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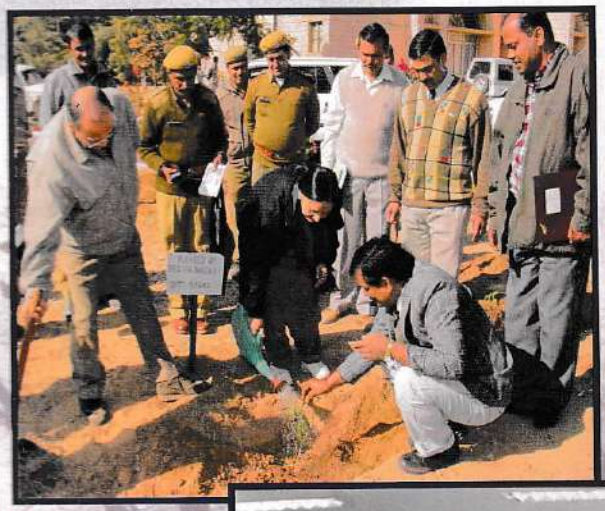
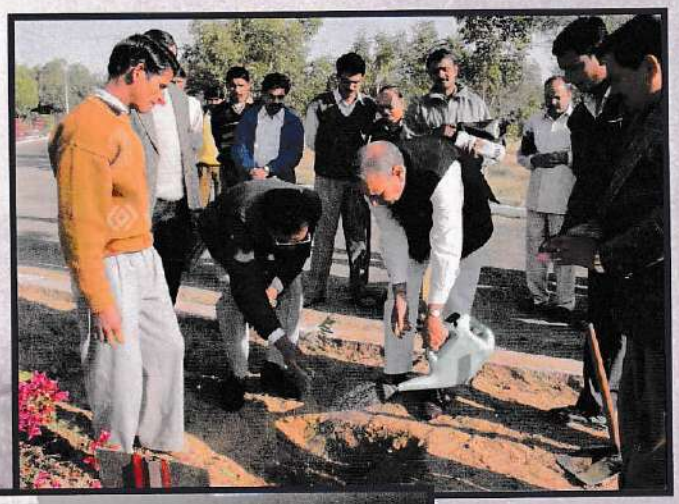
ANNUAL REPORT 2001-2002





Director : K.K. Chaudhu
G.C. (R) : R.L. Meena

ARID FOREST RESEARCH INSTITUTE
(Indian Council of Forestry Research & Education)
New Pali Road, Jodhpur- 342 005.
www.afri.res.in

CONTENTS

ARID FOREST RESEARCH INSTITUTE, JODHPUR

A.F.R.I. - *At A Glance:*

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 region of Rajasthan, Gujarat and Dadra & Nagar Havelli union territory.

The Institute covers 66 ha. of area on the New Pali Road and comprises of Main Office Building, Extension Office Building, Library cum Information Centre Building, Community Hall, Scientist Hostel, Guest House, residential campus and experimental fields.

Twenty-two research projects were executed during the year. Out of these, two projects under plan and six subprojects of three main projects under FREEP were concluded. The Institute has taken up a new project funded by the UNICEF. Various components of this project aim at improving the quality of life of women & children with reference to drought preparedness awareness by conserving the Oran and Gaucher lands. A project formulation work has been completed on "*Integrated Ecosystem approach to rehabilitate degraded arid and semi arid lands of western India for combating desertification*" under UNDP-GEF.

Encouraging results were achieved in the fields of afforestation of sand dune, on salt affected lands, soil water -plant relations, tree-crop interaction, remedial measures for Khejri mortality, chemistry of plant parts, growth & yield studies, management of trees for fodder, seed studies, tree improvement etc.

Efforts were made in the field of extension by organising training and demonstration for SFD officials, publication and distribution of extension pamphlets in local language.

Significant achievements

- Soil water availability of -0.1 to -0.5 MPa was found suitable for establishment and production of biomass considering water scarcity in dry areas.
- At 3 years of age, production of dry biomass was 1.8, 1.5 and 1.2 fold in the seedlings of *E. camaldulensis*, *A. nilotica* and *D. sissoo*, respectively irrigated with sewage effluent compared to good water irrigation of same quantity.
- Competition of Khejri to agricultural crop was less compared to Rohida and optimum density of Khejri was 208 stems per hectare at the age of 11 years.
- With initial decrease in soil organic matter (SOM) under agroforestry, there is increase after 4th year, resulting in nutrient enrichment.
- *C. polygonoides* produced high biomass in the form of fuel wood utilizing lesser amount of soil-water when compared with *A. tortilis* and *P. juliflora* at 50 months of age. Surface vegetation was found suitable in effective control of sand drift.
- *C. polygonordes* was more suited to surface vegetation in effective control of sand drift and provided nursing effect to regenerating surface vegetation.

- *Colophospermum mopane* was found suitable species for direct seeding with more than 95% germination under field conditions.
- In trial on arid salt affected soils, *Salvadora persica* was the best indigenous tree species four years after planting, attaining significant growth and continued to maintain appreciable survival (ranging from 85.2 to 66.7%) in all the treatments despite very poor monsoon year.
- Double ridge mound technique appreciably increased the survival of plants on salt affected soils where water logging persists for longer duration, while circular dished mound technique was helpful in low rainfall year when water logging was less.
- *E. camaldulensis* and *A. nilotica* were found to be the most promising tree species of the six species tried under irrigated conditions in the arid zone producing maximum biomass under fertilized and control conditions after five years of plant growth.
- During 2001-02, Makadampur, Agra and Solapur performed best growth in *Acacia* provenance trial.
- Pinjore (Haryana) and Kazipeth (A.P.) provenances of *Ailanthus excelsa* have given better results.
- In International Neem Network provenance trial, introductions from Sunyani (Ghana), Tibbi Laran (Pakistan) and Chamwino (Tanzania) and among Indian provenances, Sagar and Balharshah performed better.
- National Neem Network trial, promising provenances for *Azadiractin* are Shivpuri (0.93%), Katni (0.40%) and Kanpur (0.39%). Promising provenances for oil content are North Bilaspur (49.7%), Nagpur (48.4%) Kanpur (47.2%) and Jodhpur (47.1%).
- Concentration of phenols in Leaf protein concentrates was found be lesser than that in leaves.
- *Derolus descicollis* (Coleoptera: Cerambycidae) has been recorded as one of the important factors, 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 to the concerned bodies and state government. A documentary in local language has been developed for effective extension.
- Performance of Neem International trial at Jodhpur is good and the maximum from Sunyani, Tibbi Laran and Chamwion (Tanzania).
- Standardized seed weight replications for 15 species.
- Developed macro propagation and micropropagation technique for *A. nilotica* and *A. excelsa* with mature trees.
- Single seed protein content determination method has been worked out for neem.
- Prepared establishment & management plan of seed production areas of Rajasthan & Gujarat States.
- Supplied superior clonal stock of neem to Rajasthan SFDs and provided training to Gujarat and Rajasthan SFDs.
- Prepared checklist of economically important diseases of forest nurseries and plantations of arid & semi-arid tree species.
- Evolved silvicultural /fungicidal management of economic important diseases.
- Detailed studies were under taken on VAM association of arid tree species.
- A protocol for mass production of VAM inoculum was developed.

PROJECTS COMPLETED DURING 2001-2002

Project 1: **Integrated Pest Management of forest insect pests in Plantations and Natural Forests [AFRI-11/FP-1 (Plan)/1996-2002]** *Principal investigator- Dr.S.I.Ahmed*

Findings:

I. Efficacy of phytopesticides:

i) Investigations of the bioefficacy of plant extract of *Psorelea corylifolia* and *Balanites aegyptiaca* against major insect pests have been tested in different concentrations in order to find out its effective biocidal dose. The different concentrations against *Myllocerus tenuicornis* prepared were 1, 0.1, 0.5, 0.05, and 0.005 %. The experiment was replicated thrice. It has been observed that the extract worked as repellent rather than acting as effective biopesticide. 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.

ii) 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 confirmed.

iii) The extract of *Balanites aegypticea* (fruit coat and fruit pulp) has been prepared for testing against *Patialus tecomella* in different concentrations (viz. 0.1, 0.01, 0.001 %) to find out the effective biocidal dose. The biopesticidal studies showed a positive response of *Balanites aegypticea* against *Patialus tecomella*. Amongst the different concentrations listed, 0.1% was found to be the most effective.

II. Efficacy of parasites/Pathogens/Predators

i) Insect pathogenic viruses: Nuclear Polyhedrosis Virus suspension of *Streblote siva* has been tested under the field conditions. It has been recorded that the NPV strain has been well settled in the field conditions as no epidemic has been recorded during 2000-2001.

ii) 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. r*espectively.
- *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 lay 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 along with 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 have been tested against *Myllocerus tenuicornis*. Monocrotophos (0.02%) was found highly effective against *M. tenuicornis* in the field conditions.

IV. Large scale Khejri mortality and its management in northwestern Rajasthan:

- *Derolus descicollis* (Coloeptera: Cerambycidae) has been recorded as one of the important factors, responsible for large scale drying and mortality of Khejri trees in four districts of Rajasthan. The infestation of this species has been recorded for the first time in India. Recommendations for control measure of this problem have been communicated to the concerned bodies and state government.

Project 2: Disease spectrum of arid and semi-arid tree species.
(AFRI-9/SILVI-2/1994-2002) *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 for 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 in India. *Ganoderma* root rot has been reported as a serious disease in *Acacia tortilis, Albizzia lebbeck, Dalbergia sissoo, P. cineraria, Ailanthus excelsa* and *Prosopis juliflora.* 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, Gujarat at Mehsana and Gandhinagar was prepared.

PROJECTS CONTINUED DURING 2001-2002

STATUS REPORT

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

Experiment 1: Effect of intercrops on yield and productivity of agroforestry systems

In 1998 the experiment was redesigned to include some intercrop treatments of medicinal plants and water harvesting treatments. In the revised experiment main treatments are: i.) No water harvesting and ii.) Water harvesting; sub main treatments are: T1) no intercrop, T2) mungbean - mungbean, T3) Sesame- sesame, T4) Mung - sesame, T5) *Cassia aungustifolia*, T6) Guar- Guar, and T7) Mung + til and sub - sub main treatments are i.) *Prosopis cineraria* and ii.) *Tecomella undulata*. In 2001, the average height of *P. cineraria* at 12 years of age varied from 370 cm to 485 cm and collar girth from 31.4 cm to 36.4 cm. Whereas, height of *Tecomella undulata* varied from 341 cm to395 cm and collar girth 28.5 cm to 36 cm. No significant variations were noted in tree growth as a result of intercrops and water harvesting treatments. Significant findings are: i) Comparatively less competition of khejri tree with agricultural crops; ii) better suitability of pulse crop than pearl millet in agrorofestry; iii) crop production increased with distance from tree and was more in T4 treatment (25.3 and 165.9 g m^{-2} with *P. cineraria* and 21.0 and 158 g m^{-2} with *T. undulata*); iv) biomass production from tree is more under agroforestry than in sole tree and v) *C. angustifolia* requires less water compared to other crops as evidenced by high soil water availability i.e. 2.49% and 2.44% with *P. cineraria* and *T. undulata*, respectively.

