

CHAPTER VI

ARID FOREST RESEARCH INSTITUTE JODHPUR

Arid Forest Research Institute, situated at Jodhpur in Rajasthan (India), is one of the eight institutes under the control of Indian Council of Forestry Research & Education (ICFRE), an autonomous council under the Ministry of Environment & Forests, Govt. of India. The objective of the Institute is to carry out scientific research in forestry in order to provide technologies to increase the vegetative cover and to conserve the biodiversity in the hot arid and semi arid regions of Rajasthan, Gujarat and Dadra & Nagar Haveli Union Territory.

PROJECTS COMPLETED DURING 2001-2002

Project 1: Disease spectrum of arid and semi-arid tree species. (AFRI-9/SILVI-2/ 1994-2002). For technical report contact Principal Investigator - Dr. K.K. Srivastava.

Findings: Survey of pathological problems in forest nurseries and plantations of arid and semi-arid tree species was undertaken. On neem (*Azadirachta indica*), seven nursery diseases and two plantation diseases were recorded. Fungicidal and silvicultural management has been evolved of economically important diseases. Charcoal root rot in *Azadirachta indica* and *Tecomella undulata* and seedling blight in *Harwickia binnata* has been recorded for the first time from India. The disease was managed by making isolation trenches and soil drenching with Carbendazim (*Bavistin*). Mortality factors of Shisham (*D. sissoo*) and Khejri (*P. cineraria*) were detected. Checklist of major and minor diseases in forest nurseries and plantations raised by State Forest Department.

Project 2: Integrated pest management of forest insect pests in plantations and natural forests [AFRI-11/FP-1 (Plan)/1996-2002]. For technical report contact Principal Investigator - Dr. S.I. Ahmed.

Findings:

Efficacy of phytopesticides: Investigations of the bioefficacy of plant extract of *Psorelea corylifolia* and *Balanites aegyptiaca* against major insect pests have been tested. 0.5% concentration was found to be most effective as repellent and an antifeedent. The effective concentration has also been tested under outdoor wire meshed cages, having *M. tenuicornis*, and found highly effective against the pest. 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 *Psorelea corylifolia* has been confirmed. The extract of *Balanites*

aegyptiaca (fruit coat and fruit pulp) has been prepared for testing against *Patialus tecomella* 0.1% was found to be the most effective.

Efficacy of Parasites/Pathogens/Predators : Insect pathogenic viruses - Nuclear Polyhedrosis Virus suspension of *Streblote siva* was tested under the field conditions. NPV resulted in settlement in the field conditions and no epidemic was recorded.

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 have been tested against *Mylocerus tenuicornis*. Monocrotophos (0.02%) was found highly effective against *M. tenuicornis* in the field conditions.

Large scale khejri mortality and its management in northwestern Rajasthan: *Derolus descicollis* (Coleoptera: Cerambycidae) has been recorded for the first time in India, responsible for large scale drying and mortality of khejri trees in four districts of Rajasthan. Recommendations for control measure of this problem have been communicated.

PROJECTS CONTINUED DURING 2001-2002

Project 1: Stand dynamics of some important tree species of Gujarat. [AFRI-25/FRME-2/2001-2006]. *Principal Investigator-* Dr. V.P. Tewari.

Status: Information regarding plantations of *A. nilotica* and *Eucalyptus* in various parts of Gujarat has been collected from the literature available. SFD officials were contacted and letter was sent to the CFs and DCFs in Surat, Godhara, Nadiyad, Vadodara, Gandhinagar, Ahmedabad and Rajkot for providing information regarding plantations of the said species for establishment of permanent sample plots for the study.

Project 2: Identification of mortality factors of *Prosopis cineraria* and development of suitable management strategies [AFRI-26/FP-3/2001-2005]. *Principal Investigator-* Dr. S.I. Ahmed.

Status: The actual causes/factors responsible for the large scale drying and the subsequent dieback of mature khejri trees in western districts of Rajasthan was closely examined. This devastating problem has primarily been originated with the combined effects of indiscriminate and successive lopping followed by a secondary infestation of a shoot borer *Derolus discicollis*, Gahen. The borer attack is followed by a tertiary infection of fungus disease. The infected samples reveal the presence of three highly infective species of *Fungi imperfectii* viz., *Alternaria* sp., *Phoma* sp. and *Botryodiplodia* sp. which ultimately cause the dieback disease in mature trees of khejri as a result of which the tree starts drying from the top. Data on water table, tube well, ground water, rainfall, soil nutrient status and agricultural practices are being collected for further analysis.

Preliminary recommendations for the management: Indiscriminate lopping of khejri trees by the farmers seem to be the primary cause of pest/disease infestation. Hence, a gap of one year for khejri lopping is advisable in order to

recover from the injuries made by pest and disease. The lopped portions / open wounds should be treated with AFRI PASTE. To check the severely infected and dried trees they should be uprooted and the felled trees should be lifted from the vicinity immediately. The trees, showing partial die-back symptoms should be dealt for their treatment on priority in order to check further spread of pest / disease.

Project 3: Agroforestry research for sustainable production in arid regions of Rajasthan. [AFRI-2/FEDD-2/1999-2003]. *Principal Investigator - Dr. G. Singh.*

Status: Effect of intercrops on yield and productivity of agroforestry systems - The experiment was redesigned to include some intercrop treatments of medicinal plants and water harvesting treatments. In the revised experiment main treatments were: i.) No water harvesting and ii.) Water harvesting; sub main treatments are: T1) no intercrop, T2) mungbean - mungbean, T3) sesame-sesame, T4) mung - sesame, T5) *Cassia angustifolia*, T6) guar- guar, and T7) mung + til and sub - sub main treatments are i.) *Prosopis cineraria* and ii.) *Tecomella undulata*. No significant variations were noted in tree growth as a result of intercrops and water harvesting treatments. Significant findings include; comparatively less competition of khejri tree with agricultural crops; better suitability of pulse crop than pearl millet in agroforestry; crop production increased with distance from tree and was more in T4 treatment, biomass production from tree is more under agroforestry than in sole tree and *C. angustifolia* requires less water compared to other crops as evidenced by high soil water availability.

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 a five-year-old stand. Pearl millet was harvested as the agricultural crop. However, the effect of density on tree growth was appreciable. The significant findings include husk and grain production reduced with increase in density optimum density declines with advancing age.

Maximising food, fodder and fruit yield in agroforestry in arid region - Three different species viz. *Emblica officinalis*, *Hardwickia binata* and *Colophospermum mopane* was planted with the aim to determine total production of fruit and fodder in combination with agricultural crops. Fixed crop of mungbean and rotational crop of pearl millet/mungbean were taken as the other treatment. In 2001, pearl millet was the rotational crop and mungbean was the fixed crop. The results indicate that, collar diameter of the three species was high under rotational cropping system; crop production was low near tree and increased with distance. Soil water status is more in rotational crop plot than fixed crop plot. *E. officinalis* utilizes more water than *H. binata* and *C. mopane*, with initial decrease there is increase in SOM pool under all the three species though increase was more under *E. officinalis*; study demonstrated significant temporal variation in soil organic carbon, extractable PO_4 -P, NO_3 -N and NH_4 -N and the pool of available nutrients was generally higher during summer and low during spring season.

