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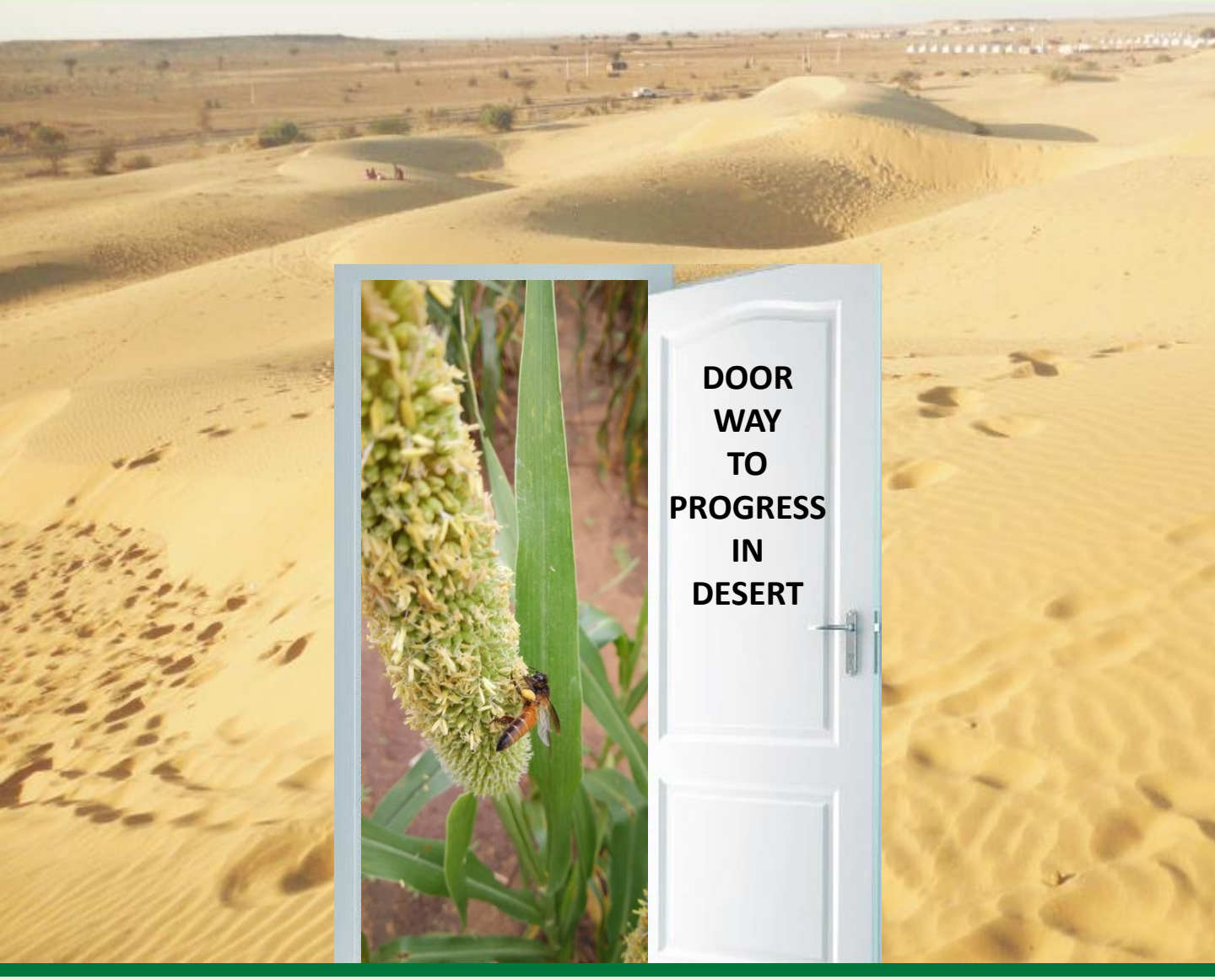
DESERT ENVIRONMENT NEWSLETTER