Experiment 2: 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. In 2001, pearl millet was harvested as the agricultural crop. However, the effect of density on tree growth was appreciable. At eleven years of age, circumference at breast height of Khejri was significantly high (37.0 cm) due to stand density of 208 SPH (D3) as compared to 29.0 cm at a stand density of 416 SPH (D1). In case of *Tecomella undulata* (Rohida), the variation was from 19.0 cm to 34.0 cm, respectively. Followings are the significant findings: i) husk and grain production reduced by 21% and 19% at 416 SPH compared to 547 and 16.5 g m^{-2} in control plot, respectively, whereas it was 0.1 and 0.4%, respectively at 208 SPH (Stem per hectare) with *P. cineraria* compared to sole crop; ii) the reduction was to the tune of 19% for husk and grain at 416 SPH and 5 and 0.6% at 208 SPH for *T. undulata* at the age of 11 years; iii) optimum density declines with advancing age; at four year of age optimum density was 417 SPH and iv) at 11 years of age optimum density observed is 208 SPH

Agroforestry Models

(a) *Tecomella undulata* in association of *Cyamopsis tetragonoloba*

Acacia nilotica and *Albizia lebbeck* in association of *Vigna radiata* under *in-situ* run-off agroforestry

Experiment 3: 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. Fixed crop of mungbean and rotational crop of pearlmillet/mungbean were taken as the other treatment. In 2001, pearlmillet was the rotational crop and mungbean was the fixed crop. The results indicate i) collar diameter of the three species was high under rotational cropping system; ii) crop production was low near tree and increased with distance. Reduction in grain production was 38% with mopane and 24% with *E. officinalis* for pearlmillet and 4% with *H. binata* and about 50% with *E. officinalis* for mung; iii) soil water status is more in rotational crop plot than fixed crop plot. *E. officinalis* utilizes more water than *H. binata* and *C. mopane* iv) with initial decrease there is increase in SOM pool under all the three species though increase was more under *E. officinalis* v) study demonstrated significant temporal variation in soil organic carbon, extractable PO_4-P, NO_3-N and NH_4-N and vi) the pool of available nutrients was generally higher during summer and low during spring season.

Experiment 4: In -situ runoff agroforestry

Bunding at proper interval facilitate the *in situ* runoff collection and moisture conservation. This is useful for agricultural activities in between the bunds and cultivation of tree for fodder and firewood. 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. In cropping season of year 2001, *Cymopsis tetragonoloba* (guar) and *Vigna radiata* (mung) were the intercrops. The findings are: i) grain production of *C.tetragonoloba* (14.9 g m^{-2}) was more compared to *Vigna radiata* (10.5 g m^{-2}) in all the three species; ii) production was more with *Acacia nilotica- V. radiata* (11.9 g m^{-2}) and *Albizia lebbeck- C. tetragonoloba* (17.8 g m^{-2}); iii) soil moisture increased with distance except in 0-25 cm soil layer being lowest of 0.65% near *A. indica* to 1.55 in center of two rows in *A. lebbeck* plot; iv) SOM decreased with both distance as well as soil depth and ranged between 0.19% to 0.27%.

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

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 the ADG (Stat.), ICFRE, Dehradun 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:

No outbreak was recorded this year. Ten different species of weed plants were collected from the *Neem, Acacia* and *Moringa* seedling. These will be identified from Botanical Survey of India, Jodhpur. Weeding should form the important Silvicultural practice for pest management. These are serving as the causative agent attracting different organisms resulting in seedling mortality in nursery containers. Timely weeding prevented the attack of insects and healthy growth of seedlings.

Insects and Non-insects recorded were *Myllocerus nepalensis* & *Myllocerus* sp. on *Eucalyptus* sp., *Myllocerus dalbergiae* on *Dalbergia sissoo, Myllocerus* sp. on Amrud and *Myllocerus tenuicornis* on *Azadirachta indica*. Data was further recorded on molluscs *Macrochlamys indica* and *Laevicaulis alte*. Nine stages of *M. indica* were collected. White spider was collected from *Cassia* sp. Three and five stripped squirrels were observed feeding on neem seeds sown in the nursery.

Life Cycle of *Laspeyresia koeingana* was studied. The adult lays eggs on shoot tips. First instar feed inside the shoot tip. 2nd & 3rd instar feed on the lower portion of neem leaf. 4th instar larvae feed on the upper surface of the leaf and it makes a protective tunnel by rolling leaf in which it hides at the time when it is not feeding or just before pupation. The leaf is joined by silken thread like whitish secretion of the mouth of the larva. It pupates attaching itself to the leaf neem and the adult emerges of seven to ten days.

Eco-friendly plant pesticides:

Keeping in the view the fourth objective of evolving eco-friendly integrated pest management strategies two low cost plant pesticides were prepared and tested in the lab conditions against 3rd & 4th instar larvae of Amaltash defoliator. This will be tested again this year on the same insect as well as on some other lepidopterous larvae before recommendation of field trials in the nursery.

Low-cost Pesticides:

1. Dry teak leaves powder + liquid extract of moth seeds. (Different concentrations).
2. Dry teak leaves powder + powder/dust of bark of gulmohar stem + liquid extract of moth seeds (Different concentrations).

Quarantine measures for Mollusca menace:

Laevicaulis alte are been distributed along with the seedlings in polythene bags transported for planting from one place to another. Hence, a quarantine check is to be implemented at AFRI & SFD nurseries at the time of transporting various seedlings to different destinations or selling to different user agencies. It is also recommended to raise neem seedlings in root-trainers to prevent mortality from mollusc's attack.

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*

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 in LPC compared to leaves as such. Quantification of the reduction in phenolic contents is in progress.

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

The International provenance trial on neem was initiated by the FAO Neem Network and the seeds were exchanged between the participating countries during 1995. The field trials have been laid out during the July - August 1996 at Jodhpur, Jaipur, Jabalpur and Coimbatore, with 18 provenances including control. The performance of the Neem International trial at Jodhpur is good and the introductions 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).

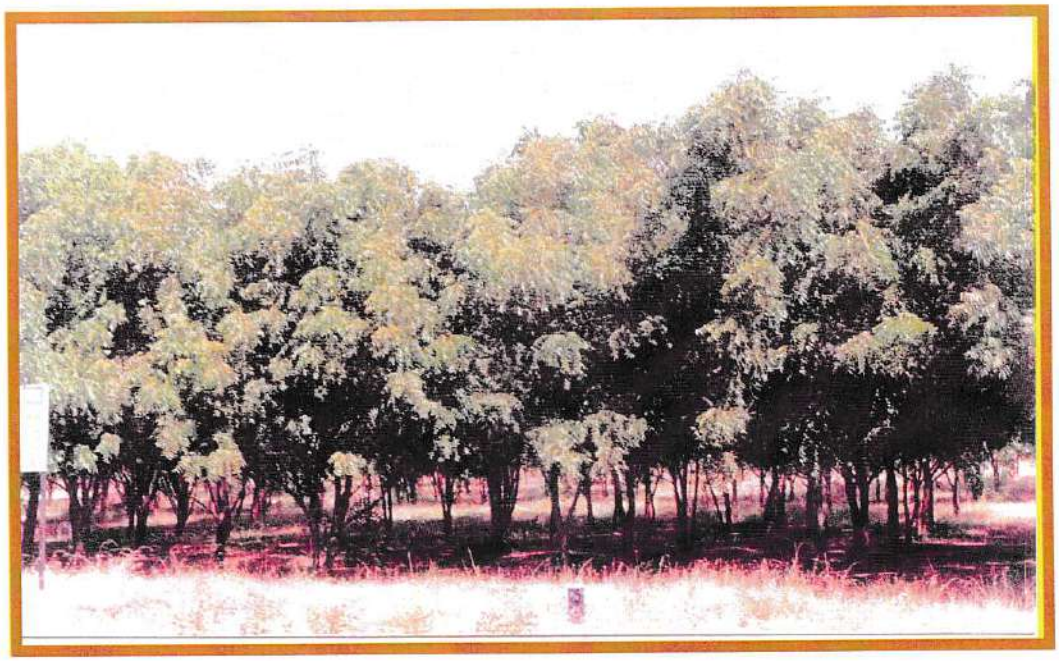
Project 8: **Provenance trial on Arid Zone species. [AFRI-16/FGTB-3/1992-2005].** *Principal Investigator: C.J.S.K. Emmanuel*

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 Palanpur (Gujarat) is superior in growth followed by Gandhinagar (Gujarat), Jhansi (U.P.) and Jaiselmer (Rajasthan). The data has also been recorded in percent on the oil and azadiractin content of all the provenances. The promising provenances for azadiractin are Shivpuri 0.93, Katni 0.40, Kanpur 0.39, Raipur 0.39, Nagpur 0.39 and lowest Jaiselmer 0.16 percent. The promising provenances for oil are North Bilaaspur 49.7, Nagpur 48.4, Jaiselmer 39.8, Kanpur 47.2, Jodhpur 47.1 and the lowest from Rewa 36.2 percent. The reproductive biology has also been studied for Neem.

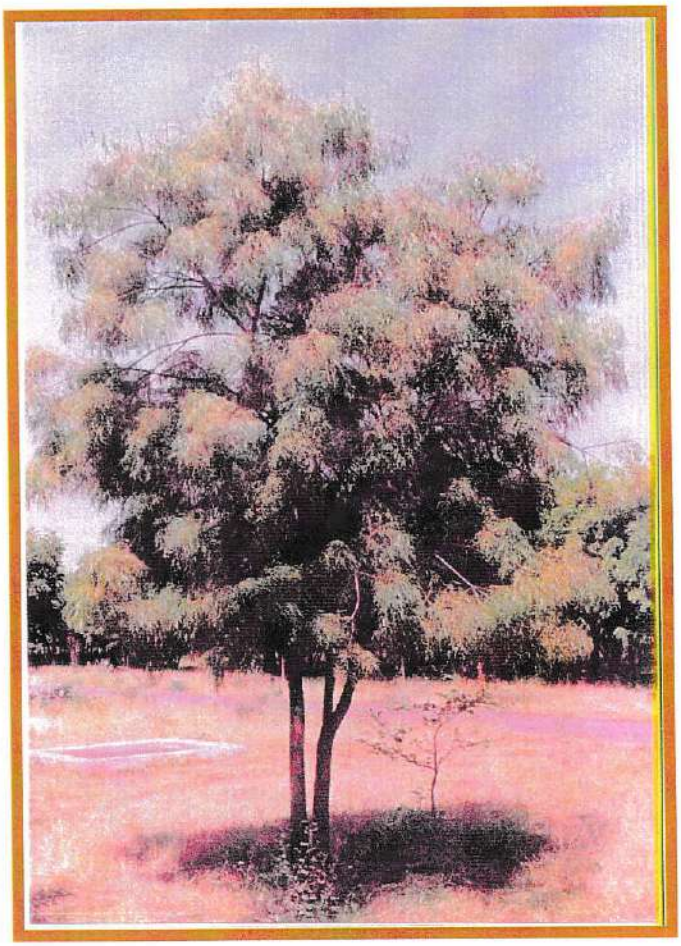
ROHIDA: The provenance trial of *Tecomella undulata* was planned in the year 1992 with 13 seed sources from Rajasthan. The growth data collected so far indicates that the Sunderpur Bir (Sikar) is superior in growth followed by Bhinslana (Jaipur) and Nagaur.

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 Pilibhit followed by Kasganj and Lalitpur. The local provenance has not given good result.

