary with age, it is not advisable to use the same ratios for comparison of selected trees. The regression method is of particular

use for growth traits because quality traits can often be determined on the basis of phenotype of the candidate tree alone by comparing it with the check trees.

Tree improvement is a stepwise process involving exploration, collection, evaluation, breeding, multiplication, distribution and conservation of genetic resources. A successful tree improvement programme begins by defining the traits that need improving. Tree improvement, in the broad sense, covers both the selection of population (species, provenance, seed stands) and the selection and breeding of individual trees within populations. Selection/breeding of individual involves identifying trees of a superior phenotype; testing their offspring in progeny trials to confirm the genetic superiority of the parents, and bringing together tested superior genotypes for seed production, to which both male and female parents contribute their superior genes.

Variability studies are important wherever selection forms the basis of genetic improvement. Selection of plus trees from available population is the first step in initiating a breeding programme in forest trees. The number of trees to be scanned in order to locate a tree of technologically acceptable standard will depend on the genetic spectrum or distribution of the species, and the correlation of characters under selection.

(x) Results/ achievements:

The target for this activity was 20ha of *Acacia nilotica,* 20ha of *D. sissoo* and 15ha of *E. camaldulensis.* It has been achieved at Jaipur, IGNP(Anupgarh & Sangeeta distributory) & Jodhpur in Rajasthan. 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. 10ha of *A. nilotica*, 5ha of *D. sissoo* and 2ha 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,* 25 CPTs of *A. nilotica* at farmers field 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 a 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

(viii) Objectives

- Mass multiplication of selected clones
- Multi-locational clonal testing selected clones

(ix) Scientific importance of investigations

Vegetative Multiplication Garden is mainly established as the clonal bank of superior germplasm and from this VMG propagules can be raised in mist house for the further multiplication. This clonal material can be planted in field with specific design for their testing and finally site specific clones can be recommended for large-scale plantations after thorough evaluation through clonal test.

(x) Results/Achievements

Base population of 72 clones of *D. sissoo* and 26 clones of *E. camaldulensis* have been planted in 5 ha area (0.5ha at AFRI nursery and 4.5 ha in AFRI campus) for the purpose of establishment of Vegetative Multiplication Garden. For the purpose of large-scale vegetative multiplication 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.

Five ha VMG is being maintained and causality replacement is also completed. Fresh cuttings 32,643 of *D. sissoo* and 14,134 of *E. camaldulensis* have been raised in mist chamber.

COMPONENT: DEVELOPMENT OF CLONAL SEED ORCHARD

(viii) Objectives

- To produce quality seeds
- To improve the productivity

(ix) Scientific importance of investigations

Clonal Seed Orchards are being established from selected genotypes with specific field designs to improve the quality of seeds. CSO are established through any vegetative

propagation mean such as grafting, air layering rooted vegetative cuttings or tissue culture etc.

(x) Results/Achievements

Till now 29.0 ha of CSO has been established. Out of this, 10 Hectares of *T. grandis* and 4 Hectares 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.

Species	Area	Rajasthan	Gujarat
D. sissoo	15 ha	11 ha at Govindpura	4 ha at Machh & Fulwadi
Tectona grandis	10 ha	-	10 ha at Machh & Fulwadi
E. camaldulensis	04 ha	4 ha at Govindpura	-
Total	**29 ha**	**15 ha**	**14 ha**

Handed over to concerned SFDs for future management

COMPONENT: DEVELOPMENT OF SEED BANK FACILITIES

(viii) Objectives

- To establish seed bank facilities.
- To procure seed testing equipment.
- To test the seeds of important tree species for various seed parameters.
- To evaluate seed lots for germinability and storability.
- To test seed for qualities.
- To develop testing protocols of various species for pre-treatment.

(ix) Scientific Importance of the project:

The effective planning and implementation of afforestation programmes depends on the availability at all times of sufficient quantities of seeds with right physiological and genetic characteristics. In the first place, the seed must be collected from a genetically proven superior source. Secondly, there must be a continuous checking by testing the physical and physiological characteristics of the seeds. Finally it is important that seed is stored until required without losing its germinative capacity and viability.