In-situ runoff agroforestry - Bunding at proper interval facilitate the *in situ*

runoff collection and moisture conservation is useful for agricultural activities. In between bunds, trees for fodder and firewood can be planted. Experiment comprising three tree species viz., *Azadirachta indica*, *Acacia nilotica* and *Albizia lebbek* was initiated in August 1996, during the monsoon period. In cropping season of year 2001, *Cymopsis tetragonoloba* (guar) and *Vigna radiata* (mung) were the intercrops. (i) The grain production of *C. tetragonoloba* was more compared to *Vigna radiata* in all the three species; ii) production was more with *Acacia nilotica*- *V. radiata* and *Albizia lebbek*- *C. tetragonoloba*. Soil moisture increased with distance except near *A. indica* and in center of two rows in *A. lebbek* plot, SOM decreased with both distance as well as soil depth.

Project 4: Market survey on selected species AFRI-24/FRME-2/1994-Continue]. *Principal Investigator- Dr. V.P. Tewari.*

Status: The price data of various forest produces viz., timber, fuel-wood, bamboo were collected from the markets of Jaipur and Ahmedabad on quarterly basis. After compilation, the same were sent to ICFRE, Dehra Dun on prescribed format for publication of Timber and Bamboo Trade Bulletin.

Project 5: Studies on the pest problems in forest nurseries and their management in arid and semi-arid region. [AFRI-12/FP-2/1993-2003]. *Principal Investigator - Smt. Seema Kumar.*

Status: Weeding should form the important silvicultural practice for pest management. Timely weeding prevented the attack of insects and healthy growth of seedlings. Insects and non-insects were recorded. Life cycle of *Laspeyresia koeingana* was studied. Two plant pesticides were prepared and tested in the lab conditions against 3rd & 4th instar larvae of amaltash defoliator. *Laevicaulis alte* are generally distributed along with the seedlings in polythene bags transported for planting from one place to another.

Project 6: Studies on the crude protein content and leaf protein concentrates of arid zone shrubs and trees. [AFRI-15/NWFP-3/1995-2005]. *Principal Investigator - Dr. Mala Rathore*

Status: Shrubs and trees for use as conventional and unconventional fodder are being identified. Crude protein contents of leaves and seeds of various trees from different provenances/regions have been determined. Investigations on phenol content showed that it has a lower concentration.

Project 7: International Neem Network Provenance trial. [AFRI-17/FGTB-2/1995-2005]. *Principal Investigator - Mr. C.J.S.K. Emmanuel.*

Status: The performance of the Neem International trial at Jodhpur is good and the introductions which performed better are from Sunyani (Ghana), Tibbi Laran (Pakistan) and Chamwion (Tanzania). Among the Indian provenances Sagar is the best with a height of 2.96 meters followed by Balharshah (India).

Project 8: Provenance trial on arid zone species. [AFRI-16/FGTB-3/1992-2005]. *Principal Investigator- Mr. C.J.S.K. Emmanuel.*



International Neem Network Provenance Trial

Status: 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 Palanpur (Gujarat) is superior in growth followed by Gandhinagar (Gujarat), Jhansi (U.P.) and Jaisalmer (Rajasthan). The data has also been recorded in percent on the oil and azadiractin content of all the provenances. The reproductive biology has also been studied for Neem. 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 Bhinslana (Jaipur) and Nagaur. Provenance trial for *Dalbergia sissoo* has been laid out in August 1995, from the seeds sent by FRI, Dehra Dun in the year 1994. The trial consists of 13 provenances with 3 replications and 6 plants in each line at a spacing of 4 x 3 meters. The line design was chosen considering low number of plants in each provenance. Out of the 13 provenances, Pilibhit provenance has shown best result followed by Kasganj and Lalitpur. The local provenance has not given good result.

NEW PROJECTS INITIATED DURING THE YEAR 2001-2002

NIL.

EXTERNALLY AIDED PROJECTS

PROJECTS COMPLETED DURING THE YEAR 2001-2002

Project 1: Studies on sand dune stabilization in Indian Desert [AFRI-3/FEDD-3; RD funded/1997-2001]. For technical report contact Principal Investigator - Dr. G. Singh.

Findings: Nutrient management in sand dune for better growth and biomass production - The study was carried out to find suitable species and its combined

surface vegetation with the aim of fast stabilization of dunes and production of fuel and fodder from this highly stressed site. Seedlings of *Acacia tortilis*, *Prosopis juliflora* and *Calligonum polygonoides* species were planted on shifting dunes and micro-windbreaks were erected to protect the seedlings from the drifting sand. *Cassia angustifolia* and *Cenchrus ciliaris* were sown as treatment (vegetation type) to develop under canopy vegetation. Vegetation types 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 to cover soil best. *C. polygonoides* produced the highest biomass in form of fuel wood utilizing minimum amount of soil water. There was an increase in SOM and soil available $\text{NH}_4\text{-N}$ due to plantation and vegetation type treatments. *C. polygonoides* with *C. ciliaris* was the best combination for fuel and fodder production where as combination with *C. angustifolia* was best to control sand drift.

Studies on plant growth and biomass production under the influence of topography and surface vegetation - Growth and biomass production of *Acacia tortilis* was examined in relation to micro-topography and *Dactyloctenium aegyptium* as the surface vegetation. Bare Dune (BD), Bare Dune Plantation (BDP), Semi Stabilized Dune with surface vegetation only (SD), Semi Stabilized Dune Plantation (SDP), Flatland Without *D. aegyptium* (FW), Flat Land Plantation without *D. aegyptium* (FWP), Flat Land with *D. aegyptium* Grass only (FG) and Flat Land Plantation with *D. aegyptium* Grass (FGP) were the habitats identified on the basis of micro-topography, presence of vegetation and plantation of *A. tortilis*. Plant growth and biomass were almost similar between BDP and FWP habitats and were more compared to SDP and FGP habitats, respectively. Reduction in biomass was 6% and 58% in SDP and FGP than that in BDP and FWP habitats, respectively and was attributed to the competitive effect of *D. aegyptium* grass, which appeared to have stronger effect on soil water utilization. Distribution of tree roots was more in 0-30 cm soil layer in non-planted habitats. Presence of surface vegetation in SDP and FGP habitats influenced tree roots to penetrate deeper soil layer. Root/shoot ratio was high in dune habitats. *D. aegyptium* grass density and biomass was high ($P < 0.05$) in flatland compared to dune. Biomass was high in FG in 1998 whereas FGP produced high biomass in 1999 and 2000. Soil water content (SWC) was high in flatland compared to dune. High SWC in BD and FW (habitats without vegetation) compared to SP and FL respectively, indicated that *D. aegyptium* extracts and utilize soil water more efficiently. Similarly, non-planted area had high ($P < 0.01$) soil water content and obviously be due to its utilization by the planted *A. tortilis* seedlings. Competitive effect of *D. aegyptium* led to higher carbon allocation in stem in the seedlings of FGP and SDP compared to BDP and FWP habitats. These findings indicate that *D. aegyptium* competes with *A. tortilis* seedlings and affects the growth and biomass of *A. tortilis*. Management in the form of weeding and/ or soil working is recommended to reduce competition and better establishment and growth in flatland in which, the performance of seedling are poor instead of high soil water content.