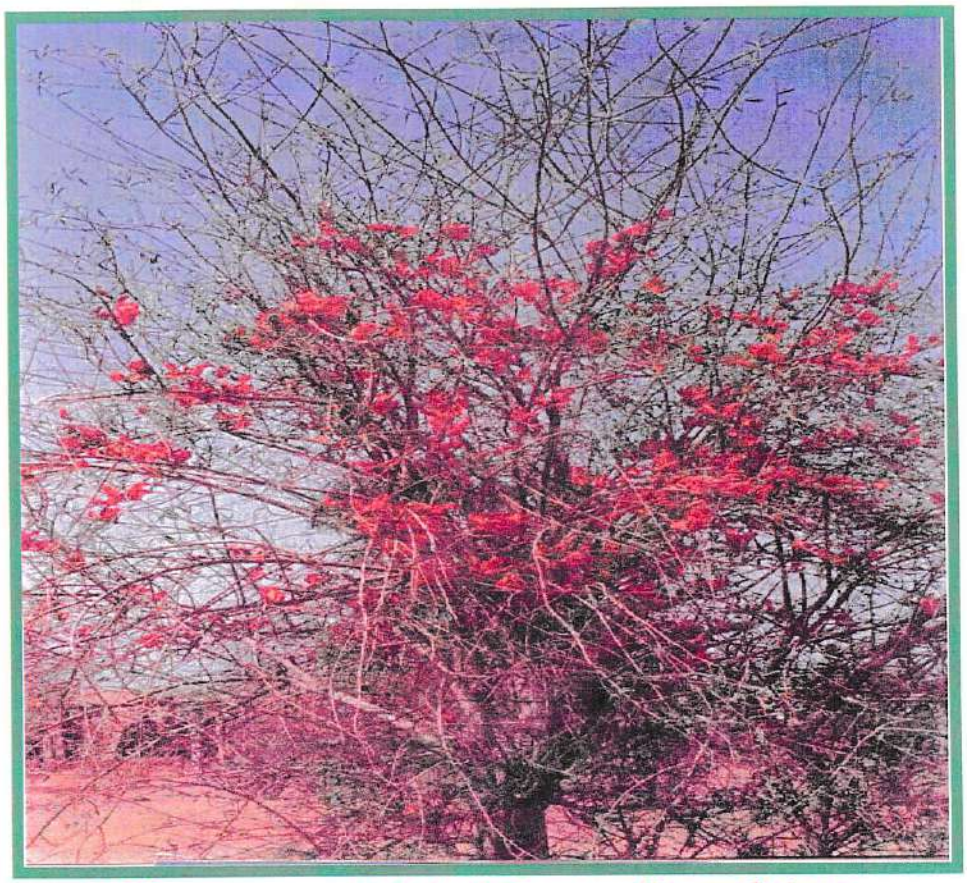
NATIONAL PROVENANCE TRIAL OF NEEM



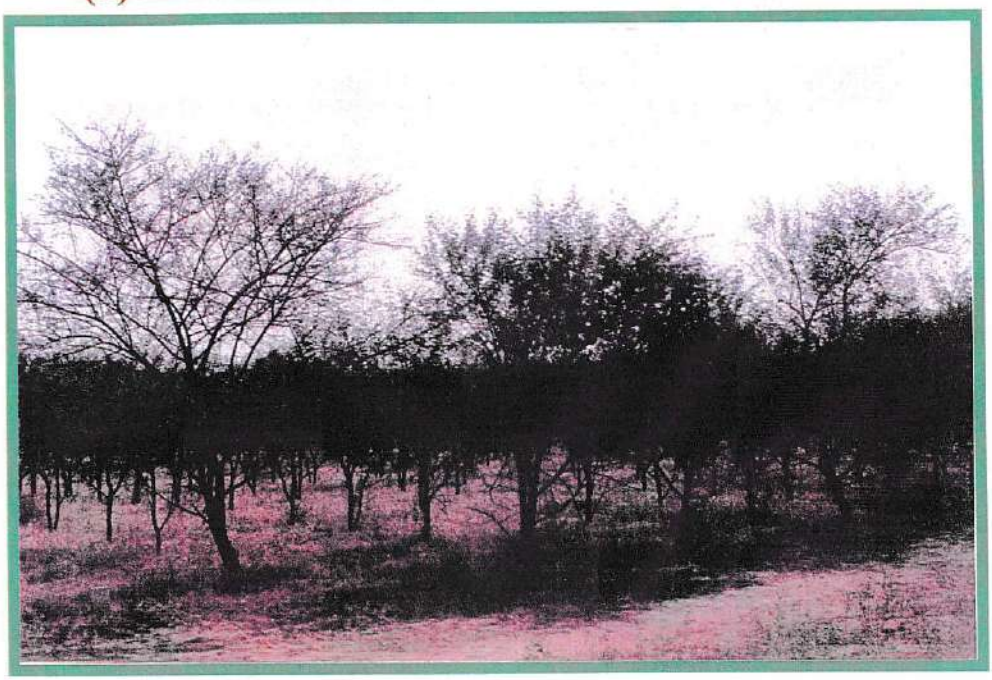
A VARIANT IN NEEM



PROVENANCE TRIALS



(a) Provenance trial of *Tecomella undulata*



(b) Provenance trial of *Acacia nilotica*

NEW PROJECT INITIATED DURING THE YEAR 2001-2002

Project 9: **Stand dynamics of some important tree species of Gujarat. [AFRI-25/FRME-2/2001-2006].** *Principal Investigator – Dr. V.P. Tewari*

Information regarding plantations of *A. nilotica* and *Eucalyptus* in various parts of Gujarat has been collected from the literature available. SFD Gujarat has been contacted for details and requested for funding also. On receipt of the fund the project will be carried out during 2002-2003.

Project 10: **"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*

In the recent studies, carried out in the division of forest protection, Arid Forest Research Institute, Jodhpur, in order to find out the actual causes/factors responsible for the large scale drying and the subsequent die-back of mature Khejri trees in western districts of Rajasthan, it is closely examined that 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 imperfactii viz., Alternaria* sp., *Phoma* sp. and *Botryodiplodia* sp. which ultimately cause the die-back disease in mature trees of Khejri as a result of which the tree starts drying from the top.

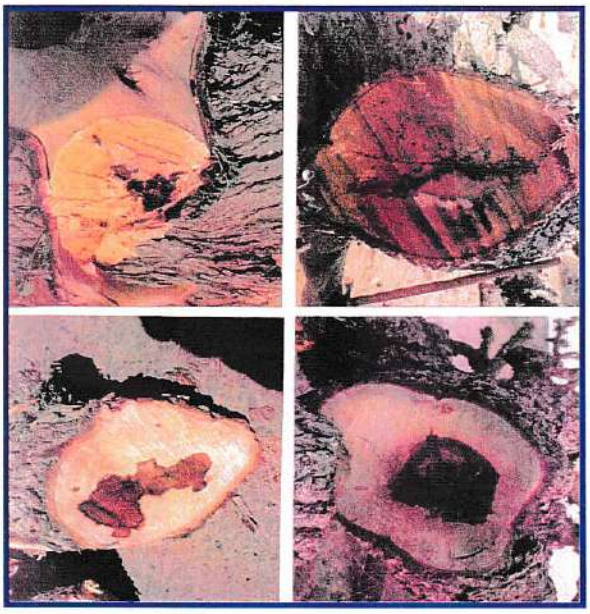
Amongst the other probable contributory factors: i.) Continuous depletion of water tables in western Rajasthan, ii.) Increasing number of tube wells or over exploitation of ground water; iii.) Effect of low rainfall, iv.) Change in soil properties and agricultural practices are some of the suspected causes, which may play an important role in large-scale drying of Khejri in western zone of Rajasthan. The data on the above aspects are being collected from the Khejri dominated areas for further studies. Preliminary studies made in this context reveal that the problem of Khejri mortality carry manifolds factors mainly entomological and pathological.

Entomological Problems:

Derolus descicollis is a new pest record on *Prosopis cineraria* from arid areas of Rajasthan. The epidemic of this species has been recorded for the first time in the year 2000-2001 in the northwestern districts of Rajasthan. Gahen (1906) has described the systematic position of *Derolus descicollis* and reported this species to have been collected from Karachi (Pakistan). Beeson (1941) reported *D. descicollis* as a pest of *Acacia modesta* and *Heritiera fomes*. No further record on the status of this species has been cited in the literature as yet. Though, there exists no information on the bio-ecology and control of *D. descicollis*, but based on the observations made during the recent studies, conducted in the affected areas of Nagaur, Sikar, Churu and Jhunjhunu districts of Rajasthan, a preliminary report is prepared to describe the pest status and biology of *D. descicollis*. Scanning of literature also reveals

MORTALITY OF KHEJRI

Dead standing Khejri tree



Tree trunks showing infestations

Derolus discicollis, Khejri shoot borer

that this species of shoot borer seems to have been introduced in north western part of India through **Sindh province** of Pakistan as the first record of this species has been made by C.J. Gahan during in 1906 from Karachi (Pakistan).

Plant Pathological Problems:

The preliminary studies on dieback showed the association of three following pathogens namely: *Alternaria* sp.,*Botryodiplodia theobromae,* and *Phoma* sp. All the three pathogens belongs to the group – *Fungi Imperfecti*, class – *Deuteromycetes*. These pathogens are air borne in nature and weak parasites and usually infect the host through wounds formed by mechanical injury (lopping) or damage caused by insects. *B. theobramae* also causing canker on standing trees wounds formed by sun-scorching in many tree species viz., *Acacia nilotica, Albizia falcataria, Leaueaena leucocephala* and *Azadirachta indica. Phoma* sp. and *Alternaria* sp. have also been reported as the canker causing pathogens but they also attack on pods, seeds and foliage through conidia and spores.

Preliminary recommendations for the management:

The austere and 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** (One part of Copper Carbonate (say ½ Kg) + One part Red Lead (say ½ Kg) + Two part white petroleum jelly (1Kg) or 1.25ltr raw linseed oil and 3 ml Monocrotophos in order to check the fungal infection and egg laying by the shoot borer, *D. descicollis*. Severely infected and dried trees should be uprooted and the felled trees should be lifted from the vicinity immediately after their exploitation. The trees, showing partial die-back symptoms should be dealt for their treatment on priority in order to check further spread of pest / disease.

EXTERNALLY AIDED PROJECTS

Project 11: Studies on sand dune stabilization in Indian Desert [AFRI-3/FEDD-3; RD funded/1997-2001]. *Principal Investigator -Dr. G. Singh*

Findings:

Experiment1: Nutrient management in sand dune for better growth and biomass production

The study was carried out to find suitable species and in combination with surface vegetation with aim of fast stabilization of dune 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 dune 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 NH_4-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. 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 the sand drift when the seedlings attain greater height leaving the under canopy soil bare.

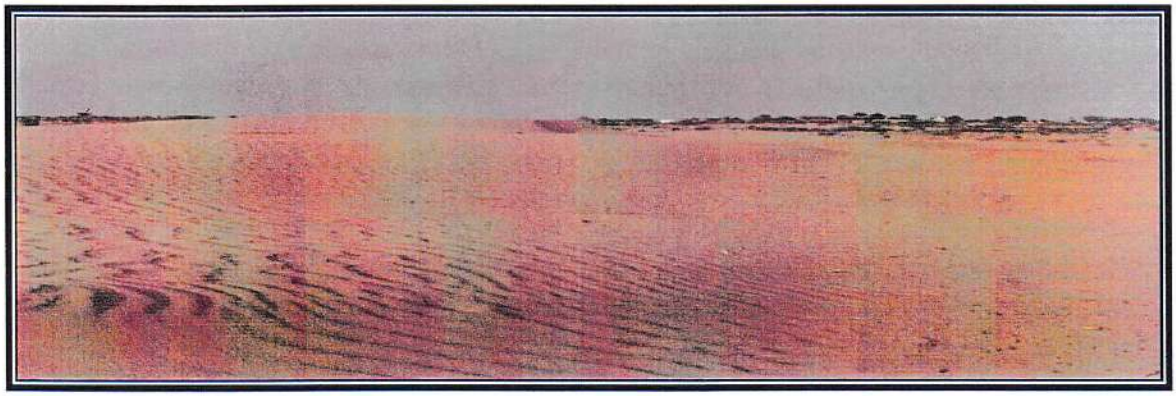
Experiment 2: Studies on plant growth and biomass production under the influence of topography and surface vegetation.

Growth and biomass production of *Acacia tortilis* was examined in relation to micro-topography and *Dactyloctenium sindicum* as the surface vegetation. Bare dune (BD), bare dune plantation (BDP), semi stabilized dune with surface vegetation only (SD), semistabilized dune plantation (SDP), flatland without *D. sindicum* (FW), flat land plantation without *D. sindicum* (FWP), flat land with *D. sindicum* grass only (FG) and flat land plantation with *D. sindicum* 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 ($P<0.05$) 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. sindicum* 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 duny habitats. *D. sindicum* 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. sindicum* 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. sindicum* 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. sindicum* 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 in stead of high soil water content.

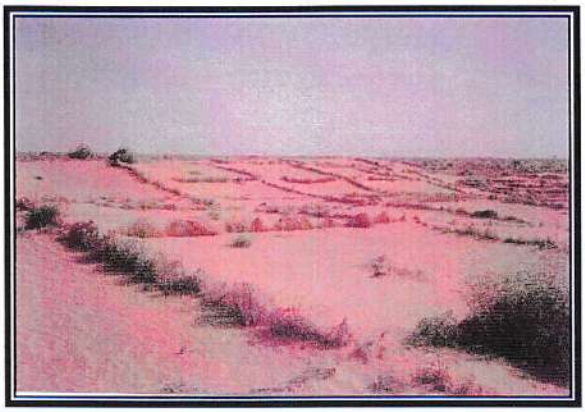
Experiment 3: Studies on effect of adult neighbours on regenerative population of *Cassia angustifolia* in duny area for habitat restoration.