ENVIS Centre on Combating Desertification

ICAR-CAZRI

In this issue :



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From the desk of chairman

Dear Readers,

Indian Thar Desert represents a harsh ecosystem with extreme climatic conditions having diverse life forms which require adapted mechanisms for their survival. In addition to critical role of plants in desert biodiversity, species of insects and microorganisms comprises of largest group of organism, some of them are little known or rarely discussed. They are involved in various vital ecosystem services such as pollination, decomposition, recycling of nutrients and act as important links in the food chain, predators, parasitoids, herbivore etc. However, in food chain, indiscriminate use of agrochemicals or pesticides indirectly upshot the toxic levels. To obviate these snags the application of beneficial microorganisms in agriculture has increased in terms of bio-fertilizers and bio-pesticides as these sustainably provide higher economic yields. Systematic studies have been initiated to explore bio-control potentials of microorganism in order to develop a cost effective and practical management strategy in augmenting disease/pest control. The present issue discusses various aspects of microorganisms/insects and their key role in development of healthy desert ecosystem.

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Know Your Desert

Beneficial insects of the Indian Arid Zone

Insects are often considered as harmful creatures by a majority of people. But contrary to this, insects are one of the most important components of the ecosystem. Out of nearly one million known insect species only about one to three percent are considered as pests. Others are harmless and many are directly beneficial for mankind. Insects play several important roles in various ecological processes in different habitats. They provide valuable major ecosystem services such as pollination, decomposition, recycling of nutrients, as important links in the food chain, predators, parasitoids, herbivore etc. Agricultural production is directly affected by the ecosystem services provided by insects such as nutrient cycling, pest regulation and pollination.

Pollinators

The most important ecological service provided by insects is that of pollination. Pollinators are crucial for the survival of humankind. Pollinators include honey bees, bumble bees, wasps, butterflies, moths, ants, flower beetles etc. About three-fourths of the world's flowering plants and about 35 percent of the world's food crops depend on animal pollinators to reproduce. The common honey bees species in the Indian arid zone are *Apis florea*, *Apis cerana indica* and *Apis dorsata* from the family Apidae, carpenter bee species *Xylocopa iridipennis* from the family Xylocopidae

Honeybee collecting pollens from Bajra

Predators and Parasitoids

Insect predators and parasitoids that attack and feed on other insects, particularly on insect pests of plants are considered natural enemies. The natural enemies of insects can maintain pest populations below economically damaging levels. Predaceous natural enemies are generally characterized as free-living, mobile, larger than their insect prey, and are able consume several preys throughout their life cycle. Free-living adult parasitoids seek out a host and parasitize different life stages of their host (i.e., egg, larva, and pupa, adult) by laying an egg (solitary) or several eggs (gregarious) on or within their host. The immature parasitoid(s) feed on their host to complete development, kill their host, and emerge as free-living adult.

Predators: All the insect species of orders Odonata (dragon flies) and Neuroptera (lacewings and ant lions) are predators, while a large percentage of species in the orders Hemiptera (bugs), Coleoptera (beetles), Diptera (flies) and Hymenoptera (wasps, bees and ants) are predators, either as larvae or in both larval and adult stages. They are generally larger than their prey. In the arid region, the common insect predators are ladybird beetles, syrphid flies, lacewings etc are mainly free-living species that consume a large number of preys during their lifetime. Predator adults and immature stages are often generalists rather than specialists. Some adult predators feed on pollen if prey is not available. Insect predators are frequently found in all agricultural and natural habitats.

Ladybird beetles: Lady beetles or, ladybugs, are among the most visible and best known beneficial predatory insects. Both adults and larvae, feeding primarily on aphids, mites, thrips, small insects, and insect eggs as well as pollen and nectar. Ladybird beetles are usually red or orange with black markings. They have alligator-like larvae. The adults pass harsh climate in hibernation and females lay their bright yellow or orange eggs in clusters near aphid colonies during favourable cool weather when population of aphids increase. *Coccinella septempunctata* and *Cheilomenes sexmaculata* (Fabricius) are two common ladybird beetles of the Indian arid zone.