Studies on effect of adult neighbours on regenerative population of Cassia angustifolia in dune area for habitat restoration - The study was carried out to determine the effect of canopy and distances from the adult neighbour on emergence and survival of *Cassia angustifolia* seedlings and their relations with soil water availability with aim to provide surface vegetation and control of sand drift. Five trees of each neighbors 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 (1.02.5 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 neighbours. Seedlings of IC zone attained greater height initially but did not show significant variations with OC and OS zone. Soil moisture was significantly ($P < 0.01$) higher 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 influenced the emergence and survival of *Cassia angustifolia* seedlings. *C. polygonoides* which had branching from the base and spreading canopy was found the best neighbour providing nursing effect to the regenerated *C. angustifolia* seedlings. Further, *C. polygonoides* utilized lesser quantity of soil water compared to *P. juliflora* and *A. tortilis*.

Project 2: Investigation of soil water plant relationship in respect of different tree species. [AFRI-5 /FEDD-5/W.B./1998-2001]. For technical report contact Principal Investigator - Dr. G. Singh (World Bank Project)

Findings: To screen tree species for efficient water use and growth under arid conditions : Experiment was started with planting one-year-old seedlings of *Eucalyptus camaldulensis*, *A. nilotica* and *Dalbergia sissoo* in July 1998. Five treatment were imposed viz. T₁- available soil water at -0.05 to -0.1 MPa, T₂- available soil water at -0.10 to -0.5 MPa, T₃- available soil water at -0.5 to -1.0 MPa, T₄- available soil water at -1.0 to 1.50 MPa and T₅- available soil water at -0.03 MPa to till death of the plant. Height, collar diameter, number of branches and biomass of all the three species decrease with increase of soil water stress. The effect of water stress visualized first on leaf followed by shoots and root. Root study indicated that effect of water stress was relatively lower on root than shoot and leaf. Increasing levels of soil water stress progressively impaired the physiological functions of *E. camaldulensis*, *D. sissoo* and *Acacia nilotica* seedlings. However, the quantum of influence differed from parameter to parameter. The rate of photosynthesis and transpiration reduced with water stress. Water stress level of T₂ seedlings had no appreciable influence



Soil water plant relationship in respect of different tree species

on stomatal resistance. However, with increase of water stress to T_3 , there was steep increase in stomatal resistance. In severely stressed T_5 seedlings, the stomatal resistance was three folds higher compared to unstressed seedlings. Nutrient uptake was high for the seedlings of T_1 treatment and was due to higher quantity of biomass production, which reduced drastically for the seedlings of T_5 treatment. -0.1 to -0.5 MPa (T_2) is more suitable for this region without compromising much with biomass reduction in *D. sissoo*. The drastic reduction in growth, physiological, biochemical function and nutrient uptake in the seedlings of all the three species at -0.5 to -1.0 MPa available soil water indicates the critical point for growth and biomass production. Temporary wilting was observed to be -1.96 MPa available soil water for *D. sissoo*. The instantaneous WUE was observed to be the high at sufficient soil water availability and decreased with water stress. However, at moderate water stress (-0.5 to -1.0 MPa) WUE was more in case of *D. sissoo* than the other two species. Soil water availability of -0.10 to 0.50 MPa is recommended for better growth and establishment of *D. sissoo* but high biomass production in *E. camaldulensis* and *A. nilotica* need sufficient soil water availability.

To study the effect of varying level of sewage water on the growth of the plants - Experiment was started with planting one-year-old seedlings of *Eucalyptus camaldulensis*, *A. nilotica* and *Dalbergia sissoo* in July 1998. The treatments were initiated in the first week of September 1998 after proper establishment of the seedlings. Five treatments imposed were T_0 - municipal effluent @ 1PET to the soil only; T_2 - municipal effluent @ $\frac{1}{2}$ PET; T_3 - municipal effluent @ 1PET; T_4 - municipal effluent @ 2 PET and T_5 - good water @ 1 PET. Municipal effluent quantity significantly affected the height, collar diameter and number of branches and biomass. Total dry biomass of *E. camaldulensis*, *A. nilotica* and *D. sissoo* increased by 2.4, 1.5 and 1.7 fold in the seedlings of T_4 treatment whereas in the in seedlings of T_3 treatment, which received same quantity of effluent as in T_5 treatment, the increase was 1.8, 1.5 and 1.2 fold in respective species. Biomass increase was 1.4 times in *E. camaldulensis* for the seedlings of T_2 treatment compared to the seedlings of T_5 treatment though it received just half quantity of municipal effluent. The seedlings of *D. sissoo* and *A. nilotica* produced total dry biomass at par with that of the seedlings of T_5 treatment. Root growth increases as the municipal effluent quantity increases. Above ground biomass mainly the foliage biomass markedly increase with increase in municipal effluent quantity. High photosynthesis and transpiration rate was observed in *E. camaldulensis* whereas in growing months of March-April and July- August photosynthetic rate was highest in *D. sissoo* whereas transpiration rate was highest in *A. nilotica* seedlings. Nutrient concentration in all the three species increased significantly with increase in municipal effluent quantity and was always higher in municipal effluent irrigated seedlings compared to good water (T_5) irrigated seedlings. Soil pH and SOC increased with increase in quantity of municipal effluent quantity. Extractable nutrient NH_4-N and PO_4-P increased significantly in upper soil layer. Availability of Na and Ca increased with soil depth whereas K and Mg accumulated at the topsoil layer and decreased in the lower (60-90) soil layer. All the micronutrient increased with increase municipal effluent quantity. In *E. camaldulensis* accumulation of nutrient was high in 0-15 cm soil layer whereas in soil of *D. sissoo* and *A. nilotica* seedling accumulation was high in lower soil layer. Mn increased with increase in soil depth in all the species. Increasing quantity of municipal effluent improved the growth, physiological parameter, and biomass

production and nutrient uptake. Application of sewage water did not show any adverse effect on plant functions compared to the seedlings irrigated with good water up to the age of three years.

Project 3: To screen various plant species for high yielding commercial forestry under irrigated condition in Indian arid zone [AFRI-7/FEDD-7 (WB)/1994-2001]. For technical report contact Principal Investigator - Dr. Ranjana Arya.