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 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 (1.0–2.5 m) from the trees were selected for the study. Adult neighbour affected soil seed

Sand dune Stabilization



Sand dune : approaching towards the village



Existing: Micro wind breaks of dry material

Applied: Live micro wind breaks of *C. angustifolia*

Stabilized dune : having *C. polygonoides* and *P. juliflora* provided with surface vegetation of *C. ciliaris* and *C. angustifolia (*under harvesting)

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 (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 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* that might be beneficial for under canopy *C. angustifolia* or other vegetation, maintenance of biodiversity and stabilization of dune in combine.

Project 12. **Investigation of soil water plant relationship in respect of different tree species. [AFRI-5 /FEDD-5/W.B./1998-2001** *Principal Investigator: Dr. G. Singh*

Findings:

Experiment 1: 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. T_1- available soil water at -0.05 to -0.1 MPa, T_2- available soil water at -0.10 to -0.5 MPa, T_3- available soil water at -0.5 to -1.0 MPa, T_4- available soil water at -1.0 to 1.50 MPa and T_5- 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. Rate of photosynthesis, transpiration reduced with water stress. Water stress level of T_2 seedlings had no appreciable influence 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 much compromising 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.

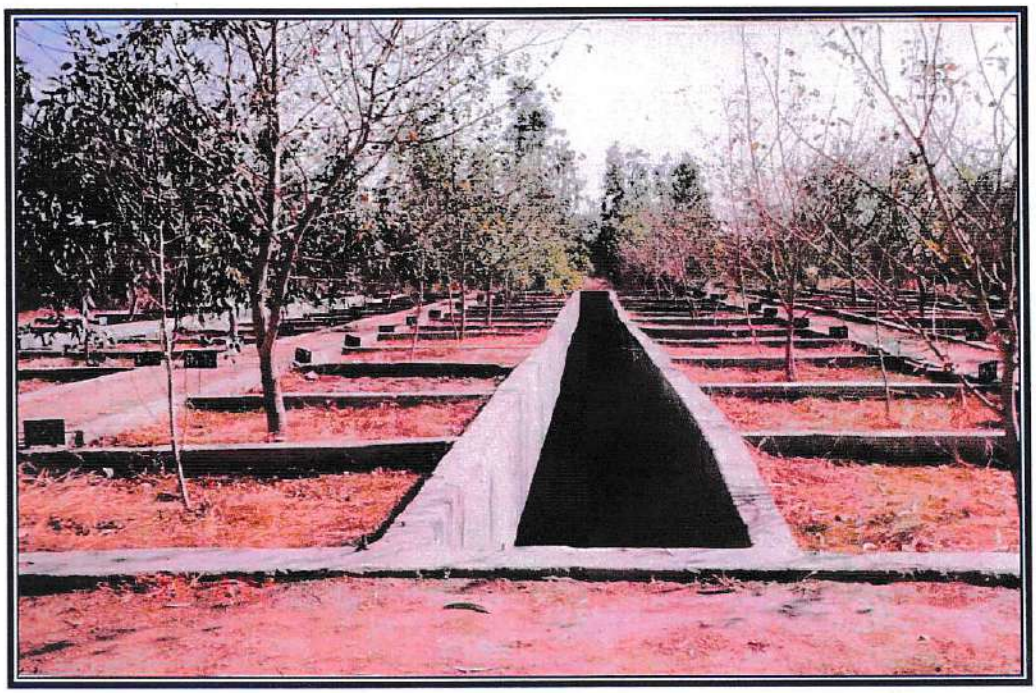
Experiment 2: To study the effect of varying level of sewage water on the growth of the plants.

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 @ ½ 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

Soil- water-plant relations:

Plants growing in non-weighing type of Lysimeter

(a) At the time of planting



(b) At the age of 42 months

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 were at a par with that of the seedlings of T_5 treatment. Root growth increased as the municipal effluent quantity increases. Above ground biomass markedly increase with increase municipal effluent quantity mainly the foliage biomass. 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 washigh 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 swage 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 13: Screening of exotic and indigenous plant species for their performance on salt affected soil with different management project. [AFRI-6/FEDD-6/1997-2003]. *Principal Investigator: Dr. Ranjana Arya*

A total of seven experimental trials were undertaken at the salt affected area of Gangani in Jodhpur district laid from 1997 to 2001.

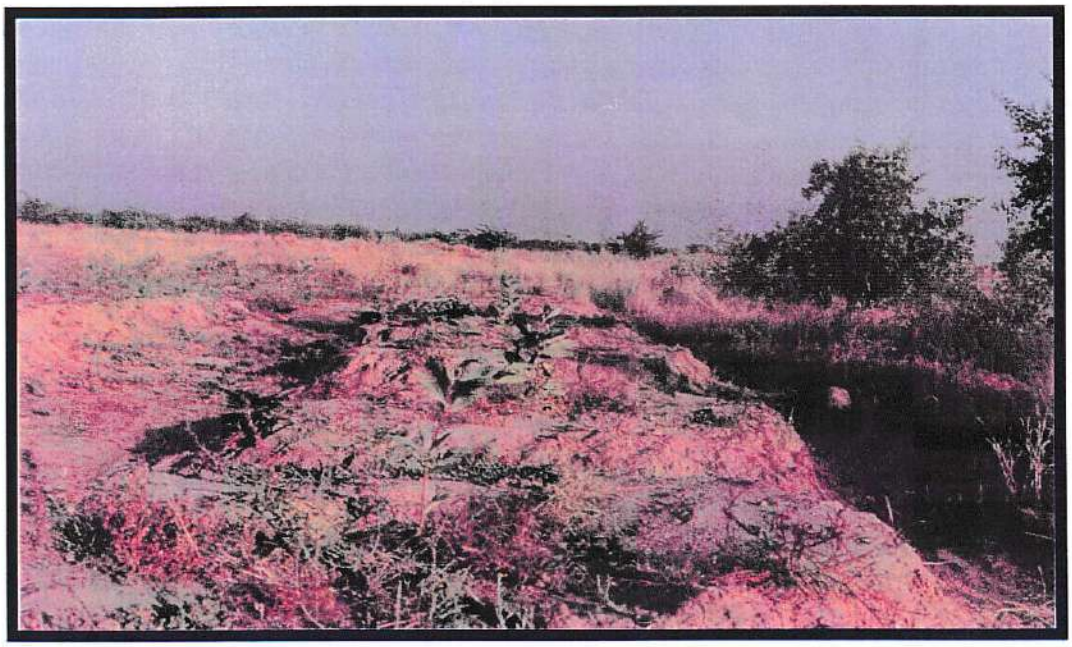
Experiment 1:

Trial of *Atriplex lentiformis* was laid in 1997 with three levels of gypsum: Control (G_0), Gypsum @ 100 % soil GR (G_1), and Gypsum @ 150 % soil GR (G_2) and six nitrogen levels: 1. 0 (N_0), 2. 20 (N_1), 3. 40 (N_2), 4.60 (N_3), 5. 80 (N_4), 6. 100 (N_5) g of urea leading to 18-treatment combinations Bush survival was recorded in September 2001.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 progresss. Weed evaluation was carried out and now *Sueda fruiticosa* was the dominant herb and *Sporobolous* spp., *Dactyloctenium* sp and *Chloris* were the dominant grasses.

Experiment 2:

Trial of *Salvadora persica* was planted in 1997 with two levels of gypsum (control and 100 % soil GR) and four levels of nitrogen (0, 20, 40 and 60 g of urea). Plant survival recorded in September 2001, four years after planting showed no appreciable decrease in survival (ranging from 85.2 to 66.7 %) in all the treatments despite very poor monsoon years. Absolute growth data at 48 months of age showed that treatments were not significantly

PLANTING TECHNIQUES ON SALT AFFECTED LANDS



Acacia colei **planted on Circular Dished Mound**

S. nudiflora **planted on Circular Dished Mound**

affecting the height and crown diameter. Mean maximum height 200 cm and crown diameter of 198 cm was recorded in T7 treatment (Gypsum @ 100% GR and 20 g urea). Status of soil properties was analysed before and after monsoon after four years of plant growth. Soil pH_2 and EC_2 values indicate that trench around the plants recorded higher values as compared to upper soil layer (0-20 cm) in the plant pit after the cessation of monsoon activity. The values were either slightly higher or nearly equal to lower soil layer (20-40 cm) in the plant pit suggesting the leaching of salts from the upper soil layer. Soil pH and EC values before monsoon (in May 2001) indicate that there was no appreciable difference in these properties in either plant pit or trench. Percent organic carbon values were analysed before and after the monsoon season. The highest organic carbon values were recorded for trenches followed by upper and lower soil layers after the monsoon period. Collection of water in soil trenches resulted in higher weed growth and higher % OC values. However, during the summer season intense solar radiation resulted in loss of organic cover and now % OC values decreased for trenches and upper soil layer in the plant pit, while the maximum % OC values was recorded for lower soil layer in the plant pit for almost all the treatments

Experiment 3:

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. Percent increment in growth recorded 12 months after treatment application in September 2001 indicated that in a very poor monsoon year treatment application influenced the height but effect of fertilizer was more in non gypsum treated plants as compared to gypsum treated plants. Phosphorous application resulted in higher growth as compared to nitrogen application. Flowering was recorded in 60% plants in March 2002. Replication three and four were on shallow soils and suffered large casualties. Replacements were carried out in August 2001 and trial was redesigned including circular dished mound and ridge planting techniques.

Experiment 4:

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. Biomass estimation was studied and G_1 treated bushes recorded maximum biomass, followed by G_2 and G_0. 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. Mean percent survival recorded in April 2001, 20 months after plant growth and 10 months of fertilizer application showed that effect of treatments was not statistically significant. However, CAN treated bushes recorded better survival as compared to urea treated bushes with or without gypsum application. Height and crown diameter were recorded in April 2001. Two factors ANOVA was performed to find out the effect of treatments on survival The maximum average height 89 cm and maximum crown dia of 158 cm was for full G.R with 9 g of nitrogen (CAN). ANOVA results showed that gypsum application was not significantly influencing the height while nitrogen application influenced the height at p 0.00005. CD values showed that all the nitrogen levels attained significantly higher growth than control but they were not statistically different from each other. However, CAN treated bushes recorded better height as compared to urea treated bushes with or without gypsum

application. Similar trend was observed for crown diameter. Biomass estimation was undertaken. Data analysis is under progress.

Experiment 5:

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 $G_1$and control G_0, a total of six treatments. Treatment combinations were T_1= S_1 Go, T_2 = S_2G_0, T_3 = S_3G_0, T_4 = S_1 G_1, T_5 = S_2G_1, T_6 = S_3G_1. Bushes received no rainfall after planting. Survival of the bushes recorded after nine months of planting in April 2001 showed maximum survival in raised bund structure (ridge) 83 and 75% in gypsum and non gypsum treated bushes followed by in elevated slope (ES) 81 and 72% respectively and in double ridge mound (DRM) 75 and 66% respectively. 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. Now 80.6 and 61% survival is recorded for gypsum and non-gypsum treated bushes. All the structures were showing appreciably higher survival despite very poor monsoon in 2000-2001. Growth parameters (height and crown diameter) were recorded at nine and fourteen months after planting. At 9 months of age T_4 treatment recorded maximum height and crown diameter but there was no difference between gypsum treated and control bushes. However, at 14 months of age treatments were influencing the growth and two factors ANOVA showed that S_1 and S_3 attained significantly higher height and crown diameter as compared to S_2 treatment. S_1 and S_3 were not statistically different with each other.