Adult and larva of ladybird beetle

Lacewings: Many lacewings are important predators of insect pests. The larvae of all lacewings are predaceous but in some species adults may also be predaceous. Lacewing larvae have a voracious appetite and consume soft-bodied pests such as aphids, mites, thrips, jassids and mealybugs. The most abundant are the common green Lacewings (*Chrysoperla carnea*). The adults are about 1.2 to 1.9 cm long, and are yellowish-green with golden eyes and large, delicate netted wings. The lacewing lays her eggs on foliage. The eggs are oval, pale green in color, and are attached to the end of a hair-like stem. In a few days they hatch.

Syrphid fly/ hover fly: Syrphid flies are also known as "Flower flies" and are most easily recognized by their typical hovering (helicopter like) flight above flowers or aphid-infested plants. Syrphid flies are important pollinators and some species of syrphid flies look like a bee or wasps. Larvae are voracious predators of aphids and other small insects. Adult syrphid flies require sugar from flower nectar as a source of energy for their flight and female flies feed on pollens as a source of protein before they can lay mature eggs.

Parasitoids: Insect parasitoids mainly belong to two orders Hymenoptera and Diptera that parasitize adults, larvae or eggs of other insects. Insect parasitoids have an immature life stage that develops on or within a single insect host, ultimately killing the host. Most beneficial insect parasitoids are wasps or flies, although some beetles and other insects may have life stages that are parasitoids. Most of them only attack a particular life stage of one or several related species. The female searches for host and lays eggs in or on it. The immature parasitoid develops on or

within a pest, feeding on body fluids and organs, eventually leaving the host to pupate or emerging as an adult. Some common example of insect parasites are *Aphytis lingnanensis* parasitizes scale insects, *Aphelinus asychis, Aphelinus varipes, Diaeretiella rapae, Aphidius colemani, Aphidius, matricariae* and *Aphidius ervi* parasitizes cereal aphids and *Trichogramma* parasitic wasps attack Lepidopteran eggs.

Decomposition

Insects play crucial role in the breakdown of organic matter of both animal and plant origin materials (both leaf litter and woody material) which facilitates its return to the soil as nutrients. Without the help of insects, break down and disposal of wastes, dead animals and plants would be impossible and this waste would accumulate in our environment. Insects such as termites, dung beetles, carrion beetles, flesh flies and flies are very important as primary or secondary decomposers. Termites are major decomposers of plant material in the deserts and contribute to nutrient cycling and soil fertility.

Enhancing the population of the beneficial insects

As indiscriminate sprays of pesticides destroy beneficial insects also, unnecessary applications of non-selective insecticides should be avoided. Instead of treating entire crop with pesticides selective spot application helps in conserving non target fauna. Spraying pesticides during hours when bees are not active also helps in conserving bees to some extent. The larval or young stages of many beneficial insects feed on other insects but the adults of most of the predators and parasitoids of pest insects require nectar and pollen at certain stages of their life for growth and reproduction. A diversified ecosystem with many types of trees, shrubs and other flowering plants provides microhabitats , food sources (prey, nectar, and pollen), alternative hosts and shelter for natural enemies and thus encourages colonization and population buildup of natural enemies. Under arid conditions *Acacia senegal* (Kumat), *Ziziphus nummularia* (Ber). *Lawsonia inermis* (Henna) etc. in the organic farm provide pollen and nectar to variety of pollinators, predators and parasitoids besides providing shelter for insects. Provision of water in small containers also help in attracting beneficial insects to the farm.