Findings: *Eucalyptus camaldulensis* maintained the maximum height through out the study period and after 63 months of growth *E. camaldulensis* attained the maximum average height followed by *Acacia nilotica* and *D. sissoo*. For crown diameter, trend was *A. nilotica* > *D. sissoo* > *E. camaldulensis*. *D. sissoo* suffered with decreasing incremental growth in crown diameter since 1998. *Tectona grandis* was at fourth place in growth. All the tree species except *T. grandis* were planted with VAM inoculum in 1995. However, during initial three years of growth no significant effect of VAM was noticed on growth and survival. Higher dose of fertilizer applied after five years of plant growth to the VAM treated plants positively influenced the height for all the species. Fertilizer application was not effective in increasing the crown diameter for all the species. Fertilization significantly influenced the biomass yield. Increase was significantly higher in leaf and branch mass. Maximum biomass was recorded for *E. camaldulensis* closely followed by *A. nilotica* for both the treatments and followed by *D. sissoo*. Component allocation wise *E. camaldulensis* and *D. sissoo* have more stem biomass as compared to *A. nilotica*. Root biomass was also influenced by fertilizer application for all the species; number and total root length of lateral roots were significantly higher in fertilized trees as compared to control for all the species. *E. camaldulensis*, may be considered the most water use efficient tree species among all the three tree species, followed by *A. nilotica* and *D. sissoo*. However, from the point of view of stem biomass, difference between *E. camaldulensis* and *A. nilotica* was substantial. In the fertilized plot, *E. camaldulensis* produced 1.5 times more stem biomass as compared to *A. nilotica*, while in the control plot this difference was 1.35 times. In fact the observations showed that there was slight increase in percent moisture content for middle and lower layer for all the three species indicating minor drift. Mean monthly soil moisture vary in different months for different species. Study indicates that percent moisture status under different trees varies in different seasons at different soil depths and distances under similar irrigation. Soil properties were not showing any adverse effect due to plantation under any tree species.

Project 4: Studies on VAM association in irrigated plantations and agroforestry systems. (AFRI-8/SILVI-1/ WB/1994-2001). For technical report contact Principal Investigator - Dr. K.K. Srivastava.

Findings: Survey work was conducted on VAM association in five tree species namely, *A. nilotica*, *A. indica*, *Prosopis cineraria*, *Tecomella undulata* and *Dalbergia sissoo*. Seasonal variation in spore population was studied for different age group plantations of different tree species in irrigated conditions and agroforestry systems. A total of 36 different VAM fungi, belonging to five genera (*Glomus*-26; 3 each of *Gigaspora* and *Sclerocystis* and 2 each of *Acaulospora* and *Scutellospora*) were isolated and identified. A protocol was developed for

preparation of pure inoculum and mass multiplication of VAM. VAM inoculation experiments on arid and semi-arid tree species showed VAM inoculated seedlings performed better in term of bio-mass and percentage on infection as compare to control. Indigenous strains of VAM were found better than non -indigenous strains. VAM inoculation was found more effective in root trainer raised seedlings as compared to poly -bags. VAM association studies of *A. nilotica* plantation revealed the presence of five VAM genera namely *Glomus*, *Gigaspora*, *Scutellospora*, *Acaulospora* and *Sclerocystis*. Field trial on neem genotypes Vs VAM strains on neem has been laid out. Demonstration trials on biofertilizer have been laid out at Model plantation, Jodhpur and experimental area, Rohat (Pali).

Project 5: To develop vegetative propagation technique for *Acacia nilotica* and *Ailanthus excelsa* (AFRI-19/FGTB-4(WB)/1994-2001). For technical report contact Principal Investigator - Dr. U.K.Tomar.

Findings: All the cuttings rooted in various experiments. High survival percentage was recorded during hardening stage (80%). Survival percentage of these plants was low (40%) in field, because of heavy termite attack in some ramets. Field transferred, 50% plants produced flower buds in just 2-3 months. Vegetatively propagated plants also exhibited high branching pattern. Macropropagation of *Acacia nilotica* is possible from mature tree. Twenty percent success in rooting and 80% success at hardening stage have been achieved. These plants have been successfully established in field. Grafting experiments have also been conducted. Ten per cent success was achieved in only splice approach grafting, in which scion and rootstock was grafted from seedlings. The grafted plants are growing well since last three years. Macropropagation of *Ailanthus excelsa* is possible through one and two-year-old seedlings and present studies provide the methodology of propagating such material. However, success rate is quite poor.

Project 6: To develop tissue culture technique for *Acacia nilotica* and *Ailanthus excelsa* (AFRI-20/FGTB-5(WB)/1994-2001). For technical report contact Principal Investigator - Dr. U.K. Tomar.

Findings: Hardening of *in vitro* regenerated plants was very difficult and a very little success has been achieved in developing a successful hardening procedure. *In vitro*-rooted plant are growing well since last one year and same plants are transferred to field. Micropropagation of *Acacia nilotica* is a distinct possibility through mature tree. Shoot culture can be established throughout the year and can be maintained for long term (about 2 years) with an average multiplication rate of 2.5 fold after each subculture. Rooting success is highly satisfactory. However, research is still needed to develop hardening procedure. Micropropagation studies also generated research database for establishment of *in vitro* cultures, shoot multiplication, rooting and hardening. First two steps, *viz.* establishment of shoot cultures, shoot multiplication are well standardized. However, for *in vitro* rooting and hardening further investigations are required for improvement in success and making micropropagation technique more economic and efficient.

Project 7: Provenance trials on *Acacia nilotica* and *Ailanthus excelsa* [AFRI-16/FGTB-1/WB/1995-2001]. For technical report contact Principal Investigator - Mr. C.J.S.K. Emmanuel.

Findings: The data on growth parameter 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 Makadampur, Agra and Solapur. 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 provenances 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 Varanasi (U.P.) 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 collected from 35 provenances. The seedling raised from 32 provenances were transplanted in the field. Due to drought conditions the mortality rate was very high and seeds were again sown and mortality replacement was done.

Project 8: Planting stock improvement programme [AFRI-23/WB/PSIP/1994-2001]. For technical report contact Principal Investigator - Mr. C.J.S.K. Emmanuel.

Findings:

Component I: Development of seed production area. Principal Investigator - Mr. C.J.S.K. Emmanuel.

The target for the SPA was 200 hectares and was achieved. Data was recorded on the survival and growth parameters of the SPAs before handing over to the State Forest Departments. Training to manage seed production areas was imparted to the SFDs personnels.

Component II: Development of Seedling Seed Orchards. Principal Investigator - Mr. C.J.S.K. Emmanuel.

The target activity of 55 hectares was achieved with 20 ha of *Acacia nilotica*, 19 ha of *D. sissoo* and 16 ha of *E. camaldulensis*. Seven hectares of provenance trial cum SSPA of *E. camaldulensis* was raised at Jodhpur from seeds obtained from CSIRO, Australia. 32 ha of SSO was planted at Govindpura, Jaipur and 16 ha at IGNP area. The targets were completed and the area was handed over to the State Forest Department. Trainings were imparted to the State Forest Department officials of Gujarat and Rajasthan for the maintenance of the SSOs, CSOs and SPAs.

Component III: Development of Clonal Seed Orchards. Principal Investigator - Dr. V.K. Tomar.

Clonal Seed Orchards of 29.0 ha was established, out of this, 10 ha of *T. grandis* and 4 ha of *D. sissoo* have been established in Gujarat. 10 ha CSO of *D. sissoo* and 4.0 ha of *Eucalyptus camaldulensis* have been established in Rajasthan. Fresh ramets of *D. sissoo* and *Eucalyptus camaldulensis* clones have been raised in mist chamber and supplied to SFDs for casualty replacements in CSOs.