Experiment 6:

Another trial was laid with 3 salt tolerant species namely *A. lentiformis, A. nummularia* and *Sueda nudiflora* and three treatments of planting (control, circular raised platform (CRP) and double ridge mound) in a RBD in August 2000. In this trial also double ridge mound structure recorded overall 73.6 % survival followed by 95.6 % in circular dished mound (CDM) and 65 % in control in January 2001, after 4 months of planting. While there was no change in survival for DRM and CDM soil structures after 12 months of planting for any species, survival was reduced to 51 % 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.

Experiment 7:

A trial with two tree species, *Acacia colei* and *Azadirachta indica* was laid with three treatments of planting (control, circular dished mound (CDM) and double ridge mound) along with gypsum (full GR), FYM, 3 Kg per plant and SSP 15 g as basal dose, in a RBD in August 2001. Monthly irrigation of 30 l/plant was carried out from October 2001.
Highest mean percent survival was recorded for CDM structure (97 %) followed by DRM (89 %) and control (85 %) after three months of planting. Species wise *Acacia colei* showed better survival than *Azadirachta indica*

Project 14: **To screen various plant species for high yielding commercial forestry under irrigated condition in Indian arid zone [AFRI-7/FEDD-7 (WB)/1994-2001]** *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 (666 cm) followed by *Acacia nilotica* (477.5 cm) and *D. sissoo* (439-cm). For crown diameter, trend was *A.nilotica* > *D. sissoo* >*E. camaldulensis*. *D. sissoo* suffered with decreasing incremental growth in crown diameter since 1998. Collar diameter at 5 cm above the ground recorded at 16 month of age showed that *E. camaldulensis* had maximum collar diameter followed by *A. nilotica* and *D. sissoo*. Similar trend was maintained by the species up to 52 months of age. After 52 months, *A. nilotica* attained maximum collar dia followed by *E. camaldulensis* and *D. sissoo*. Maximum dbh was recorded for *A. nilotica* followed by *E. camaldulensis* and *D. sissoo* throughout the study period. *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 (164g N and 184g P (P_2O_5)/tree) 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. However, in case of *A. nilotica* 28% crown increment was registered as compared to 21% for control plot. DBH was also not influenced by fertilizer application. 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. *D. sissoo* was at third place. 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 seems to be most water use efficient tree species producing maximum amount of total dry biomass in both the treatments under similar irrigation conditions. Hence, it may be considered as the most water use efficient tree species among all the three tree species. *A. nilotica* was a close second with *D. sissoo* at third place. 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. For branch biomass, this trend was reversed. *D. sissoo* was placed third in both the cases. Mean soil moisture was not influenced by the treatments at any soil depths. Mean soil moisture determined 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) showed that there was no difference in percent soil moisture among the tree species at any distance or depth between tree and no tree side. It suggests that neighbouring trees were not influencing the water withdrawal. Monthly mean from all the three depths indicated that percent moisture was least for *E. camaldulensis*

followed *A. nilotica* and *D. sissoo* except from October to December when *A. nilotica* was having the minimum soil moisture at 40-cm distance. Water withdrawal was more from the middle and lower layer in case of *E. camaldulensis* while it was more from upper layer for *A. nilotica*. At 80-cm distance, *A. nilotica* withdrew maximum water except in the month of May when it was at third place behind *E. camaldulensis* and *D. sissoo*. Its water utilization was more from upper layer than from middle and lower layer. *E. camaldulensis* withdrew more water from middle and lower layers in comparison to upper layer. However, no withdrawal was observed at the distance of 120 cm due to no major drift of water from irrigation point. 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. There was either no change or slight decrease in % OC values at any soil depth in 40 and 80 cm tree distances there was increase in % OC for 120-cm distance. Organic carbon content was maximum for *A. nilotica* and minimum for *E. camaldulensis*. Organic carbon contents were not influenced by treatments applied. Soil pH was analysed and no significant change in pH status of soil was observed in any treatment.

Project 15: Studies on VAM association in irrigated plantations and agroforestry systems. (AFRI-8/SILVI-1/ WB/1994-2001): *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 of 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 biomass and percentage on infection as compare to control (un-inoculated). Indigenous strains of VAM fungi 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 VAMF genera namely *Glomus*, *Gigaspora*, *Scutellospora*, *Acaulospora* and *Sclerocystis*.

Field trial involving neem genotypes and VAMF strains has been laid out. Results are awaited. Demonstration trials on biofertilizer have been laid out at Model plantation, Jodhpur and experimental area, Rohat (Pali).

Project 16: To develop vegetative propagation technique for *Acacia nilotica* and *Ailanthus excelsa* (AFRI-19/FGTB-4(WB)/1994-2001). *Principal Investigator: Dr. U.K.Tomar*

Findings:

Acacia nilotica:

All the cuttings rooted in various experiments were transferred in polybags and kept in mist polyhouse for few weeks and then transferred to green house. High survival percentage was recorded during hardening stage and it was more than 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.

Ailanthus excelsa:

Grafting experiments have also been conducted. But (10%) 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. Success has also been achieved in inducing roots in coppice stem cuttings of mature trees. However, success rate is quite poor and requires further research investigations.

Project 17: To develop tissue culture technique for *Acacia nilotica* and *Ailanthus excelsa* (AFRI-20/FGTB-5 (WB)/1994-2001) *Principal investigator : Dr. U.K.Tomar*

Findings:

Acacia nilotica:

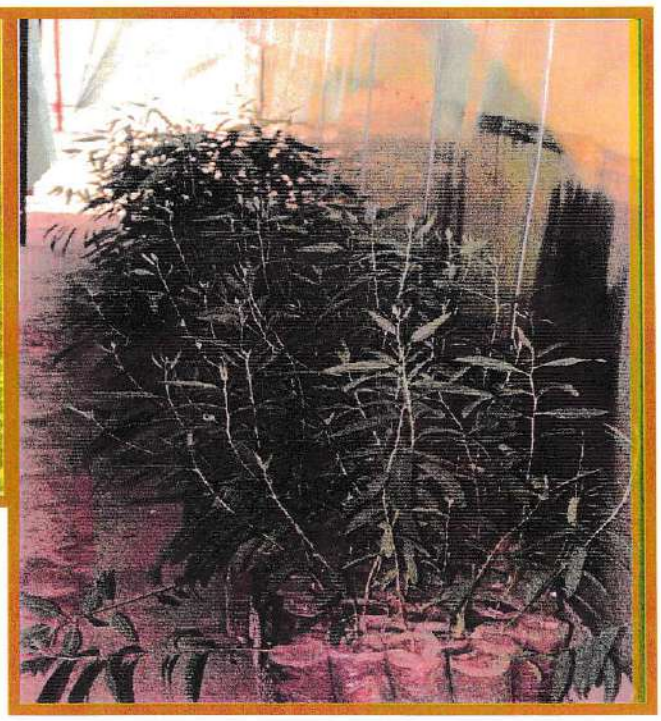
Hardening of *in vitro* regenerated plants was very difficult and very little success has been achieved in developing a successful hardening procedure. The *in vitro* regenerated plantlets (3-10cm long) were gently removed from the test tube and washed thoroughly with milli-'RO' water to remove traces of agar adhered to the roots. These plantlets were transferred in the Jam bottles containing soil rite as potting mixture along with Hoagland solution and kept in culture room conditions for a period of four weeks. Initially, Hoagland solution was supplied on alternate days and then once a week for 30days. After wards, these plants were transferred to soil mixture and kept under mist polyhouse condition and were irrigated with tap water. Such *in vitro*-rooted plant are growing well since last one year and same plants are transferred to field

MICRO AND MACRO PROPAGATION OF TREE SPECIES

Vegetative multiplication of *A. excelsa*

In vitro regeneration of *A. excelsa*

Neem seedling through seed (NOVOD)



Vegetative Multiplication of *E. camaldulensis*

Micropropagation of *Acacia nilotica* is a distinct possibility through mature tree. Shoot culture can be established throughout the year. Shoot cultures 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, success is hardening procedure is not satisfactory at present)

Ailanthus excelsa:

Among the auxins tried, rooting occurred on MS + NAA (0.5-1.5 mg/l). On MS + 1.5 mg/l NAA medium, 50% of micro shoots produced root at the cut end along with callus. Addition of 18.4 mg/l Manitol in the MS medium causes early rooting. However, maximum, rooting observed on MS + 1.2 % Agar medium and root length was also high on this medium.

Rooted plantlets were transferred in plastic cups containing soilrite and kept in growth chamber. Plantlets provided with 3000 lux light intensity with a photoperiod of 16 hours/d and temperature at 28° C. Initially humidity was mentioned at 90% and it was reduced after every week up to the 60% with in one month. The plantlets were provided ½ MS liquid medium for initial 15 days for their proper growth. After one month the plantlets were transferred in polybags containing compost as potting mixture and kept in Polyhouse. A poor survival (10%) was recorded during the hardening stage. Plants grew rapidly in Polyhouse conditions and in compost soil mixture. After 2 weeks plants are shifted to shade house where they grew well. However, Success rate in the hardening is very low and requires further research work.

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 18: Provenance trials on *Acacia nilotica* and *Ailanthus excelsa* [AFRI-16/FGTB-1/WB/1995-2005]. *Principal Investigator: C.J.S.K. Emmanuel*

The data on growth parameter have been recorded for the provenance trials of *Acacia nilotica* laidout 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.

In the 1997 seeds have been collected from 45 seed sources of *Acacia nilotica* from all over India. The seeds have been supplied for raising provenance trials to five ICFRE Institutes and six State Forest Departments. The seedlings have been raised from this material and transplanted in the field at six different research stations of the State forest Departments. The trial has been planted in the field by two ICFRE institutes and four State Forest Departments only. The seedlings raised at AFRI, Jodhpur have been planted in the field at the JNV University campus. There was mortality in the trial and this was replaced in monsoon season of 2001.The mineral values of different provenances has been estimated to be used as fodder is presented in following table.

Mineral value of different provenances of Acacia *nilotica* in ppm

S. No.	Provenance	Phosphorous	Nitrogen	Manganese	Copper
1	Hastinapur	3049.66	12569.00	100.80	71.90
2	Manikpur	1862.00	5656.50	88.40	19.10
3	Mathura	2489.00	13687.00	93.60	27.40
4	Maunath Bhanjan	2148.00	14455.50	118.30	52.10
5	Bareilly	2147.00	8310.00	93.80	42.80
6	Aligarh	2259.30	8016.00	65.60	71.00
7	Agra	2457.30	9902.30	122.93	54.30
8	Makdampur	2102.60	32332.00	97.86	50.30
9	Haldwani	2812.00	31355.00	108.20	54.50
10	Etawah	2476.00	7402.30	308.40	30.40
11	Shivpuri	2698.00	7821.33	93.60	24.50
12	Raisen	2368.00	8310.16	94.30	23.70
13	Jhabua	1849.30	9706.80	98.60	23.70
14	Navelakha	1944.00	6809.00	72.30	21.20
15	Bilaspur	2418.00	7399.33	68.50	26.30
16	Daund	3217.30	8449.80	96.10	36.90
17	Gondpipri	2115.30	15922.00	79.20	22.90
18	Sangli	2520.60	12920.00	113.10	23.60
19	Solapur	2818.30	13377.80	119.50	50.13
20	Akola	2261.00	11592.00	102.00	35.30
21	Nangal	2432.00	13757.10	88.20	39.60
22	Sirsa	2539.60	8259.00	109.60	41.20
23	Rajpipla	2286.30	11313.00	106.60	28.60
24	Parlekhmundi	4522.30	7255.60	91.70	26.50
25	Bolangir	2489.00	11243.16	98.10	26.70
26	Gurgaon	2641.00	11382.00	122.50	39.70
27	Jodhpur (C)	2533.30	14874.10	105.20	45.80
28	Jodhpur (I)	2761.30	12081.10	101.00	49.50

The A*ilanthus 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 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 2001.

Project 19: Planting stock improvement programme [AFRI-23/WB/PSIP/1994-2001]. *Principal Investigator: Sh. CJSK Emmanuel*

Component I: Development of seed production area *Principal Investigator: Sh. CJSK Emmanuel(Rajasthan) & Dr.D.K.Mishra (Gujarat)*

Findings:

The target for the SPA was 200 hectares and was achieved last year itself. This year data was recorded on the survival and growth parameters of the SPAs before handing over of the SPAs to the State Forest Departments. Training to manage seed production areas has been imparted to the SFDs.