Nisha Patel

ICAR - Central Arid Zone Research Institute, Jodhpur

Know Your Desert Plant

Ephedra foliata : A sole Gymnosperm species in western Rajasthan

Ephedra foliata Boiss & Kotschy ex Boiss.(Family-Gnetaceae) is the only Gymnosperm species in western Rajasthan having ecological and economic significance. It is commonly known as shrubby horsetail and locally called as *Suo phogro* or *Andhokhimp*. It is a typical Gymnosperm of hot deserts, distributed in Asia and Africa. In India, it occurs in Punjab and Rajasthan. In Rajasthan, *E. foliata* occurs in Barmer, Bikaner, Churu, Jaisalmer, Jodhpur and Jhunjhunu districts. It grows in sandy to gravelly-rocky habitats in association with native woody perennial species like Danda thor (*Euphorbia caducifolia*), Kankera (*Maytenus emarginatus*), Khejri (*Prosopis cineraria*), Guggal (*Commiphora wightii*) etc.

E. foliata is a climbing dioecious much branched shrub with thick and pendulous stem. Leaves are highly reduced scale like, minute and 2-3 at each node. Male spikes are yellow, ovate, 1-3 together on 1-2 cm long peduncle. Female spikes are often in 2-3 flowered cymes on 2-10 mm long peduncles. Fruit is a berry ovoid-globose, white and fleshy with two brownish black seeds. Seeds are glabrous, planoconvex, acute at apex and rounded at the base. Flowering and fruiting in *E. foliata* occurs from January to April.

Male flower

Female flower

Ripe fleshy fruits of *E. foliata* are eaten by desert inhabitants in times of scarcity. Its green branches are browsed by camel, goats and sheep. It also serves as soil binders. Species of *Ephedra* are known to possess antimicrobial, antioxidant, antidiabetic, hepatoprotective and cardiovascular activities. They are reported to contain alkaloids ephedrine, pseudoephedrine, methylephedrine and methyl pseudoephedrine. Due to high browsing pressure and cutting of woody perennials for fuel wood in the region, its population has decreased and now it is a threatened species in western Rajasthan. Further, *E. foliata* being a dioecious species, its survival depends on the presence of both male and female plants growing in close proximity to produce fruits in female plants. Therefore, there is urgent need for its *in situ* conservation in natural distribution cover and also to create awareness amongst local inhabitants for its ecological and economic importance for desert ecosystem. It can be easily propagated from seeds, which can be collected from its natural stands in protected sites. Thus, seedlings can be raised in the nursery and transplanted in its suitable habitats in the region.

Sangeeta Goyal* and J.P.Singh**

ENVIS RP*, ICAR - Central Arid Zone Research Institute, Jodhpur**

Know Your Institutions

ICAR - National Research Centre on Equines, Equine Production Campus, Bikaner (Rajasthan)

The ICAR - National Research Centre on Equines, Equine Production Campus, Bikaner is a Sub-Centre of NRC on Equines, Hisar and it was established on 28 September, 1989 for conducting research on optimization of production potential of the equines. The campus has state-of-art laboratories for conducting research in equine genetics, nutrition, medicine, reproduction and management. The Campus has the responsibility to generate technologies for augmenting equine performance in order to uplift the socio-economic status of poor equine owners. Conservation and propagation of equines through ecotourism has recently been initiated. The elite Marwari horses of Rajasthan, Kathiawari horses of Gujarat, Zanskari horses of Ladakh, Manipuri horses of Manipur and Poitou donkeys of France are maintained and bred here. An Equine Information Centre and a Museum has been developed for depicting the basic and technical details about the equines. Cryopreservation of semen, artificial insemination, ultra-sonography and endoscopy of equines is routinely also carried out.

