Environmental Information System
INDIA
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DEN NEWS

Volume 16 (2) July-December, 2014

Dear Reader

As part of our continuing efforts, we are pleased to hand over this issue of DEN newsletter in a new format. Equipping the reader with newer information of value is the aim of this newsletter and for this ENVIS team shall strive with all its efforts and energy.

This issue has interesting information on cold desert of India as well as some desert plants. Integrated farming system has proven to combat desertification and hence provide a valuable technological solution to stop the menace of desertification. This issue onwards, we will also touch upon policies and programmes of different Ministries/Departments of Govt. of India that has a bearing on combating desertification. Some programmes of Environment, Forest and Climate Change Ministry of Govt. of India are featured in this issue. Regular columns on events by ENVIS Jodhpur and information on future conferences are included.

Have a joyous and informed reading.

Suresh Kumar
ENVIS Co-ordinator

KNOW YOUR DESERT

Indian Cold Desert

Introduction

The Himalayan mountain range has significant bearing on the climate of India, as its towering height created a vast rain shadow zone in the north. The cold dry tracts of this zone referred as the cold arid region are spread over in the northern states of Jammu and Kashmir (Leh and Kargil districts, Fig.1), Himachal Pradesh (Lahaul-Spiti, Kinnaur and parts of Chamba district), Uttarakhand(very small parts of Uttarkashi, Chamoli and Pithoragarh districts) and Sikkim (barren and isolated northern tip). Among the cold arid parts of India, Ladakh in Jammu & Kashmir is one of the highest (2,900 m - 5,900 m sl) and coldest. It is spread over 70,000 square km across the river Indus (Fig.2), Shayok and Zangskar having three important mountain ranges viz. Kharakuram, Ladakh and Zangskar.

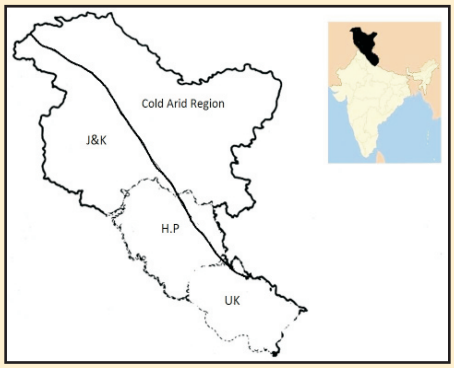

Fig.1: Cold Desert of India

Leh and Kargil districts constitute the Ladakh region. Leh(45,110 sq km) the largest district in the country at 2900 to 5900 m above msl has total human population of 117637, with a density of 3 persons/ sq km.Kargil (4036 sq km)has a human population 119307 with population density of 8 persons/ sq km. For centuries, Ladakh pursued a relatively self-reliant existence, economically based upon subsistence agriculture and trade with Tibet in pashmina, salt and dried apricots. Villages grew up in valleys where the melt-water from glaciers (Fig.3) provided sufficient irrigation to sustain barley and wheat crops. Animals such as sheep, goats, donkeys, cows and dzo (a cross between the cow and yak) played an important part in Ladakhi

Fig.2: River Indus

Fig.3: Snow clad peaks of high mountains

agriculture, providing dung for fuel, besides transport, wool and milk.

Climate

In general, the region has short mild summer to long cold winter. The temperature ranges between -40°C in winter to +35°C in summer. Mean precipitation ranges between 80-300 mm with potential evapotranspiration of 700-800 mm per year. The growing period varies from 80 to 150 days.

Agriculture in Ladakh: A Unique Farming System Approach

Predominantly small scale agriculture drives the economy of the region, having 244 villages. Over 80% land holdings in the region are 2 ha or less. Growing barley, wheat and peas, and rearing livestock are main vocations. Farming systems (Fig.4) are mixed livestock – crop based. The land is irrigated by a system of channels which funnel water from the ice and snow of the mountains. At lower elevation temperate fruits are grown in pockets while the high altitudes are the preserve of nomadic herders. Apricots and Pashmina are important export items. Currently, largest commercial agricultural products are vegetables (Fig.5) – sold in large amounts to defense establishment. Farming system in Ladakh region feature interaction among five components:

- crop fields,
- a private land support system (fruit and multipurpose trees in and around crop fields),
- community woodlands and pastures,
- livestock, and
- man in uniquely specific socio, economy- cultural fabric.