Component II: Development of Seedling Seed Orchards. *Principal Investigator: Sh. CJSK Emmanuel*

Findings:

The target for this activity was 55 hectares and this was achieved with 20 ha of ha *Acacia nilotica, 19* ha of *D. sissoo* and 16 ha of *E. camaldulensis.* Seven hectares of provenance trial cum SSPA of *E. camaldulensis* has been 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. This year trainings were imparted to the State Forest Department officials of Gujarat and Rajasthan for the future maintenance of the SSOs, CSOs and SPAs.

Component III: Development of Clonal Seed Orchard *Principal Investigator: Dr. U.K. Tomar*

Findings:

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

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 Garden *Principal Investigator: Dr. U.K. Tomar*

Findings:

Base population of 72 clones of *D. sissoo* and 26 clones of *E. camaldulensis* have been maintained in 5 ha area (1ha at AFRI nursery and 4 ha in AFRI campus) for 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.

Causality replacements in CSOs and VMG completed. Clonal material of *D. sissoo* supplied to Rajasthan SFDs for field trials. Training also provided to Rajasthan and Gujarat SFDs

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

Findings:

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. Neem fruits of green, green-yellow and yellow showed 95-100% germination. Larger neem seeds showed higher percent germination then smaller ones. Sinkers also showed the same trend. Neem seeds collected from superior trees and top of the tree from any direction always had higher germination capacity.

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 (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. 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.

Component VI: To Develop Model Nursery *Principal Investigator H.C.Chaudhary*

- A full-fledged model nursery capable of raising 1.20 lakh seedlings at a time has been established under this project. The nursery is equipped with the following facilities/ equipments:
- Four bigger size shade houses of following dimensions
- Shade House I: 29 m X 10 m X 2.9 m
- Shade House II: 33.9 m X 12.3 m X 2.6 m
- Shade House III: 15 m X 12 m X 3.7 m
- Shade House IV: 21 m X 12 m X 3.7 m
- Four number smaller shade houses having dimension of 14 m X 4.4 m X 3.7 m each.
- Overhead sprinkler system.
- Coursed stone masonry boundary wall.
- Diesel engine fitted potting media mixing unit.
- Compost bin with manually operated chaff cutter.
- Water desalination unit working on the principal of Reverse Osmosis.
- Five water tanks having a total water storage capacity of 1.05 lakh liters.
- Roots trainer blocks of 150 cc, 250 cc and 300 cc capacity as detailed below:
- 150 cc: 3750 blocks, each block containing 20 root trainers.
- 250 cc: 1500 blocks, each block containing 12 root trainers.
- 300 cc: 923 blocks, each block containing 12 root trainers.
- Total: 6183 blocks containing 1,04,276 root trainers.
- Raised bed structure of the size 10.1 m x 9.5 m x 1.80 m
- Transportation stands (12) for easy and convenient transportation of the seedlings from the nursery to the plantation site.
- Labourer working shed
- Transportation trolleys for transportation of seedlings and other materials from one place to another place within the nursery.
- Various nursery implements.

Project 20: Integrated development of Neem in different agroclimatic zones – 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*

- In this year of the project 150-sample trees selected. Total height, clear bole height, DBH and crown width measured and observations on general morphological characteristics have also been recorded. 107 samples have been sent to IBPGR for cryo-preservation and 110 to TERI for chemical evaluation.
- An experiment in 2.25 ha of land has been laid out at Rohat for studying the performance of seedlings and 2 ha at AFRI to study the VAM interaction with different genotypes.
- Seedling seed orchard SSO of 4 ha has been raised at AFRI (729 plot and in Acacia provenance trial), Jodhpur. Seedlings were raised from CPTs with high Az and high oil content.

- 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 analysed.
- Seeds have been collected from 150 sample trees during the month of July 2001 and analysed for various seed -parameters.
- 450 sample trees of neem were selected in different agro-ecological regions of Gujarat State. Measurements were taken for total height, DBH, length of the clear bole and crown width. Data thus collected were processed and compiled (in collaboration with Silviculture division).
- 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 seed trees during the month of July 2001 have been tested for 100 seed weight moisture content and, percent germination. The 100 seed weight means was 19.18 gms. and it varied from10.57 to 26.87g. Moisture content was also varied from 1.44 to 23.27% (mean 10.65%) and germination percentage was quite variable and ranged from 2% to 96%. Seeds were grouped as per AER (Agro-Ecological Regions of Gujarat State). Standardization for replications for seed weight was also carried out for neem seeds collected from Gujarat State and it was found that seed weight of AER-1 was less variable (uniform size) then the seeds collected from other regions. A minimum of 10 replications was required for the determination of seed weight of neem seeds.
- 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 21: Comprehensive Community Drought Preparedness Programme to Improve Quality of Life of Women & Children in Jodhpur District (AFRI-27/Silvi-3/UNICEF/2001-03) *Principal Investigator: H.C. Chaudhary IFS.*

Survey of 1175 community rangelands called *Orans* and *Gauchars* located in Jodhpur, Bilara, Luni and Bhopalgarh tehsils of the Jodhpur District has been completed. During the survey detailed information about the present status of the *Orans* and *Gauchars* viz. administrative location, area, latitude, longitude, vegetation status (trees, shrubs, herbs), number of ponds available in each *Oran/Gauchar* including water availability status in respect of each *Oran/Gauchar*, name of villages including livestock population dependent on each *Oran/Gauchar* for meeting their requirement of fuel wood, fodder and water, availability of alternative water sources, type and level of diversion of *Orans/Gauchar* lands for non grazing purposes, details of past intervention (if any) by State Forest Department or any other department for rehabilitation of these areas, level of people's faith, name and address of the resource persons have been collected. The area profile of the *Orans* and *Gauchars* surveyed is as below:

Area Class (Bigha)	Tehsil								Total
	Luni		Jodhpur		Bilara		Bhopalgarh*		
	Oran	Gau.	Oran	Gau.	Oran	Gau.	Oran	Gau.	
1	2	3	4	5	6	7	8	9	10
>2000	4	1	0	5	1	5	0	1	17
1001-2000	5	3	5	3	1	4	0	0	21
501-1000	11	2	6	7	5	11	1	7	50
101-500	61	18	51	31	39	50	9	32	291
51-100	35	11	73	22	24	15	1	21	202
11-50	114	25	88	44	75	40	9	32	427
1-10	40	12	9	11	51	13	14	17	167
Total	270	72	232	123	196	138	34	110	1175

(Survey work is still in progress)

Information about the number and water availability position positions of the ponds available Orans and Gauchars surveyed is as below:

(Number of ponds)

Average Water Availability (in months)	Tehsil				Total
	Luni	Jodhpur	Bilara	Bhopalgarh*	
1	2	3	4	5	6
12	14	39	24	13	90
11	5	1	0	0	6
10	4	14	22	5	45
9	6	12	0	0	18
8	15	25	19	6	65
7	11	5	1	1	18
6	43	48	39	21	151
5	26	15	13	6	60
4	63	61	87	15	226
3	143	89	93	20	345
2	40	45	31	26	142
1	4	3	1	8	16
Total	374	357	330	121	1182

(Survey work is still in progress)

Encroachment positions of Orans and Gauchars located in various Tehsils as collected during the survey is as below:

(Number of Orans and Gauchars)

Approximate Encroachment %	Tehsil				Total
	Luni	Jodhpur	Bilara	Bhopalgarh*	
1	2	3	4	5	6
0	101	93	98	14	306
0-5	115	103	47	50	315
6-10	42	59	56	44	201
11-20	35	46	59	12	152
21-30	15	15	34	8	72
31-40	8	12	5	4	29
41-50	8	11	14	7	40
51-60	6	5	5	1	17
61-70	2	2	1	0	5
71-80	4	6	5	2	17
81-90	2	0	4	2	8
91-100	4	3	6	0	13
Total	342	355	334	144	1175

(Survey work is still in progress)

Soil samples have also been collected from the *Orans and Gauchars* surveyed which will be chemically analyzed in the laboratory to ascertain the basic soil properties of various Orans and Gauchars so that suitable rehabilitation plans keeping in view the capabilities of various Orans and Gauchars lands can be prepared.

Project 22: 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- H.C. Chaudhary, IFS*

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, Azadirechta indica, Delonix regia, Cassia fistula, Derris indica, Alistonia scholaris, Tecomela undulata, Dalbergia sissoo, Bougainvillea spp.* During the first ten months of the plantation *Cassia siamia* has attained maximum height followed by *Azadirechta indica.* During the winter months frost severely affected the growth of *Delonix regia. Casia fistula* suffered high casualty and did not provide good survival and growth performance. Winter planting of the seedlings in the month of February also provided good survival percentage and the growth. The Chairman, Urban Improvement Trust, Jodhpur has declared the avenue plantations raised under the project as the best roadside plantation of the Jodhpur.

Research Achievements Statewise under Institutes jurisdiction

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	Twelve	Ten	Three
Gujarat	Two	Two	One

Technology Assessed and Transferred

- Use of surface vegetation for soil improvement and sand dune stabilization
- This PSIP project was a joint project to be carried-out in consultation and co-operation with forest department. MOU has been signed with the SFDs for selection, rejection, analysis and help in the culling operation and management of SPAs. Documentation of SPAs selected and sample plots laid out has been prepared. 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 workshop in both the states.

Education & Training

(a) Education

***Ph. D Thesis Awarded by FRI, Deemed University* on**

1. Effect of varying level of water stress and phosphorus application on the growth of *D. sissoo* to Dr. Bilas Singh, under supervision of Dr. G. Singh.
2. Effect of municipal effluent on tree growth and soil properties in Indian arid zone to Dr. Madhulika Bhati, under supervision of Dr. G. Singh

(a) Trainings attended by AFRI Officials

I. International

Sr. No.	Training on	Venue	Participants	Description and impact of training
1	Information Technology	Univ. of Melbourne, Australia	Sh. M.R. Baloch	Enhancement of IT.
2	Forest Genetics & Tree Improvement	Univ. of Melbourne, Australia	Dr. U.K. Tomar	Broadened the outlook and acquainted with the advance techniques of forest Genetics especially in the area of modern Genetics (DNA markers and Genetic Transformations).
3	Wood Composites by Enzymatic Methods	Univ. of Gottingon, Germany	Dr. Mala Rathore	Acquainted with the advance technologies of wood composites by enzymatic methods.
4	Climate Change/ Carbon Sequestration	Oregon State Univ. USA	Sh. N. Bala	It was very informative and useful. A concept paper has been prepared & project on carbon sequestration is being formulated to address carbon sequestration aspect in Indian Arid Zone.
5	Exchange visit	Indonesia, CIFOR HQ at Bogar	Dr. G. Singh	Preparation of review on tropical dry forest and development of concept for future planning.
6	Computer Application (IT)	Toranto	Sh. A.K. Sinha	The training has been very useful in managing LAN & WAN of the institute.
7	Rehabilitation and management of degraded land	CSIRO, Australia	Dr. Pramod Kumar	The training has been very useful.
8	Country Focused Training on Regional Ecosystem Monitoring Technology	Japan International Cooperation Agency, Japan	Sh. H. C. Chaudhary	The participants were introduced to various techniques used for monitoring of various aspects of different types of ecosystem.