Mandate

- Basic and strategic research on equine health and production
- To provide advisory and consultancy services and capacity development

Services

- Elite horse, donkey and mule production for conservation and propagation of equines
- Artificial insemination and pregnancy diagnosis
- Cryopreservation of elite germplasm of equine species and breeds
- Training on different aspects of equine husbandry
- Organisation of health camps and farmers' meetings for close interaction and problem solving.
- Participation in animal fairs, farmers' fair, print, social and electronic media programmes for showcasing the technologies and providing various services
- Advisory and problem-solving services through Toll Free Telephone
- Disease diagnostic services for equine diseases
- Providing vaccines of important diseases of equines
- Promoting equine ecotourism for conservation and propagation of equines

Research Achievements

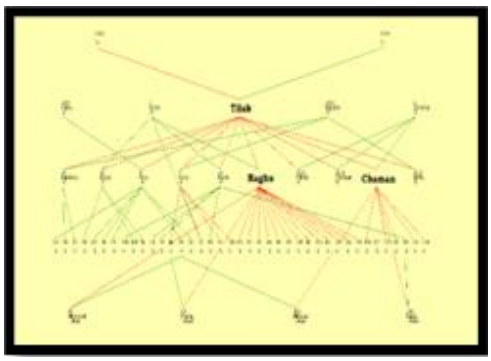
- **Phenotypic characterization of indigenous equines:** Two major horse breeds of the country viz. Marwari and Kathiawari and four pony breeds viz. Spiti, Zanskari, Bhutia and Manipuri were characterized based on the phenotypic characteristics including coat color and biometric indices.

- **Genotypic characterization of Indian equine breeds:** Molecular characterization of six indigenous equine breeds has been carried out using micro satellite markers. Genetic diversity analysis, population structure and relationship among six Indian horse (Kathiawari, Marwari) and pony breeds (Manipuri, Spiti, Zanskari and Bhutia), along with English Thorough bred horses as an outgroup was carried out which indicated high genetic diversity in all India breeds except Spiti ponies.

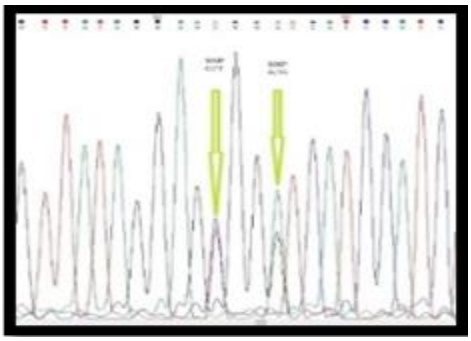
- **Equine genetic resources:** Conservation, propagation and improvement of equine genetic resources is continuing at the Campus with great impetus on maintaining the true to the type animals of Marwari breed. The Marwari animals are being bred for their body height and elegant look. At present the Campus has 51 Marwari horses with 8 superior studs. Recently breeding of Kathiawari animals has also been initiated at the Campus.

- **Establishment of nucleus herd of exotic donkeys:** Jennies and jacks of European breed (Poitou), imported from France in the year 1990, are being maintained for the improvement of indigenous donkeys and production of superior mules. The Campus has 32 Poitou animals at this time.
- **Indigenous donkey:** The Centre has initiated the establishment of nucleus heard of small grey and large white donkeys found in India for their conservation and improvement.
- **Equine sanctuary:** An *in-vivo* conservation programme in the form of developing an equine sanctuary at the Campus has been initiated by procuring Zanskari ponies from Zanskar valley of Jammu & Kashmir, and Manipuri ponies from Imphal, Manipur. At present the Campus is maintaining 19 Zanskari and 15 Manipuri ponies. Semen from the stallions of these breeds was cryopreserved for the first time and foals have been produced through artificial insemination using frozen semen. This feat is for the first of its kind in our country.

- **Development of databases:** In order to carry out performance analysis over years, the inventory, growth and reproduction databases for the Marwari, Kathiawari, Manipuri, Zanskari horses, and Poitou and Halari donkeys have been prepared for the period 1989 to till date. The pedigree, inbreeding coefficient, growth curve analysis and breeding parameters were derived.