Fig.4: A view of farming system in village

Fig.5: Farmers sowing potato in village Nang

Pre-chemical input agricultural yields in Ladakh under traditional system were higher due to careful system of recycling essential crop nutrients through human and animal consumers (i.e. use of manure and night soil). This was supplemented by rotational cropping with peas (except in highest areas) to provide additional nitrogen. Livestock plays an essential part in the agricultural cycle, especially for the production of dung, for ploughing and threshing. Thus, traditional farming system in Ladakh was based on human labour, animal power and hand-made tools.

As entire agriculture in farming system is irrigated, therefore, central to agriculture is the harvest of irrigation of summer snow melts from high mountains. Channels often many kilometers long, ferry the water to the villages where a finally tuned system of small channels and an equally finely tuned social system of determining who gets what water and when, direct the water to small terraced fields. At the fields, little soil dams in the drains are created using long handled spades

to distribute the water in a gentle and even flow. Between the fields, mini meadows of a rich assortment of grasses and herbs add their colour (mauve of lavender, yellow of a local clover) and winter fodder. Wood is produced in coppices of willow and poplar in farms and woodlands, along with some fruit and nut trees at lower altitudes.

Government Initiative to Enhance Agriculture Productivity

Agricultural development in Ladakh is driven by J&K Govt., which in turn is directed by Ladakh Autonomous Hill Development Council (LAHDC) of Leh and Kargil. In fact, LAHDC in both the districts has the final say in plans relating to agriculture and other developmental sectors. Some of the recent attempts are : introduction and subsidizing of HYV seeds, chemical fertilizers, mechanization (such as threshing machine, mechanical tillers), irrigation, and various export oriented produce such as, floriculture, vegetable and mushroom production. These programmes did increase the agricultural productivity, from 16000t to 22000t between 1981-82 and 1995-96. In the Leh district however, this high input agriculture has many negative impacts also on environmental and social milieu of the region.

Impact of Modern Changes

For the last three decades, Ladakh has been increasingly exposed to modern influences brought largely by tourism and other economic "developments". Ladakhi agriculture has been hit particularly hard. Subsidized food is often cheaper than food grown locally. Local agriculture now seems "uneconomic", and many Ladakhis are abandoning their farms in pursuit of paid jobs in Leh or outside Ladakh. Conventional wisdom in agriculture is gradually being lost. In the "modern" economy being created by global economic forces, women are increasingly marginalized. Traditionally women in Ladakh enjoyed remarkably high position, being at the centre of every household and involved in all decisions. The paid-jobs available now are generally filled by men, while the women are left behind to do the agricultural work that was once shared by both.

ICAR/CAZRI's Initiatives

Visualizing the importance of natural resources and agro-ecosystems in cold desert, ICAR decided to expend the activities of CAZRI beyond hot arid regions of the country by establishing one research centre for cold desert in Leh, Ladakh during XI plan. CAZRI, RRS, Leh became fully functional during June, 2013 to:

- undertake research for the development of sustainable farming options in cold arid ecosystems,
- provide scientific management by development of location specific technologies, its proper transfer, and
- act as repository of information on the state of natural resources and desertification process and its control.

Outcome of these initiatives will be reported in due course of time.

- J.C. Tewari, M.S. Raghuvanshi and Kamlesh Pareek, CAZRI, Jodhpur and Leh.

KNOW YOUR DESERT PLANTS

American plant *Cordia boissieri*: Flourishes well in the Indian Desert

Cordia: What, Where and Why ?

Cordia L. is the largest genus in the family Boraginaceae with approximately 325 species that occur widely in tropical and subtropical parts of the world. Most of these species originate from Asia (Palestine, Turkey, Iran, Mesopotamia, Saudi Arabia, India, Pakistan, South China and Indonesia) while others are spontaneous in Southern and Eastern Africa and in Abyssinia. The genus *Cordia* also occurs in Australia, New Caledonia, Middle America, Guiana and the tropical area of Brazil. Some species are naturalized in various countries where they are sometimes cultivated for various economic products. Some *Cordia* species are of considerable potential economic importance medicinally and *Cordia boissieri* A. DC. is also recorded in the official pharmacopoeias of various countries.