Component IV: Vegetative Multiplication Gardens. Principal Investigator - Dr. V.K. Tomar.

Base populations of 72 clones of *D. sissoo* and 26 clones of *E. camaldulensis* have been maintained in 5 ha area. The purpose of raising clonal stock. Green House and polyhouse installed at AFRI is working very satisfactorily for rooting of the cuttings in this arid environment. Casualty replacements in CSOs and VMG

completed. Clonal material of *D. sissoo* supplied to Rajasthan SFDs for field trials. Training was provided to Rajasthan and Gujarat SFDs Departments.

Component V: Development of seed bank facilities. *Principal Investigator - Dr. D.K. Mishra.*

Seed germination and seed-testing laboratories with all the desired equipments have been established. All the equipments are working properly. Neem seeds collected from various morphologically variable trees have been tested for various seed testing parameters. 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. Seeds of *A. nilotica* collected during previous years have been tested and it was found that the seeds even older than eight years showed about 65% germination capacity. Effects of seed size and pre-treatments 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. Seeds of *A. nilotica*, *Prosopis cineraria*, *Dalbergia sissoo* and *Ailanthus excelsa* were tested for the duration and viability percentage.

Component VI: To develop model nursery. *Principal Investigator - Mr. H.C. Chaudhary.*

Established a full-fledged model nursery capable of raising 1.20 lakh seedlings with required facilities.

PROJECTS CONTINUED DURING THE YEAR 2001-2002

Project 1: Screening of exotic and indigenous plant species for their performance on salt affected soil with different management projects. [AFRI-6/FEDD-6/1997-2003]. *Principal Investigator - Dr. Ranjana Arya.*

Status: A total of seven experimental trials exist at the salt affected area of Gangani in Jodhpur district laid from 1997 to 2001. Trial of *Atriplex lentiformis* was laid in 1997 with three levels of gypsum. Overall there was no appreciable decrease in survival of bushes as compared to survival in Nov 2000. Biomass estimation was carried out in December 2001, data analysis is under progress. Weed evaluation was carried out and now *Sueda fruticosa* was the dominant herb and *Sporobolous* spp., *Dactyloctenium* sp. and *Chloris* were the dominant grasses. Trial of *Salvadora persica* was planted in 1997 with two levels of gypsum four levels of nitrogen. Plant survival recorded in September 2001, four years after planting showed no appreciable decrease in survival in all the treatments despite very poor monsoon years. Growth data, status of soil during the study period were recorded. *Acacia ampliceps* was planted with and without gypsum in Sept 1998. Fertilizer application of nitrogen and phosphorus was carried out in August 2000 in first and second replication. Data recorded for increment of growth rate and flowering. A trial of *A. lentiformis* was planted in August 1999 on double ridge mound with three levels of gypsum such as control G_0 , half gypsum requirement G_1 and full gypsum requirement G_2 . 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. Height and crown diameters were recorded. Two factors ANOVA were performed to find out the effect of treatments on survival. ANOVA results showed that gypsum application was not significantly influencing the height while nitrogen application influenced the height. CD values showed that all the nitrogen levels attained significantly higher growth than control but they were not statistically different from each other. However, Calcium Ammonium Nitrate (CAN) treated bushes record better height as compared to urea treated bushes with or without gypsum application. Similar trend was observed for crown diameter. Biomass estimation was undertaken. An experimental trial of *A. amnicola* was laid out in August 2000 with three planting treatments (double ridge mound S_1 , elevated slope planting S_2 and simple bund planting S_3) with full gypsum requirement. Bushes received no rainfall after planting. Survival of the bushes recorded after nine months of planting in April 2001. However, the survival recorded after 14 months of planting showed that, there was no change in percent survival for double ridge mound and elevated structure, decline in survival for raised bund structure was observed. (Growth parameters were recorded at nine and fourteen months after planting and 14 months of age treatments were influenced the growth. Another trial was laid with 3 salt tolerant species namely *A. lentiformis*, *A. nummularia* and *Sueda nudiflora* and three treatments of planting in a RBD in August 2000. There was no change in survival for Double Ridge Mound (DRM) and Circular Dished Mound (CDM) soil structures after 12 months of planting for any species, survival was reduced in control. Species wise *Sueda nudiflora* recorded nearly 100 % survival in all the three treatments; survival was highest in CDM for *Atriplex nummularia* and *A. lentiformis*. Plant growth was also significantly higher on soil structures as compared to control. A trial with two tree species, *Acacia coleii* and *Azadirachta indica* was laid with three treatments of planting. Highest mean percent survival was recorded for Circular Dished Mound (CDM) structure followed by Double Ridge Mound (DRM) and control after three months of planting. Species wise *Acacia coleii* showed better survival than *Azadirachta indica*.

Project 2: Integrated development of neem in different agroclimatic zones of Gujarat (AFRI-21/FGTB-6 (NOVOD)/1999-2002).

Components : Selection of CPT/sample trees, phenological observations, Development of model plantation, model villages).
Principal Investigator- Dr. U.K. Tomar.

Status: 150-sample trees selected, recorded growth parameters and total height, clear bole height, DBH and observed general morphological characteristics. 107 samples have been sent to IBPGR for cryo-preservation and 110 to TERI for chemical evaluation. Established experimental plot of 2.25 ha at Rohat to study the performance of seedlings and 2 ha at AFRI to study the VAM interaction with different genotypes. Seedling Seed Orchard (SSO) of 4 ha of *Acacia* provenance trial from CPTs with high Az and high oil content. Phenological observations (quantitatively) recorded. Seeds have been collected from 150 sample trees and analysed for various seed -parameters. 450 sample trees of neem were selected in different agro-ecological regions of Gujarat State. Measurements recorded and compiled. Phenological observations were recorded for the selected sample trees. This study was done once in a year at the time of seed collection. Seeds collected from 100 trees were tested for seed weight moisture content and, percent

germination. Seeds were grouped as per Agro-Ecological Regions of Gujarat State. Standardization for replications for seed weight was also carried out for neem seeds collected from Gujarat State. The experiment laid out in 5 ha of land at Hathrol for studying the performance of three types of seedlings (summer, winter and coppice seedlings) was maintained and growth data recorded.

Project 3: Comprehensive community drought preparedness programme to improve quality of life of women and children in Jodhpur district (AFRI-27/Silvi-3/UNICEF/2001-03). *Principal Investigator- Sh. H.C. Chaudhary.*

Status: Survey of 1175 community rangelands called *Orans* and *Gauchars* located in Jodhpur, Bilara, Luni and Bhopalgarh tehsils of the Jodhpur district were conducted. Detailed information on their socio-economic status, vegetative status, water availability, fuelwood, fodder and other alternative resources, diversion of land for non-grazing and intervention if any SFD or other department for rehabilitation were collected. Soil samples collected from the *Orans* and *Gauchars* were analysed.