As a biological product the behaviour of a seed can not be predicted and will depend upon the species, year of collection, storage length and condition. Handling of seed during harvesting, extraction, cleaning also results in damage, which manifests itself in varying degree of magnitude subsequently during transit or storage. Seed testing procedures have, therefore, been developed for maintaining quality control and to provide the prospective seed user the information, which has a bearing on the planting value of seed.

(x) Results/achievements:

Seed germination and seed-testing laboratories with all the desired equipment have been established. All the equipment are working properly. Effect of temperature different fruiting seasons substratum on germination, energy period and germination energy of neem (*Azadirachta indica*) seeds, stored at low temperature and at ambient temperature, was studied. It was observed that the top of filter paper gave maximum percentage germination, energy period and germination energy than the seeds incubated in vermiculite and sand. Seeds of *Eucalyptus camaldulensis* showed the similar trends. However, seeds of *Acacia nilotica, Dalbergia sissoo* and *Prosopis cineraria* showed higher percentage germination in vermiculite then the filter paper or sand incubation. Our studies showed that initial moisture content had no effect on the long-term storability 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 in size and had less moisture content than the seeds of summer season.

Seeds of *Acacia nilotica, Dalbergia sissoo* and *Prosopis cineraria* were used for pre-treatment studies. Pre-treatments viz. cold water, KNO_3, hot water, acid microwave oven and mechanical scarification were tested. MS showed best results in all tested species. Seeds of *A. nilotica* collected during previous years have been tested and it was found that the seeds even older than six years showed about 67% germination capacity.

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.

The tetrazolium test, which uses a pale -yellow coloured solution that is reduced within viable seeds to a bright red compound, was used for seed viability tests. Seeds of *A. nilotica, Prosopis cineraria, Dalbergia sissoo* and *Ailanthus excelsa* were tested for the duration and viability percentage. It was observed that for the completion of test, *Acacia nilotica* and *Dalbergia sissoo* required 12h followed by *Ailanthus excelsa* 16h & *P. cineraria* 22h.

Moisture content, seed weight and number of seeds per 1000 seeds of 15 species have been determined. Seed weight, number of seeds per pod, pod weight, pod length and width, seed size and germination studies were conducted on the seeds collected from 50 CPTs of *Dalbergia sissoo.* Seed weight replications for 15 tree species have been standardised.

COMPONENT: TO DEVELOP MODEL NURSERY

(viii) Objectives

- Production superior quality of seedlings
- Standardization of potting mixtures and containers (root trainers) for various arid zone tree species

(ix) Scientific Importance of the project:

Production of quality seedling which are able to withstand harsh climatic conditions which are encountered more often than not in the mandate region of the institute is very important for success of artificial afforestrartion programs in arid and semi-arid region. Experiments are being conducted at the AFRI Model Nursery to standardise methods for raising seedlings suitable for arid and semi arid region in order to increase overall success rate and cost-effectiveness of afforestation programmes being undertaken by SFDs.

(x) Results/Achievements

The existing nursery in AFRI has been upgraded into a model root trainer nursery. Shade house, covering space of nearly 420-sq. m. has been created. During the year micro-sprinkler system and water supply to nursery through pipeline from AFRI Main Campus has been made operational. Remaining unfenced portion of the Model Nursery along the canal side has also been fenced through construction of coursed stone masonry boundary wall. All the physical infrastructure development works targeted to be undertaken at Model Nursery have been completed.

During the year, total 1,20,000 seedlings of different tree species were raised in root trainers and polythene bags for utilization at various research sites and for supplying to willing persons on payment basis. During the year, guidelines for utilization of spare capacity of AFRI Model Nursery to make nursery research financially self-sustainable were framed and are being implemented.

During the year, experiments for standardization of the size of nursery container for raising seedlings of four number species namely ***Prosopis cineraria, Tecomella undulata, Acacia nilotica*** and ***Dalbergia sissoo*** was laid. Data collected during the experiment are being analyzed to arrive at conclusions.