Cordia boissieri is a popular landscape plant in the south-western United States. It is locally known as “Mexican/Texas Olive”, wild olive or anacahuita. It is adapted to most soils with good drainage. It grows 3 to 7.5 m tall as a densely branched, multi-stemmed shrub or small tree (Fig 6 A). Leaves are up to 15 cm long, medium green, and covered with numerous small hairs (Fig 6 C). Plants are drought tolerant, but benefit from irrigation during the hot season with improved growth and flowering. Plants are prized for their long flowering season from spring to fall. Tubular, white flowers with yellow throats appear in terminal clusters (Fig 6 B) and develop into ovoid drupes, half an inch long and bright red-brown (Fig 6 D).

Economic Importance: It has many economic uses which are as follows:

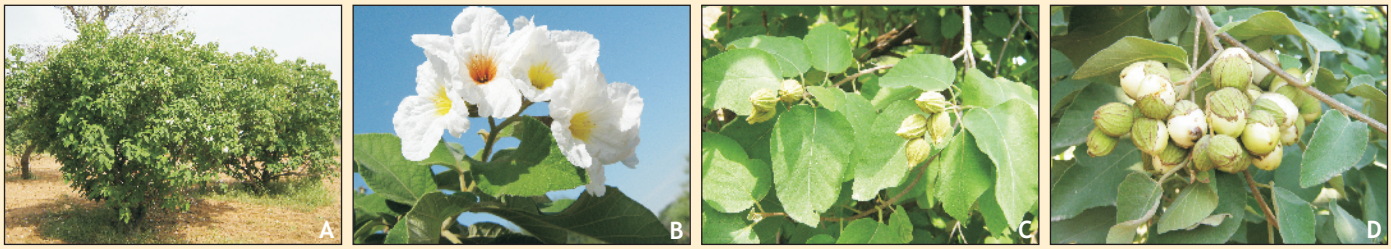

Fig 6: A. Habit of *Cordia boissieri*; B. Flowering twig; C. Close-up of leaf arrangement; D. Ripened fruits

♦ **Wood:** An extract is prepared from its wood to manufacture pills recommended for pectoral disease.

♦ **Flowers:** Flower's cookings are recommended to sooth cough.

♦ **Fruits:** A syrup is prepared from fruits to sooth cough.

♦ Siricote is cultivated as an ornamental species, since it is fully covered with beautiful and scented funnel-shaped white flowers.

Seeds are considered recalcitrant and the preferred method for propagation is through stem cuttings. Yellowish white or light brown fruits are collected and the seed inside feels hard and filled out. Seeds are then cleaned, air-dried, and stored in a cool, dry place.

They germinate well. In view of its rarity and immense economic importance, its multiplication for ex-situ conservation has yielded encouraging results in Indian Desert conditions.

This plant which is becoming rarer in its native place, has adapted well and is luxuriantly flowering, setting fruits and seeds in natural conditions of Desert Botanical Garden at CAZRI, Jodhpur.

- Ravikiran Kulloli and Suresh Kumar, CAZRI, Jodhpur.

TECHNOLOGICAL SOLUTIONS TO COMBAT DESERTIFICATION

Integrated Farming Systems

Introduction

Impacts of land degradation and desertification assume more severity and larger extent with increasing variability in rainfall, temperature and increased incidences of extreme events. All these adversely affect the life of desert dwellers' and their livestock, quite often making survival a challenge. Farmers in this region have followed indigenous farming systems as a means to combat desertification, by maintaining a crop- livestock - tree/shrubs – human continuum. The areas falling in <250 mm rainfall zone have predominance of grasses and shrubs, hence range/ pasture development with livestock rearing is a major proposition. In areas receiving rainfall between 250-300 mm, besides grasses and shrubs, multipurpose trees species dominate and mixed farming encompassing agroforestry system, mixed cropping, livestock and pasture management are main livelihood options.