Project 4: Development of suitable models for urban aesthetic forestry suitable for arid & semi arid region of Rajasthan (AFRI-28/Silvi-4/UIT/2001-06). *Principal Investigator- Sh. H.C. Chaudhary.*

Status : Under the project roadside plantations having different combination of the species have been raised at three locations within the Jodhpur district to assess suitability of various ornamental plants for raising roadside avenue plantations in arid and semi arid region of the Rajasthan. Data are also being recorded to assess the growth performance of various species under the conditions of high inputs. Initial observations have shown that significantly higher growth of the ornamental plants can be achieved even in the arid and semi arid areas when we provide higher inputs in the form of higher quantity of water, fertilizers, pesticides and soil working. Species planted are *Cassia siamia*, *Azadirachta indica*, *Delonix regia*, *Cassia fistula*, *Derris indica*, *Alistonia scholaris*, *Tecomela undulata*, *Dalbergia sissoo* and *Bougainvillea* spp. The Chairman, Urban Improvement Trust, Jodhpur has declared the avenue plantations raised under the project as the best roadside plantation of the Jodhpur.

NEW PROJECTS INITIATED DURING THE YEAR 2001-2002

NIL

Research Achievements Statewise

Name of State	No. of Projects Completed in 2001-02	No. of Ongoing Projects in 2001-02	No. of Projects Initiated in 2001-02
Rajasthan	12	10	3
Gujarat	2	2	1

Technologies Assessed and Transferred

- ◆ Use of surface vegetation for soil improvement and sand dune stabilization
- ◆ Documentation of SPAs selected and sample plots laid out has been done. Literature on the establishment and management of Seed Production Areas in Gujarat and Rajasthan have been prepared and distributed to the concerned state staff during the training workshops in both the states.
- ◆ Package with various combinations of trees for urban aesthetic forestry for Jodhpur has been developed.

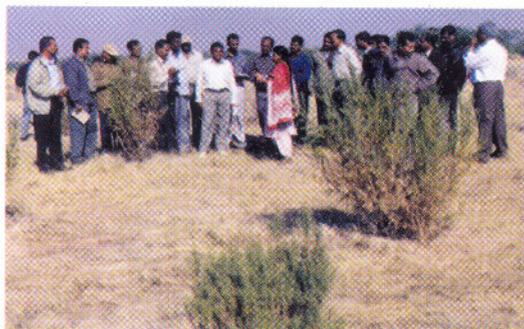
Education & Training**Trainings Attended**

Sl.	Name and designation	Training	Place of Training	National/ International
1.	Sh. M.R. Baloch International	Information	Univ. of Technology Australia	Melbourne,
2.	Dr. U.K. Tomar	Forest Genetics & Tree Improvement	Univ. of Melbourne, Australia	International
3.	Dr. Mala Rathore	Wood Composites by Enzymatic Methods	Univ. of Gottingon Germany	International
4.	Sh. N. Bala	Climate Change/ Carbon Sequestration	Oregon State State Univ. USA.	International
5.	Dr. G. Singh	Exchange Visit	Indonesia, CIFOR HQ at Bogar	International
6.	Sh. A.K. Sinha	Computer Application (IT)	Toranto	International
7.	Dr. Pramod Kumar	Rehabilitation and Management of Degraded Land	CSIRO, Australia	International
8.	Sh. H.C. Chaudhary	Country Focused Training on Regional Ecosystem Monitoring Technology	Japan International Cooperation Agency, Japan	International

9.	Sh. Bharat Sharma, Sh. C.P.Rangdale, Sh. V.K.Sahni	FAS	ICFRE, Dehra Dun	National
10.	Sh. A.K.Sinha, Sh. V.K.Sahni	LAN Management	ICFRE, Dehra Dun	National
11.	Sh. P.S.Sakhla, Sh. Pratap Ram	LAN Management	ICFRE Dehra Dun	National
12.	Dr. B.M.Dimri, Dr. S.Mohan	Research Writing	NFLIC, Dehra Dun	National
13.	Smt. Anuradha Bhati, Smt. Saroj Sisodiya, Smt. Varsha Vashita	Library Management	Libsys Corp Gurgaon	National
14.	Smt. Sangeeta Tripathi, Sh. Rajesh Gupta, Dr. N.K. Bohra, Dr. Shivesh Kumar, Sh. Devedra Kumar, Sh. Hemant Kumar, Sh. Mahendra Singh	Management and Utilisation of <i>Prosopis juliflora</i>	CAZRI, Jodhpur	National
15.	Dr. S. Mohan, Dr. Pramod Agarwal, Ms. Parveen, Dr. Meeta Sharma, Dr. Shivesh Kumar, Sh. Devendra Kumar Sh. S. Panikaur, Manhendra Singh, Bihari Lal Darji	"Neem and Holistic Sustainable Human Development" by NOVOD Board	CAZRI, Jodhpur	National

Trainings Organised

Sl.	Subject	Venue	Target Group
1.	Project Related Training "PSIP"	Jaipur and Rajpipla	SFD officials for establishment and management of SPAs.
2.	Research Results/Technologies Developed.	AFRI Jodhpur.	SFD officials from Rajasthan and Gujarat (RFO's and Foresters) (26/12/01 to 28/12/01)
3.	In-service Training of Southern Forest Rangers	AFRI, Jodhpur	RFO trainees from Coimbatore, Tamil Nadu. (28.11.2001 to 30.11.2001)



Training to SFDs Officers

In service training of
Southern Forest Rangers

Linkages and Collaborations

National

Tata Energy Research Institute, New Delhi

The Institute has formulated the UNDP-GEF project brief on "*Integrated Ecosystem approach to rehabilitate degraded arid and semi arid lands of western India for combating desertification*" for Ministry of Environment and Forests, Govt. of India. The project will promote participatory Integrated Ecosystem Management (IEM) of some globally important arid and semiarid areas of north-western India. It covers an area of 28910 ha and is spread over eleven sites in Rajasthan and Gujarat representing seven selected types of land degradation with the basic objective of conserving biodiversity, sequestering carbon and improving the socio-economic condition of desert dwellers.

The project will be implemented in phases over 5 years. The first phase will focus on the creation of an enabling legal, policy and institutional environment for the implementation of IEM. In the second phase appropriate models will be tested in the selected sites in combination with local knowledge and lessons learnt will be documented. In the final phase of the project monitoring of impacts, dissemination and replication of the project result will be carried out to generate global benefits as well as sustainable socio-economic and environmental benefits at the regional and national level.



Workshop on Integrated Approach in Combating Desertification

International

1. International Neem Network, FAO, Rome.
2. Oregon State University, Corvallis, USA - development of concept paper on "Productivity and carbon flux in forest of Indian arid zone and mitigation of carbon emission through forestry options"
3. Centre for International Forestry Research (CIFOR) - development of three concept papers on:
 - i) "Community development through rehabilitation of degraded forestlands in dry tropical zone";
 - ii) "Combating desertification through rehabilitation of degraded forestlands in desert fringes of India" and
 - iii) "Protection to *Prosopis cineraria* in Indian desert- A detailed proposal to control mortality and studies on bio-ecology and biophysical environment for social upliftment of the inhabitants."