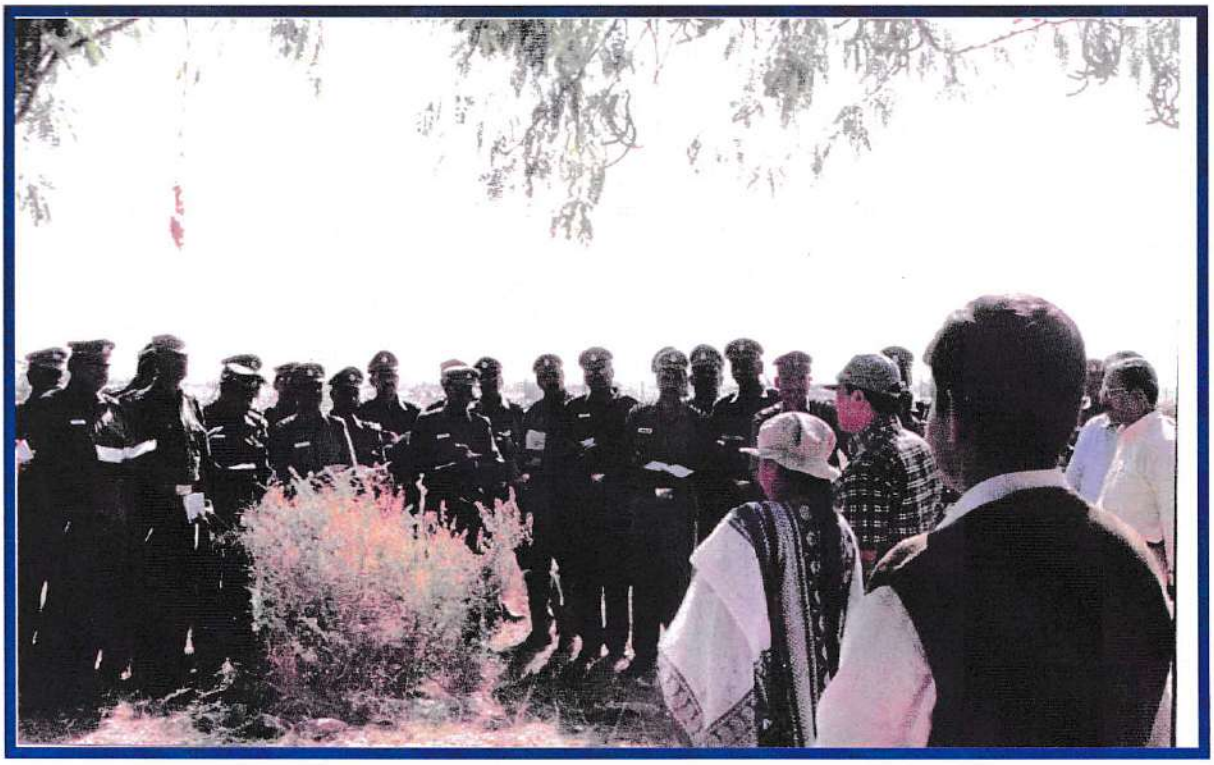
II. National

Sr. No.	Training on	Venue	No. of Participants	Name of Participants
1	FAS training	ICFRE, Dehradun	3	Sh.Bharat Sharma, Sh.C.P.Rangdale, Sh.V.K.Sahni
2	LAN management	ICFRE, Dehradun	2	Sh.A.K.Sinha, Sh.V.K.Sahni
3	LAN management	ICFRE, Dehradun	2	Sh.P.S.Sakhla, Sh.Pratap Ram
4	Research writing	NFLIC, Dehradun	2	Dr. B.M.Dimri, Dr.S.Mohan
5	Library management	Libsys Corp, Gurgaon	3	Smt. Anuradha Bhati, Smt. Saro Sisodiya, Smt. Varsha Vashita
6	Management and utilisation of *Prosopis juliflora* on2-5th May, 2001	CAZRI, Jodhpur	7	Smt. Sangeeta Tripathi Sh.Rajesh Gupta, Dr.N.K.Bohra Dr. Shivesh Kumar,Sh. Devedra Kumar,Sh. Hemant Kumar, Sh Mahendra Singh
7	"Neem and holistic sustainable human development" by NOVOD Board on 16-17 March 2002	CAZRI, Jodhpur	9	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

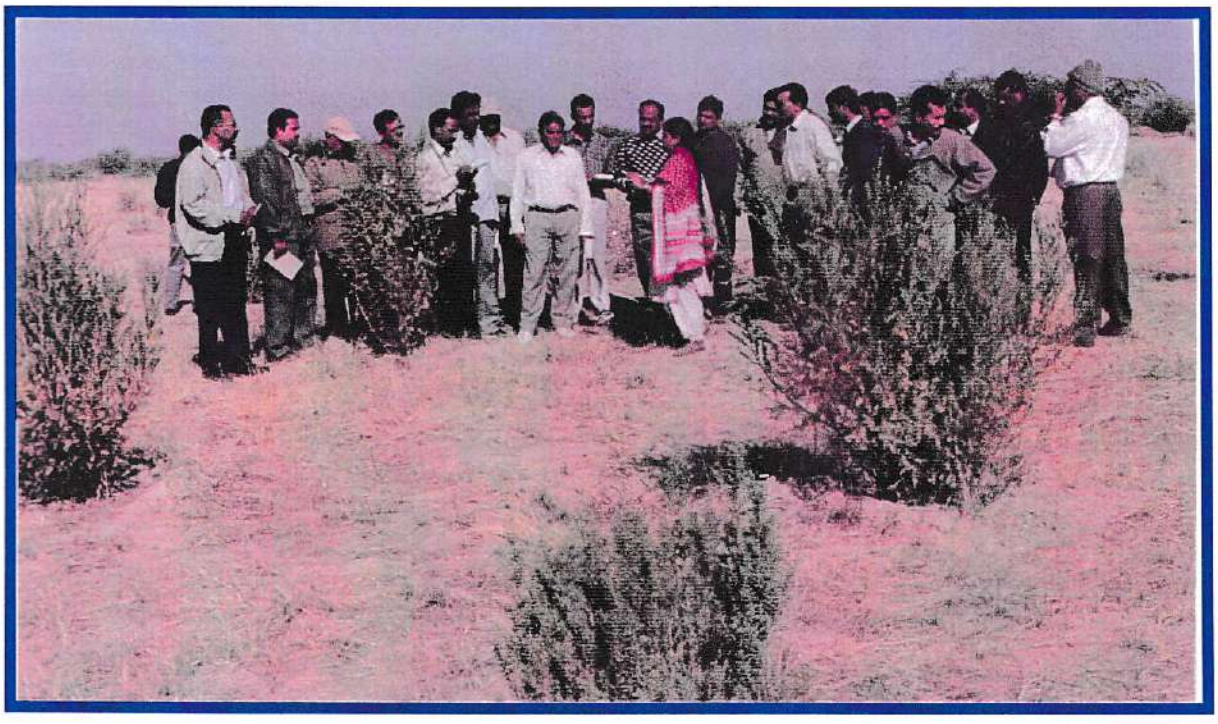
(b) Trainings Imparted by Institute:

Sr.No.	Training on	Venue	No. of participants	Details of training
1	Project related training "PSIP"	Jaipur and Rajpipla	50	SFD officials for establishment and management of SPAs.
2	Research results/technologies developed.	AFRI, Jodhpur.	50	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	60	RFO Trainees from Coimbtore, Tamilnadu. (28.11.2001 to 30.11.2001)

FIELD VISITS OF
STATE FOREST DEPARTMENT OFFICIALS



(a) Visit of RFO Trainees : Tamil Nadu



(b) Visit of SFD Officials : Gujarat

Linkages and Collaboration

National:

1.Tata Energy Research Institute, New Delhi

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 northwestern India. It covers a 28910 ha area 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, and environment.

The seven types of degraded land are represented by: (1) degraded forest land in the Aravalli, (2) scrub land in the central Saurashtra region of Gujarat; (3) gullies and ravines in southwest Barmer district of Rajasthan; (4) degraded pastureland in Kutch and north-western Rajasthan; (5) land degradation due to dryland salting along the Little Rann of Kutch; (6) sand desert with shifting dunes in north-western Rajasthan; and (7) rocky/sandy hummocks in Shergarh tehsil of Jodhpur. The GEF alternative will build on the baseline by adopting and applying the IEM approach for combating desertification by promoting community level planning, enabling a legal and policy environment and demonstrating appropriate technical models.

In each of the project's eleven representative sites three different but integrated spatial units such as agricultural lands (farmers lands), common access resources (pasturelands and wastelands) and designated forest areas will be targeted. On farmers land, the production system will be intensified by introducing agroforestry models, adopting of soil and water conservation measures to rationalize land use and promoting food and energy self sufficiency in order to enhance the management of natural resources and reduce pressure on forest areas. Technologies will also be demonstrated to rehabilitate salt land and sand dunes to enhance both productivity and carbon sequestration. In pasturelands and wastelands, participatory integrated plans for management, adoption of silvi-pastoral models and sustainable use will be demonstrated. Alternative income generation activities will be promoted. In designated forest areas the joint forest management (JFM) model will be strengthened including a suitable mechanism of usufruct sharing from protection and conservation of forest resources. Capacity building and empowerment of local institutions and stakeholders for the implementation of IEM will be done.

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.

International:

1. International Neem Network, FAO, Rome.
2. Oregon state university, Corvallis, USA and 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) and development of three concept papers such as
   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

A) Chapters in Books:

1. G. Singh and Sarita Mutha (2001). Tree: a bio-resource for sustainable production in arid areas. *In: Bioresource Technology* (Ed. G. Tripathi)
2. G. Singh and M. Bhati (2001). Utilization of industrial wastewater for tree plantation. *In: Bioresource Technology* (Ed. G. Tripathi).
3. N. Bala (2001). Water regimes and Forests. *In: Bioresource Technology* (Ed. G. Tripathi).
4. Chapter "Genetical improvement of teak: concept, application and achievements"; by C.J.S.K Emmanuel in the book "Genetics and Silviculture of Teak" Edited by A.K. Mandal and S.A. Ansari
5. Chapter " Genetic Variations and Tree Improvement" by C.J.S.K. Emmanuel in the ICAR university level text book "Forest Tree Breeding" Editor Dr. C. Surendran, Director, Centre for Plant Breeding and Genetics, TNAU, Coimbatore.
6. "*Agrobacterium tumefaciens* mediated genetic transformation of Oryza sativa". By Tarun Kant, S.L. Kothari, Halina-Kononowicz Hodges, Thomas K. Hodges. 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)
7. "An insight into Bioinformatics –Its evolution, present status and future prospects". By Tarun Kant. In: Glimpses in Plant Sciences (Ed. P.C Trivedi), Pointer Publishers, Jaipur, (2002)- Accepted

8. 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).

9. 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).

10. 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).*

11. N. Bala (2002). Water regime and forests. In: Bioresource Technology (Ed G. Tripathi)

12. 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.

B) Research Papers in Scientific Journals:

1. 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.

2. G. Singh, and T.R. Rathod (2001). Growth of woody perennials in relation to habitat condition in northwestern Rajasthan. *Tropical Ecology*, 42: 223-230.

3. 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.

4. 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)

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). Canopy covers effect of adult neighbours on regenerative population of *Cassia angustifolia* in duny area of Indian desert. (Submitted to review committee).

7. 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. *Indian Forester, 4:* 409-418. (Published in 2001).

8. 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. *Indian Journal of Forestry*, 23(3): 305-311.(Published in 2001).

9. 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).

10. 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 *Albizzia lebbeck* in Rajasthan. *Indian Forester*, 128: 103-104.

11. Volume equations for *Eucalyptus camaldulensis* in IGNP area, V.P. Tewari, Bilas Singh and V.S. Kishan Kumar, *Indian Forester*, 127, 2001, 1367-1370.

12. Lopping on the growth and fodder production of *Ailanthus excelsa*, V.S. Kishan Kumar and V.P. Tewari, *International Forestry Review*, 3(1), 2001, 54-57.

13. Construction and validation of tree volume functions for *Dalbergia sissoo* grown under irrigated conditions in the hot desert of India, V.P. Tewari and V.S. Kishan Kumar, *Journal of Tropical Forest Science*, 13(3), 2001, 503-511.

14. Volume equations for *Dalbergia sissoo* in IGNP area, V.P. Tewari, S.L. Chauhan and V.S. Kishan Kumar, *Annals of Forestry*, 9(1), 2001, 140-143.

15. 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.