3. EXTENSION ACTIVITIES

(a) Facilities generated and services rendered

(i) Consultancy of various agencies e.g. testing of samples etc.: Nil

(ii) Library and documentation - computer facilities: Work for installation of Local Area Network (LAN) and Wide Area Network (WAN) at the institute were initiated during the year. Tree CDs were obtained from National Forestry Library and Information Center (NFLIC), Dehradun.

(iii) Video films: Nil

(b) Transfer of Technology

(i) Training - e.g. to farmers, NGOs, SFDs, Institutes etc.:

Training on ***"Krishkon Ke Liye Neem Vraksharopan Tatha Iske Bahuupyogi Utpadon Par Prashikshan"*** (training for farmers on Neem plantation and its important useful product) have been organized (March 13-16, 2001) for about 200 farmers of five selected villages of Himmatnagar (Gujarat) under NOVOD project.

(ii) Teaching support : e.g. to various organizations:

SFD of Rajasthan has organized training on watershed development. Scientists of the Institute delivered lectures on needs and utility of watershed development, rainwater harvesting and moisture conservation techniques, agroforestry etc in training organized for farmers/ members of watershed development committees.

(iii) Exhibition, Kisan Mela etc:

Participated & demonstrated research results to various stakeholders/farmers in Swadesi Mela 2000 and Hastshilp Utsava 2001 organized in Jodhpur during Dec.2000 and Jan.2001, respectively. Film on rainwater harvesting has been shown in training & Public awareness program organized by Block Development Officer, Luni Block, Jodhpur.

(iv) Field demonstration:

The research experiment fields are being demonstrated to various Stakeholders, NGOS, Farmers, Forest-officials & Trainees for their extension, adoption & implementation by them.

(v) Demonstration plantations:

Demonstration of water harvesting technology and agro-forestry systems continued in different sites to local farmers under different research Projects.

(vi) Seminars, workshops etc.:

Peer review workshops on Seed and Nursery Technology were held at institute during the month of November 2000. **International Neem Network Workshop**- Data-analysis was organized from 21st-25th March 2001. The said workshop was sponsored by FAO, Rome.

(vii) Evaluation of above activities; time spared, expenditure and revenue earned:

Work executed under various projects were not formally evaluated by any external agency. However, work was evaluated in-house by DG, ICFRE, DDG (Research) & DDG (Extension) during their visit to the institute. Apart from the evaluation of works by above mentioned officials from ICFRE headquarters, Director and GCR of the institute also continuously evaluated it through periodic meetings and discussion with concerned investigators.

(c) Linkage with other Organizations/Institutes/States etc.

State Forest Departments of the mandate regions and other scientific organizations like CAZRI, Universities etc. were involved in planing and prioritization of various research activities to be undertaken by the institute through their active participation in Research Advisory Group Meeting and Peer Review Workshops organized by the institute during the year.

(d) Visit of important dignitaries or any other important event:

During the year, following dignitaries have visited the institute:

- Thiru T.R.Baalu, Hon'ble Union Minister of Environment and Forests.
- Sri Bhagraj Chaoudhary, Hon'ble Forest Minister, Government of Rajasthan.
- Sh. Jaswant Singh Bishnoi, Hon'ble Member of Parliament.
- Mr. P. Rossengger, FAO Representative for India & Bhutan
- Mr. Pierre Sigaud, Forestry Officer (Genetic Resources), FAO, Rome.

(e) Publication and extension literature brought by the institute

i) Books with title and author if any: Nil

ii) Brochures with title and author if any: **AFRI – ACHIVEMENTS & EXPERTISE.**

iii) Folders, pamphlets with titles.- Nil

Vist of important dignitaries & other imp[illegible]nts

Hon'ble Union Min. Thiru T.R. Baalu reviewing AFRI Research

Valedictory Function of International Neem Network-2001

Participants of International Neem Network-2001

4. Financial Statement giving details of total expenditure incurred on maintenance, developments, etc., under various heads during the year 2000-2001

FINANCIAL STATEMENT FOR THE YEAR 2000-2001

(Rs. In lakh)