Publications

Books

1. Ahmed, S.I and Shivesh Kumar (1999). Role of Environmentally Acceptable Entomopathogens in Forest Insect Pest Management. In Modern Trends in Environmental Biology. CBS Publishers, New Delhi. (Published in 2002).
2. A.K. Mandal and S.A. Ansari; Chapter "Genetical improvement of teak: concept, application and achievements"; by C.J.S.K Emmanuel in the book "Genetics and Silviculture of Teak".
3. Dr. C. Surendran; Chapter "Genetic Variations and Tree Improvement" by C.J.S.K. Emmanuel in the ICAR university level text book "Forest Tree Breeding" Director, Centre for Plant Breeding and Genetics, TNAU, Coimbatore.
4. G. Singh and M. Bhati (2001). Utilization of industrial wastewater for tree plantation. In: *Bioresource Technology* (Ed. G. Tripathi).
5. G. Singh and Sarita Mutha (2001). Tree: a bio-resource for sustainable production in arid areas. In: *Bioresource Technology* (Ed. G. Tripathi).
6. Meeta Sharma and S.I. Ahmed (2000). Integrated pest management of marwar teak defoliator, *Patialus tecomella*, Pajni, Kumar and Rose (Coleoptera: Curculionidae), in arid and semi arid areas. In Recent Trends in Insect Pest Control to Enhance Forest Productivity. (Ed by P.K.Shukla and K.C.Joshi) Tropical Forest Research Intitute, Jabalpur: pp. 199-211. 64. (Published in 2001).
7. N. Bala (2001). Water regimes and Forests. In: *Bioresource Technology* (Ed. G. Tripathi).
8. N. Bala (2002). Water regime and forests. In: *Bioresource Technology* (Ed G. Tripathi).
9. Shivesh Kumar and Ahmed, S.I (2000). Natural enemy complex of insect pest spectrum and mites of *Prosopis cineraria* Linn and *P. juliflora* Swartz., DC in Indian Thar Desert. In Recent Trends in Insect Pest Control to

Enhance Productivity. (Ed by P.K.Shukla and K.C. Joshi) Tropical Forest Research Institute, Jabalpur:pp 218-230. (Published in 2001).

10. Tripathi, Y.C. Tiwari, V.K., Srivastava, K.K., Ahmed, S.I. (2001). Biopesticides as an effective tool for integrated pest management. In Forest Conservation and Management- Challenges of the Millennium. (Ed. P.Rethy, P.P.Dabral, Vinay Singh and K.K. Sood) 113.
11. Tarun Kant; An insight into Bioinformatics Its evolution, present status and future prospects". In: Glimpses in Plant Sciences (Ed. P.C Trivedi), Pointer Publishers, Jaipur, (2002)- Accepted.
12. Tarun Kant, S.L. Kothari, Halina-Kononowicz Hodges, Thomas K. Hodges; "Agrobacterium tumefaciens mediated genetic transformation of *Oryza sativa*". In: Role of plant tissue culture in biodiversity conservation and economic development (Ed. Nandi S.K., Palni L.M.S., Kumar A). Bhagyodaya Publications, Nanital, India. pp 457-478 (2002).

Research Papers

1. Ahmed, S.I and Khan Ameen Ullah (2002). A New host record of *Achmaeodera aurifera* Laporte and Gory (Coleoptera : Buprestidae) on freshly felled timber of *Prosopis cineraria* (Linn) and *Albizia lebbeck* in Rajasthan. *The Indian Forester*, 128: 103-104.
2. Ahmed, S.I., Kumar Shivesh and Paunikar, S.D. (2000). Biological control of *Streblote siva* through NPV and natural enemy complex of insect pests of *Prosopis cineraria* in Rajasthan. *The Indian Journal of Forestry*, 23(3): 305-311. (Published in 2001).
3. C.J.S.K. Emmanuel, U.K. Tomar, Tarun Kant (2002) Assessing Geographical Variability in Neem - Presented at CAZRI.
4. G. Singh (2001). Canopy covers effect of adult neighbours on regenerative population of *Cassia angustifolia* in dunny area of Indian desert. (Submitted to review committee).
5. G. Singh (2001). Growth, biomass production and soil water dynamics in relation to habitat and surface vegetation in hot arid region of Indian desert. *Forest Ecology and Management* (Submitted).
6. G. Singh (2001). Influence of soil moisture and nutrient gradient on growth and biomass production of *Calligonum polygonoides* in Indian desert affected by surface vegetation. *J. Arid Environment* (Submitted in revised form).
7. G. Singh and T.R. Rathod (2001). Plant growth, biomass production and soil water dynamics in a shifting dune of Indian desert. *Forest Ecology and Management*, 5832: 1-12.
8. G. Singh, and T.R. Rathod (2001). Growth of woody perennials in relation to habitat condition in northwestern Rajasthan. *Tropical Ecology*, 42: 223-230.
9. G. Singh, N. Bala, Thanaram Rathod and Bilas Singh (2001). Effect of textile industrial effluent on forest development and soil chemistry. *J. Environ. Biol.* 22(1): 59-66.
10. Kumar, S and Ahmed, S.I (2000). Records of pestiferous and molluscs from

- Rajasthan, India. *Rec. Zool. Surv. India* 98(3): 67-7051. (Published in 2001).
11. N. Sharma, Parveen, C.J.S.K. Emmanuel, U.K. Tomar (2001) Literature review on clonal propagation of important arid zone tree species.
 12. Ranjana Arya; Yield of *Cassia angustifolia* in combination to different tree species in a silvi-herbal trial under hot arid conditions in India, (2002) *Bioresource technology* (sub. in revised form).
 13. Sharma, M and Ahmed, S.I (2000). Biology and field efficacy of *Billeae atkinsoni* (Diptera : Tachinidae) a potential pupal parasite of marwar teak defoliator in arid and semi arid areas. *The Indian Forester*, 4: 409-418. (Published in 2001).
 14. Tarun Kant, S.L. Kothari Halina-Kononowicz Hodges, Thomas K. Hodges; "Agrobacterium tumefaciens- mediated transformation of rice using coleoptile and mature seed-derived callus". *J. Plant Biochemistry & Biotechnology* vol 10, 121-126 (2001).
 15. U.K. Tomar, Tarun Kant C.J.S.K. Emmanuel (2002) Mass multiplication of desired genotype in Neem, Presented at CAZRI.
 16. V.P. Tewari and D.K. Mishra (2001). Changes in bio-diversity in Indira Gandhi Nahar Pariyojana area of Rajasthan. *My Forest* 37 (2): 449-454.
 17. V.P. Tewari, C.J.S.K. Emmanuel and D.K. Mishra (2001). Application of method of paired comparisons in the selection of candidate plus trees in tree improvement programme. *My Forest* 37 (2): 463-467.
 18. V.P. Tewari and V.S. Kishan Kumar; Construction and validation of tree volume functions for *Dalbergia sissoo* grown under irrigated conditions in the hot desert of India, *Journal of Tropical Forest Science*, 13(3), 2001, 503-511.
 19. V.P. Tewari, S.L. Chauhan and V.S. Kishan Kumar; Volume equations for *Dalbergia sissoo* in IGNP area, *Annals of Forestry*, 9(1), 2001, 140-143.
 20. V.P. Tewari, Bilas Singh and V.S. Kishan Kumar; Volume equations for *Eucalyptus camaldulensis* in IGNP area, *The Indian Forester*, 127, 2001, 1367-1370.
 21. V.S. Kishan Kumar and V.P. Tewari; Lopping on the growth and fodder production of *Ailanthus excelsa*, *International Forestry Review*, 3(1), 2001, 54-57.