In areas receiving rainfall >300 mm, crops and cropping system diversification, agroforestry and livestock rearing are major systems of sustenance of arid zone farmers (Fig.7).These local survival systems were sustainable some 80 years back but have now become inadequate to fulfil the need of ever increasing population and their aspirations.

From Alternate Land Use Systems to Integrated Farming Systems - a way forward:

Initial studies at CAZRI, Jodhpur were based on individual alternate land uses prevailing in this region. An economic analysis of these alternate land use systems over 18 years period clearly demonstrated that integration of perennial vegetation resulted in higher benefit cost ratio (1.46 - 1.87) over arable farming (1.24). Perennials also confer resilience to vagaries of desertification, thus enhancing the livelihood especially for small and marginal farmers.

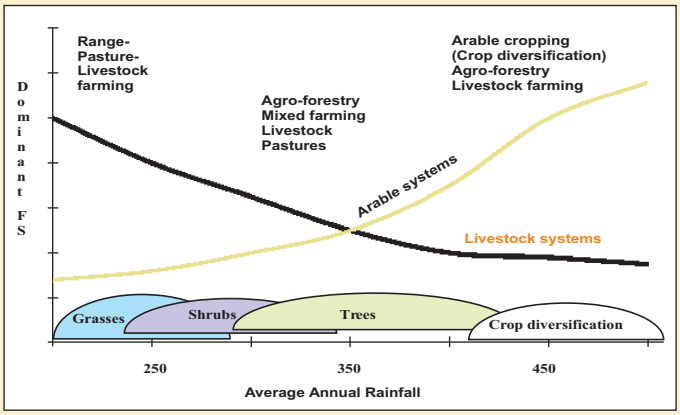

Fig. 7: Dominance of various farming systems according to rainfall pattern in arid zone (Source : Dr. T.K. Bhati, Retd., PS)

Growing of tress with crops increased the total productivity per unit land compared to sole arable farming. A tree density of 100 – 200 plants/ha was found optimum; as it had minimum interference with yield of dryland crops like cluster bean under *Khejri Prosopis cineraria* shade. An improvement in biological activities under agri-silvi system compared to sole crop was recorded. The silvi-pastoral system of *Ziziphus rotundifolia* and *Cenchrus ciliaris* could sustain 554 tharpakar cattle days/ha with 60% pasture utilization. Horti-pasture systems are more profitable than arable cropping under arid conditions. *Ber* and *C. ciliaris* are economically highly viable on the basis of B:C ratio, net present worth and annuity value (Fig.8). To combat uncertainties in production and income at farm level a judicious mix of these alternate land uses is needed. Integrated farming systems (IFS) approach harmonizes use of already scarce resources in the desert making it sustainable and resilient using ALUs as one of the components. IFS increases system productivity during good rainfall season by complementarities and synergies among different agriculture sub systems/ enterprises and augmenting the total productivity, profitability, sustainability and gainful employment for rural house hold .

Based on average land holding in the region (4-9 ha) a 7 ha integrated farming systems model has been developed at CAZRI, following twin strategy of system as well as crop diversification. This includes arable cropping (15%), agro-forestry (35%), agri-horticulture (20%), agri-pasture (10%) and silvi-pasture (20%). Crop diversification of pearl millet (40%) with pulses (30%), oilseed (10%) and cluster bean (20%) has been found more profitable and sustainable. Such an integrated

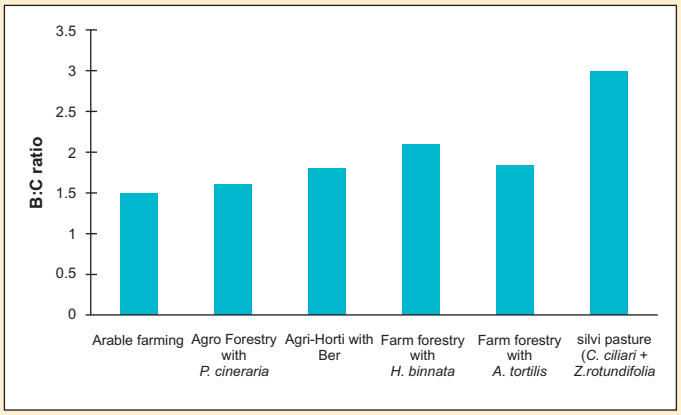

Fig.8: Benefit cost ratio of various components of IFS model (Average of 10 years)

systems can meet fodder requirement of 7 adult cattle units (2 cows, 2 calves, 8 sheeps and 8 goats) and can sustain a family of 4-5 members.