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. UK Tomar, Tarun Kant CJSK Emmanuel (2002) Mass multiplication of desired genotype in Neem, Presented at CAZRI

18. CJSK Emmanuel, UK Tomar, Tarun Kant (2002) Assessing Geographical Variability in Neem - Presented at CAZRI

19. "*Agrobacterium tumefaciens*- mediated transformation of rice using coleoptile and mature seed-derived callus". Tarun Kant, S.L. Kothari, Halina-Kononowicz Hodges, Thomas K. Hodges. *J. Plant Biochemistry & Biotechnology* vol 10, 121-126 (2001).

20. Yield of *Cassia angustifolia* in combination to different tree species in a silvi-herbal trial under hot arid conditions in India, (2002) Ranjana Arya Bioresource technology (sub. in revised form)

C) **Scientific Reports Prepared and Submitted:**

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, Dehradun: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.
3. Carbon Stocks in the State of Rajasthan, India. Prepared during three month training at OSU, Corvallis, USA and submitted to ICFRE.
4. Mitigating Carbon Emission in Rajasthan. Prepared during three month training at OSU, Corvallis, USA and submitted to ICFRE.
5. Role of Forests in Carbon Sequestration. Submitted to The Director AFRI. Pp.
6. N. Sharma, Parveen, CJSK Emmanuel, UK Tomar (2001) Literature review on Clonal propagation of Important Arid Zone Tree Species

D) 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.

E) Scientific 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".

F) Scientific Films/Documentary:

1. (2001-2002) 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.

G) Research Papers Presented in Seminars/Symposiums/Workshops:

i) S.I.Ahmed, Meeta Sharma, Shivesh Kumar, S.D.Paunikar, Aminullah Khan and V.K.Tiwari (2001) control of arid forest insect pests through biological means. Proc. CTA-cum-peer review held at HFRI Shimla on 10th October 2001.

ii) Ahmed. S.I and Shivesh Kumar (2001). Advances in integrated management of insect pests of *prosopis* spp., in arid and semi- arid areas *Proc. CTA-cum-peer review held at HFRI Shimla on 10th October 2001.*

iii) Ahmed.S.I and Meeta Gaur (2001). Progress report on integrated management of insect pests of marwar teak, *tecomella undulata (sm.) seem* in arid and semi-arid areas of Rajasthan. *Proc. CTA-cum-peer review held at HFRI Shimla on 10th October 2001.*

iv) *Hemant Kumar, R.K.Meena, MalaRathore & Kishan Kumar V.S.* "Availability of some important medicinal plants in the arid regions" sent to workshop on " Conservation, propagation, utilisation and marketing of medicinal plants" held at the Directorate of Extention, MPUA & T, Udaipur on 5-7 November 2001.

v) Vegetation Status of a salt affected soil after five years of plantation Ranjana Arya Presented in Symposium on *Impact of Human Activities on Thar Desert Environment* at CAZRI, Jodhpur on 15-17. Feb. 2001 (Proceedings in press)

(v) Plantation practices for saline and waterlogged areas Ranjana Arya and K. R. Chaudhary Presented in workshop on *Innovative Plantation Technology and Joint Forest Management in IGNP area"* at Bikaner on 10-11 January, 2002

(vi) Effect of Nitrogen and gypsum on establishment and early growth of Salvadora persica, (L). in a salt affected soil in hot arid zone Ranjana Arya and K. R. Chaudhary (2001), National Seminar on Developments in Soil Science-2001 for Sixty-Sixth annual convention of Ind .Soc. Soil Science at Rajasthan college of Agriculture, Udaipur during October 30-November 2, 2001

H) Research Papers Communicated/Accepted in Press:

1. Bilas Singh and G. Singh (2001). Influence of water deficit on the seedlings of *D. sissoo* Roxb. in arid environment: Biomass partitioning, water relations and gas exchange. *Tree Physiology* (submitted in revised form).
2. G. Singh and M. Bhati (2001). Growth, biomass production and nutrient composition of *Eucalyptus camaldulensis* seedlings irrigated with municipal effluent in loamy sand soil of Indian desert. *J. Plant Nutrition.* (Submitted)
3. B. Singh and G. Singh (2001) Influence of soil water regime on nutrient composition and uptake by *D. sissoo* seedlings. *Tropical Ecology* (Submitted).
4. B. Singh and G. Singh (2001) Influence of water deficit on the growth and root growth potential of *D. sissoo* seedlings in arid environment. *J. Tropical Forest Science* (Submitted)
5. B. Singh and G. Singh (2001). Influence of water deficit on biochemical activities in *D. sissoo* in dry environment. *Indian J. Plant Physiology* (Submitted)

Consultancy

Ministry of Rural Development has assigned the work for evaluation of the project entitled "Integrated Watershed Development Project in Sunel Watershed of Pirawa Panchyat Samiti District Jhalawar (Rajasthan) was sanctioned by the Govt. of India vide letter No.K-11/104/97 IWDP Dated 26th March 1998 to check degradation, deforestation and soil erosion by using most suitable biological and engineering measures based on local techniques, keeping in view the socio-economic upliftment of community with overall participation of local villagers.

Patents Obtained/ filed Nil

Commercialisation of technology Nil

Organised and Participation in conference, meetings, workshops, symposia, Exhibitions

(a) Organised

1. Consultative Workshop for Project Formulation under UNDP-GEF on "***Integrated ecosystem approach to rehabilitate degraded arid and semi arid land of western India for combating desertification***" at Gandhinagar, Gujarat on 21st Sept. 2001.
2. Consultative Workshop for Project Formulation under UNDP-GEF on "***Integrated ecosystem approach to rehabilitate degraded arid and semi arid land of western India for combating desertification***" at AFRI, Jodhpur, Rajasthan on 26th Sept. 2001.
3. Organized ***Liaison & RAG*** meetings on 22nd & 23rd Oct., 2001.
4. CTA workshop cum peer review on ***Forest Ecology*** on 30-31 Oct. and on ***Delbergia sissoo*** on 1.2 Nov. 2001 at AFRI, Jodhpur.
5. Consultative meeting for Finalization of Project brief under UNDP-GEF on "***Integrated ecosystem approach to rehabilitate degraded arid and semi arid land of western India for combating desertification***" at AFRI, Jodhpur, Rajasthan on 19th March 2002.
6. Consultative meeting for Finalization of Project brief under UNDP-GEF on "***Integrated ecosystem approach to rehabilitate degraded arid and semi arid land of western India for combating desertification***" at Gandhinagar, Gujarat on 22nd March, 2002.

(b) Participation:

1. Workshop on "***GEF Project under Operational Programme-12 (Integrated Ecosystem Management)***" at FRI, Dehradun on 31st May-2nd June, 2001

   I Sh. R.L. Meena, Gr. Co-ordinator(R)
   II Dr. G. Singh, Head, FEDD

2. Workshop on "***National biodiversity strategy and action plan***" at Gandhinagar, Gujarat on 31st August 2001.

   I Sh. R.L. Meena, Gr. Co-ordinator(R)
   II Dr. G. Singh, Head, FEDD

3. Workshop on UNDP-GEF Project on "***Selected Options for Stabilizing GHG Emissions for Sustainable Development***" at India Habitat Centre, New Delhi on 27th Nov., 2001.

   I Sh. R.L. Meena, Gr. Co-ordinator(R)
   II Dr. G. Singh, Head, FEDD

CONSULTATIVE WORKSHOPS ORGANIZED

(a) Gandhinagar on 21.09.2001

(b) AFRI, Jodhpur on 26.09.2001

RESEARCH ADVISORY GROUP MEETING

(a) Inaugural Session

(b) Technical session

4. National Workshop, on " ***Innovative Plantation Technology and Joint Forest Management in IGNP area"*** at Bikaner on 10-11 January, 2002

I Sh. K.K.Chauduri, Director
II Dr. G.Singh, Head, FEDD
III Dr.Ranjana Arya, FEDD

5. Workshop on "***Identification of cluster and technical parameter for selection***" at CAZRI, Jodhpur on 7.1.2002 by

I Sh. K.K.Chaudhuri, Director

6. LTER-GTOS Carbon Flux Scaling Workshop. H.J. Andrews LTER site (Blue River, Oregon, USA) May 21-22, 2001.

I N. Bala, FEDD

(c) Exhibition

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

Extension publications

1. Arid Forest Research Institute, Jodhpur
2. Know your Nursery Pests and Their Control
3. Know your Nursery Diseases and Their Management
4. अरेबिक गोंद का स्रोतः कुमटा वृक्ष
5. लवणीय भूमि का मित्रः जाल
6. मरु भूमि का कल्प वृक्षः खेजड़ी
7. मारवाड़ का सागवानः रोहिड़ा
8. बंजर भूमि की हरी चादरः विलायती बबूल
9. वर्षा ऋतु आई, वृक्ष लगाने की रुत लाई
10. कैरः मरुस्थल में परती भूमि सुधार हेतु फल वृक्ष
11- Marwar Teak : Rohida
12- Kalpavriksha of the Desert: Khejri

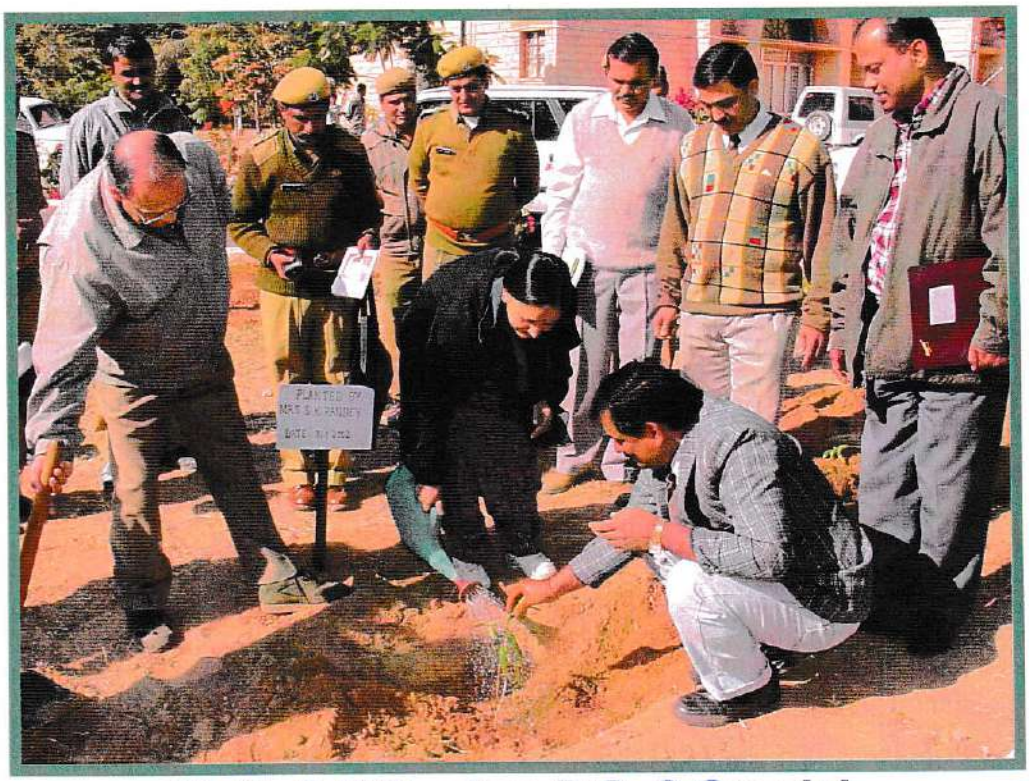
News Articles

"नीम " एक कल्प वृक्ष (आँजणा दर्शन, अप्रेल, 2001 अंक)

Awards **Nil**

VISIT OF DIGNITARIES

(a) Dr. D.N. Tewari , Hon'ble Member of Planning Commission



(b) Sh.S.K.Pandey, D.G. & Special Secretary, MOEF

(c) D.G. & Special Secretary, MOEF : Technical Discussion with Head of Institutions (SFD, CAZRI, State Remote Sensing & AFRI)

AFRI: Model Roadside Plantation

Distinguished Visitors

1. Dr. D.N. Tewari, Hon'ble Member of Planning Commission, visited the institute on 12.01.2002.

2. Sh. S.K. Pandy, Director General and Special Sectary, Ministry of Environment & Forest, visited the institute on 31.01.2002 and hold the technical discussion 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, Dehradun 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.