S.No.		SUB-HEAD	EXPENDITURE
I. PLAN			
1.	**A.**	**REVENUE EXPENDITURE**	
		(a) Research	152.37
		(b) Administrative Support	33.02
		(c) Others specify	15.00
		Total Revenue Expenditure `A'	**200.39**
	B.	**LOAN AND ADVANCES**	
		(a) Loan Advances (Conveyance)	0.85
		(b) House Building Advance	-
		Total Loans and Advances `B'	**0.85**
	C.	**CAPITAL EXPENDITURE**	
		(a) Building & Roads	-
		(b) Equipment, Library Books	-
		(c) Vehicles	-
		(d) Other specify	-
		Total `Capital Expenditure 'C'	-
		GRAND TOTAL FOR PLAN (A+B+C)	**201.24**
II. NON-PLAN			
1.	A.	**REVENUE EXPENDITURE**	
		(a) Research	-
		(b) Administrative Support (salary)	-
		Total Non-Plan	-
		TOTAL (PLAN + NON-PLAN)	**201.24**
III. EXTERNALLY FUNDED PROJECTS			
	A.	World Bank Project	84.355
	B.	UNDP Project	-
	C.	NABARD Project	0.75
	D.	Rural Development	-
	E.	NOVOD (Neem)	7.74
		TOTAL (A+B+C+D+E)	**92.84**

INTRODUCTION

The Arid Forest Research Institute at Jodhpur was established in 1988 with a view to solve the forestry research problems of the States of Gujarat and Rajasthan and the Union Territory of Dadra and Nagar Haveli. The main activities being undertaken at the institute are as below:

- Studies on silvicultural characters of tree species and shrubs of arid zone.
- Studies on seed character, germination and growth characters of arid zone trees and shrubs.
- Interaction of trees with agricultural crops under different agroforestry systems and evaluation of tree farm economics.
- Selection of superior genotypes for important tree species of the arid region.
- Development of tissue culture protocols and techniques for vegetative propagation.
- Studies on VAM inoculations (Bio-fertilizers) for the establishment and better growth of tree species.
- Study of soil characteristics of arid region including soil-species interaction.
- Studies on the oil and protein contents of various trees and shrubs.
- Development of plantation and nursery technology suitable for arid and semi-arid region.

The research wing of the Institute consists of nine research divisions as below:

1. Forest Ecology & Desert Development Division
2. Forest Genetic & Tree Breeding Division
3. Forest Protection Division
4. Social Forestry Division
5. Non Wood Forest Product Division
6. Silviculture Division
7. Forest Resource Management & Economics Division
8 Joint Forest Management Division
9 Forest Policy & Research Division

Brief Summary of Annual Report of AFRI, Jodhpur for 2000-2001

The report contains information about various activities undertaken by the Arid Forest Research Institute, Jodhpur during the year 2000-01. In preparation of the report, main thrust has been given on the reporting of research activities undertaken during the year and results achieved thereof. During the year, 5 Research projects were concluded, including one externally aided project funded by NABARD. These five projects also include the various components implemented under the research project funded by the Ministry of Rural Development and Employment, which have been formally concluded during the year. However, many of these components need to be continued for few more years to derive meaningful results from the experiments laid out. These components have already been included in the NFRP for continuation.

During the year, the targets fixed for six components of the Planting Stock Improvement Program (PSIP) included in Forestry Research Education and Extension Project (FREEP) have been fully achieved. Project funded by the National Oilseed and Vegetable Oils Development (NOVOD) Board contained various components aimed to increase awareness about economical worth of neem in Guajarat through interactive activities. During the year works were undertaken under 17 (seventeen) ongoing research projects and data collected under these projects were studied for observing further trends.

Encouraging results were achieved in the fields of afforestation of salt affected lands, plant-water relations, tree-crop interaction, chemistry of plant parts, growth studies, tree improvement through selection, entomology, seed studies, nursery and planting technology etc.

FAO Funded International Neem Network Workshop on Data Analysis was organized at the Institute in the month of March 2001.