This entirely rainfed system has shown resilience in all manifestations of desertification such as in low rainfall years (2009),long dry spells of midterm drought (Year 2008, 2011), delayed onset of monsoon (2006, 2012) and terminal drought. In all such situations, the perennial component like fruit, fuel wood and fodder trees as well as grasses provided the much needed cash as well as fodder for sustenance of livestock. Over the decade, the IFS model had shown reasonable IRR (21.6), NPW (Rs 6.5 lacs) and B:C ratio (2.05) (Fig.8). Besides, a huge amount of carbon is sequestered in tree components and into the soil.

Hence it can be concluded that by virtue of large areas under arid zone, available technologies if practised under integrated farming systems approach (Fig.9), has a great potential for combating desertification at farmer's level, too.

Khejri + crops

Ber + crops

Anjan tree + crops

Mopane + *Cenchrus ciliaris*

Ber + *Cenchrus ciliaris*

Acacia tortilis

Tharparkar cattle

Goat + Sheep

Fig.9: Various components of IFS model

- S.P.S. Tanwar, Suresh Kumar and M.M. Roy

Role of RRSC-West in Combating Desertification

Regional Remote Sensing Centre – West is one of the four Regional Remote Sensing Centres (RRSCs) of ISRO to serve important national as well as regional activities of western region of India in the states of Rajasthan, Gujarat, Punjab and Haryana. The Centre (Fig.10) located at the Central Arid Zone Research Institute (CAZRI) Campus, Jodhpur has become operational since January 1988. The Centre has carried out multifarious projects of national, regional and local importance for various users involving central, state governmental agencies, NGOs, private and public sector agencies. Some of the unique projects carried out by RRSC-West, Jodhpur are towards tackling regional issues like Desertification, Drought and Natural Resources Management.

Over the years, the Centre has executed and implemented over two hundred remote sensing and GIS projects such as the Mapping of groundwater potential zones, Early warning of locusts, Discovery of paleochannels, Mapping and mitigation of floods, Reservoir capacity estimation, Mapping of landuse, Salinity, Waterlogged areas and the Wastelands, Environmental Impact Assessment of mining projects, Route alignment for rail and roads etc. The Centre has also carried out a number of projects of societal relevance with some of the leading NGOs in the region. The Centre has become a regional hub and Centre of excellence for various space applications including those pertaining to Tele-medicine and Tele-education.

Fig.10: RRSC West

Recent Achievements:

The recent achievements at RRSC-West on desertification and water resources through the following ongoing projects are briefly discussed;

India-WRIS Project: A major project entitled "Generation of Database and Implementation of Web Enabled Water Resources Information System (India-WRIS) in the country" is being jointly executed in collaboration with Central Water Commission (CWC), New Delhi since 2009. 'India-WRIS WebGIS Version 4.0 was released on 28th March, 2014. The portal contains 12 major info systems, 35 sub info systems, 95 spatial layers and large number of attributes (> 700) with 5-100 years data of the country. The portal (www.india-wris.nrsc.gov.in) has been designed and developed keeping in view multi-users from all sections of society, varied and multi-sources data input, current map policy and existing guidelines by CWC, requirement of regular updates, near real time data accessibility, data security and scale of information. The portal also provides 'Automatic Map' and 'Report Generation' facility. About 20,000 people visit the portal per month. The project has been completed and transferred to CWC by the Centre and currently supporting CWC to convert India-WRIS project into a new National Water Informatics Centre to be established at CWC, New Delhi

SIS-DP: As a part of National level Space based Information Support for Decentralized Planning (SIS-DP) project initiated at NRSC, this centre has initiated and completed level-1 ortho product generation using Cartosat stereo pair for Himachal Pradesh and Rajasthan state and the thematic mapping at 10,000 scale are being generated with the help of partner departments for the Rajasthan state. On completion, this project will facilitate online decision support for Panchayat level planning activity in the state.