Reports

1. Ahmed, S.I.; Srivastava, K.K.; Singh, G.; and Prasad, R. (2001). A report on the scientific approach to study the causes of mortality of *Prosopis cineraria* (L) Druce (Khejri) in Western Rajasthan. *Report submitted to State Forest Department Rajasthan and DDG Research, ICFRE, Dehra Dun:pp 1-7.*
2. Ahmed, S.I. (2001). Role of biological control in forest insect management in arid and semi-arid regions. *Concept paper prepared and submitted to National Project Director (WBP), ICFRE, Dehra Dun for International Participation. pp., 1-33.*

Technical Bulletin

1. K.K. Chaudhuri, CJSK Emmanuel, D.K. Mishra & V.P. Tewari (2001). Establishment and management of seed production areas in Gujarat State. pp 1-26.
2. K.K. Chaudhuri, CJSK Emmanuel, D.K. Mishra & V.P. Tewari (2001). Establishment and management of seed production areas in Rajasthan State. pp 1-24.

Brochures

1. Ahmed, S.I. and K. K. Srivastava (2001) Preliminary report on khejri (*P. cineraria*) mortality. Submitted to the Director, AFRI & authorities of SFD's.
2. Srivastava, K.K. and Neelam Verma (2002) "Know your nursery diseases and their management"
3. Ahmed, S.I. (2002), Brochure on " Know your nursery pests and their control".

Films/Documentary

A scientific documentary film khejri mortality in Rajasthan entitled as "Khejri ek jeewan rekha- Astitva ka sankat ", prepared in collaboration of E.M.R.C. Jodhpur and AFRI, Jodhpur.

Consultancy

Evaluation of the project entitled "Integrated Watershed Development Project in Sunel Watershed of Pirawa Panchyat Samiti District Jhalawar (Rajasthan)" Ministry of Rural Development.

Conferences, Meetings, Workshops, Symposia and Exhibitions**Organised**

Sl.	Subject	Duration	Venue
1.	Workshop on Integrated Ecosystem Approach to Rehabilitate Degraded Arid and Semi Arid Land of Western India for Combating Desertification	21 st Sept. 2001	Gandhinagar, Gujarat
2.	Workshop on Integrated Ecosystem Approach to Rehabilitate Degraded Arid and Semi Arid Land of Western India for combating Desertification (under UNDP-GEF)	26 th Sept. 2001	AFRI, Jodhpur, Rajasthan
3.	Liaison & RAG meetings	22 nd - 23 rd Oct., 2001	-
4.	CTA workshop cum Peer Review on Forest Ecology and <i>Dalbergia sissoo</i>	30 th 31 st Oct, 2001 & 1 st 2 nd Nov., 2001	AFRI, Jodhpur

5.	Consultative meeting on Integrated Ecosystem Approach to Rehabilitate Degraded Arid and Semi Arid land of Western India for Combating Desertification (under UNDP-GEF)	19 th March 2002	AFRI, Jodhpur, Rajasthan
6.	Consultative meeting on Integrated Ecosystem Approach to Rehabilitate Degraded Arid and Semi Arid land of Western India for Combating Desertification (under UNDP-GEF)	22 nd March, 2002	Gandhinagar, Gujarat

Workshop/Seminars Attended

Sl.	Subject	Duration	Held at
1.	Workshop on GEF Project under Operational Programme-12 (Integrated Ecosystem Management)"	31 st May-2 nd June, 2001	FRI, Dehra Dun
2.	Workshop on National Biodiversity Strategy and Action Plan	31 st August 2001	Gandhinagar, Gujarat
3.	Workshop on UNDP-GEF Project on Selected Options for Stabilizing GHG Emissions for Sustainable Development	27 th Nov., 2001	India Habitat Centre, New Delhi
4.	National Workshop on Innovative Plantation Technology and Joint Forest Management in IGNP area	10-11 January, 2002	Bikaner
5.	Workshop on Identification of Cluster and Technical Parameter for Selection	7 th January, 2002	CAZRI, Jodhpur
6.	Workshop on LTER-GTOS Carbon Flux Scaling	21 st -22 nd , May 2001	Blue River, Oregon, USA

Exhibition

An exhibition was organised in "*Hasta Shilp Utsav-2002 of Paschimi Rajasthan*" at Jodhpur from 02.01.2002 to 14.01.2002.

Publications

1. Arid Forest Research Institute, Jodhpur
2. Know your Nursery Pests and Their Control
3. Know your Nursery Diseases and Their Management
4. Arabic Goud ka Shorta - Kamta Vraksh.
5. Lavniya Bhumi ka Mitra - Jal

6. Maru Bhumi Ka Kalp Vrikash - Khejri
7. Maarvaad Ka Saagvaan - Rohida
8. Banjar Bhumi Ki Hari Chadar - Vilayti Babool
9. Vaarsha Ritu Aay, Vriksh Lagaane Ki Rut Laayi
10. Khair Marusthal Ma Parti Bhumi Sudhaar Hetu Fhal Vrikash
11. Marwar Teak - Rohida
12. Kalpavriksha of the Desert - Khejri

News Articles

"Neem" Ek Kalp Vriksha (Anjna Darshan, April 2001)

Distinguished Visitors

1. Dr. D.N. Tewari, Hon'ble Member of Planning Commission, visited the institute on 12.01.2002.
2. Sh. S.K. Pande, Director General of Forests and Special Secretary, Ministry of Environment & Forest, visited the institute on 31.01.2002 and held the technical discussions with the Head of institutions, i.e. CCF, CAZRI, State Remote Sensing Centre at AFRI, Jodhpur.
3. Sh.R.P.S. Katwal, Director General, ICFRE, Dehra Dun participated in the Consultative Workshops at Gandhinagar and AFRI, Jodhpur on 21st and 26th Sept. 2001, respectively.
4. Sh. D.C. Sood, Principal Chief Conservator of Forests, participated in the Consultative Workshops at AFRI, Jodhpur on 26th Sept. 2001.
5. Sh. J.P. Agrawal, Chief Conservator of Forests, Gujarat State, participated in Liaison and RAG meeting on 22nd-23rd Aug., 2001.
6. Sh. R.G. Soni, Chief Conservator of Forest, participated in the Consultative Workshops at AFRI, Jodhpur on 26th Sept. 2001.

Miscellaneous

Organised sports meets on 15th Aug., 2001 and on 26th Jan., 2002.