Natural Resource (NR) Census-Land use Land cover: As a part of National Level Land Use / Land Cover Mapping at 1:250,000 scale using Indian Remote sensing Satellite (IRS) based multi-temporal AWiFS datasets for Kharif, Rabi and Summer season, Land use land cover mapping for Rajasthan, Gujarat States and Daman & Diuand and Dadar Nagar Haveli Union territories was completed for 2013-14 and hosted in Bhuvan. NRSC also serve the country through a Bhuvan portal. (www.bhuvan.nrsc.gov.in). The year wise census on land use land cover helps to monitor the land use change due to climate and other factors.

Natural Resource (NR) Census-Geomorphology: As a part of National Geomorphology project for Geological Survey of India (GSI), NRSC has completed mapping of Geomorphology at 1:50,000 scale using IRS-LISS-3 with the help of partner departments during this year. RRSC-W has coordinated with partner departments in completing the mapping for Rajasthan and Gujarat State with due quality verifications and hosted in Bhuvan.

Monitoring and Evaluation of National Watershed Development Program For Rural Areas (NWDPRA)-Watersheds of Rajasthan:

As a part of National program for monitoring the impact of NWDPRA watersheds for Ministry of Agriculture, the Centre has successfully completed Monitoring, Evaluation and Impact Assessment of 36 NWDPRA watersheds covering 21 districts of south eastern

Rajasthan using remote sensing, GIS and MIS. The result of this study is also hosted in Bhuvan and Ministry of Agriculture websites.

Mapping of Mosquito Breeding Habitats: In coordination with Desert Medicine Research Centre (DMRC), Indian Council of Medical Research (ICMR), Govt. of India, Jodhpur, the Centre has completed Mapping of mosquito breeding habitats and location of vertebrate hosts in north and southern part of Rajasthan state covering Udaipur, Dungarpur, Banswara, Sri Ganganagar & Hanumangarh districts using remote sensing and geographic information system (RS&GIS). This study has helped DMRC to identify emergence of Japanese Encephalitis in this region.

Disaster Management Support: The Centre has organized Regional Meeting on National Disaster Emergency Management (NDEM) for senior level officials of western states and developed GIS based decision support system to identify escape route and the safe place in case of any nuclear or chemical disaster event in and around Jodhpur city using high resolution satellite data for Defense lab, Jodhpur. The centre also coordinates with Rajasthan state government in identification of flood prone area and flood forecasting activities.

Sand dune Morphometry: To assess the aeolian impact on Thar Desert, the remote sensing and ground penetrating radar based study on sand dune has been initiated over Rajasthan desert.

Hydrologic modeling of Luni basin: Water balance components at the 9x9 minutes grid level is being estimated experimentally on a daily basis using VIC model for entire country and hosted on Bhuvan web portal by NRSC. The Centre has initiated estimating water balance components at 3x3 minutes grid for Luni basin. Input data preparation for VIC model at 3x3 minute grid was completed. Running of the model for real time data is being planned and this will help us to assess the water balance components such as rainfall, runoff and evapo-transpiration at every 5x5 Km area.

Identification of Potential Rainwater harvesting sites: Identification of micro level field rainwater harvesting sites using a proto type model based on DEM, soil, slope, climate, land use and land cover was developed for a cluster of 50 villages in Jodhpur district.

Water footprint analysis study: Estimation of spatial water use by domestic, agricultural, livestock and water availability using remote sensing and GIS was identified for 15 Tahsils around Jodphur as an in house Technology Development Project.

Spectral study to assess wheat production: Spectral analysis to assess suitable variety and time of wheat cultivation for better production carried out for ISSAPUR NBPGR Farm, New Delhi was completed for 2013-14 and the similar study over NBPGR Farm of Jodhpur has been initiated.

Training Programs: Organised Regional Trainings for IWMP, NABARD and NUIS officials of Rajasthan state and organised state level workshop on Bhuvan NUIS, National Hydrogeomorphological maps for western states of Rajasthan and Gujarat.

- A. T. Jeyaseelan, RRSC, Jodhpur.

KNOW POLICIES AND PROGRAMMES RELEVANT TO COMBATING DESERTIFICATION

Schemes of the Ministries of Environment, Forests and Climate Change, New Delhi

Name of Scheme	Relevance to Combating Desertification
Integrated Afforestation and Eco Development Scheme(IAEPS)	To promote afforestation and Projects development of degraded forests by adopting an integrated approach to the development of land and other related natural resources on watershed basis through the micro-planning process.
Area Oriented Fuel wood and Fodder Projects Scheme (AOFFPS)	To augment the production of fuel wood and fodder in 242 identified fuel wood districts in the country.
Conservation and Development of Non-Timber Forest Produce (NTFP) including medicinal plants	Special focus on tribal population for whom NTFP is the main source of livelihood.
Grants-in Aid scheme	Promoting peoples' participation- funds provided to NGOs and Voluntary Agencies (VA) for afforestation and tree planting activities.
Eco-Task Forces	Afforestation, pasture development, soil and water conservation and other restorative work carried out by 4 eco-task forces in selected locations. These forces comprise ex- servicemen and serving JCOs and officers.
Association of Scheduled Tribes and rural Poor in Regeneration of Degraded Forest on Usufruct Sharing Basis	For rehabilitation of degraded forests in tribal dominant areas; Also aims at providing wages, employment and usufructs to the tribal people.

Compiled: Ritu Purohit and Suresh Kumar, ENVIS, CAZRI, Jodhpur.

EVENTS BY ENVIS

1. REPORT ON CHILDREN'S DAY CELEBRATION

ENVIS centre celebrated Children's day by conducting an Environment based Quiz Competition for school students on 14th Nov. 2014 at Dr. Raheja Library of the Institute. A total of 60 students enthusiastically participated in quiz competition (Fig.11). After the quiz, the students visited the Desert Botanical Garden, where they were enriched with information on Cacti, medicinal plants, succulent plants, threatened species and their regeneration in net and green house. A film on CAZRI was also shown to the students. On the basis of scores received in quiz competitions, they were awarded I, II & III Prizes and certificates were distributed to all the participants. In the Award Ceremony following students received the prizes from DR. R.K. Bhatt, Incharge Director. Organizing secretary Mr. Tirth Das thanked schools for sending their students. Teachers accompanying students expressed their gratitude for organizing such event which helped in dissemination of knowledge about arid zone.

Prize	Name of the Student	Class	Name of the School
1st	Pratyush Goyal	VII	Delhi Public School, Jodhpur
2nd	i) Aastha Garg	VIII	Delhi Public School, Jodhpur
	ii) Arya Agarwal	VIII	Delhi Public School, Jodhpur
3rd	i) Akshaj Singhal	VII	Delhi Public School, Jodhpur
	ii) Harsh Dangwal	VIII	St. Paul's School, Jodhpur

Fig.11: A. Quiz Competition B. Watching a movie on CAZRI C. Visit to Botanical Garden D. Prize Distribution

2. GUEST LECTURE

ENVIS centre on Combating Desertification organized a Guest Lecture on *"Access to Genetic Resources and Benefit Sharing: International Agreements and National Mechanisms in India"* on 17th December 2014. Dr R.S. Rana, Member, NBA and Former Director, NBPGR New Delhi gave the key note address. He enlightened the audience with minute details of the theme of his presentation. He discussed different agreements and protocols etc. He planted a sapling of *Prosopis cineraria* (Fig.12). Dr. Suresh Kumar HD-II and PI- ENVIS welcomed the guest speaker and also shared his views on the topic. Lecture ended with a vote of thanks by Dr. Dipankar Saha.

Fig.12: Dr R.S. Rana planting memorial tree "Khejri"

CONFERENCES

1.The 5th DDD conference took place on 17-20 November 2014 on Drylands, Deserts and Desertification 2014 at BGU, Sede Boqer Campus, Israel.

2. 84th Annual Session of the National Academy of Sciences, India and Symposium on "Desert Science - Challenges and Opportunities" was held during December 4-6, 2014 at Jai NarainVyas University, Jodhpur - 342 001, India.

Central Arid Zone Research Institute, Jodhpur 342 003, INDIA

ENVIS : Desert Environment Newsletter, Volume 16, Issue 2 (July - December, 2014)

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