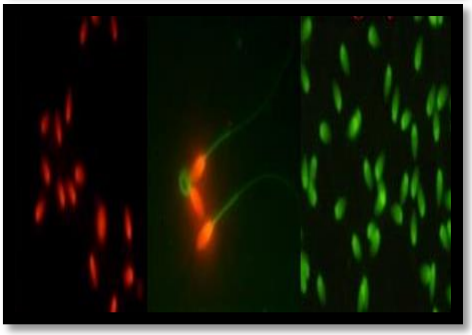


- **Marker assisted selection:** Endurance and fertility are the two most important traits identified for improvement in horses. In order to select the animals at an early age the SNP markers known to be associated with endurance and fertility were taken up and their polymorphism in indigenous horses was ascertained and the association study is in progress.

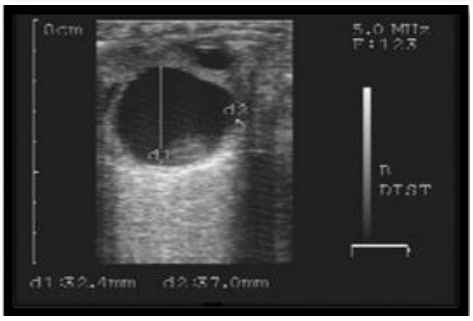


- **Semen cryopreservation and artificial insemination (AI):** In order to conserve the germplasm of indigenous equine breeds, the technique for cryopreservation of semen of Marwari stallions and donkeys has been standardized. The technique of artificial insemination using frozen semen for production of superior quality Marwari horses, superior mules and donkeys has been perfected. The pure germplasm of endangered indigenous breeds of horses is being conserved using this technology.

- **Seminology studies :** Various studies related to determine the quality of the stallion semen were developed and practiced routinely at the campus These functional tests will facilitate in choosing the right semen sample to be cryopreserved and hence enables to increase the fertility in an AI programme. Computer Assisted Semen Analyser (CASA) is also being used in assessing the quality of semen.

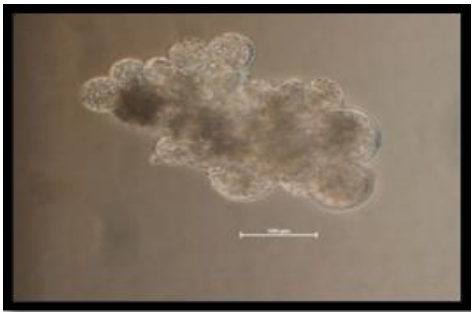


- **Pregnancy diagnosis :** An eCG based sandwich ELISA has been developed for detection of pregnancy between days 30 to 150 of gestation in mares. The kit is cost effective, horse specific and animal friendly. Pregnancy diagnosis as early as 10 days post-insemination has been achieved using ultra sonography in donkey and horse mares.



- **Embryo transfer in equines:** As a strategy for the multiplication and conservation of equine species embryo transfer techniques developed in equines. The technology of embryo transfer was standardized in equines and the embryo cryopreservation technique was also developed.

- **iSCNT for production of horse cloned embryos:** The intra and inter species somatic cell nuclear transfer (iSCNT) technique has been explored for the production of horse cloned embryos. The protocol for standardized and maturation of iSCNT embryos was attempted in different media. The inter-species embryos matured up to 32 cell stage and intra-species embryos matured up to 64 cell stage.



- **Utilization of animal energy with enhanced system efficiency:** Single animal drawn matching plough, seed drill (two furrows) and harness were designed for donkeys and mules and successfully used in performing various agricultural operations.
- **Sustainable utilization of mule power for chaffing operation:** The mules were successfully used for chaff cutting operation to reduce women drudgery. Average output capacity of chopped pearl millet straw in rotary mode chaff cutter was 660 kg h^{-1}. Deployment of mules for operating a chaff cutter in rotary mode of operation is a viable option for sustainable utilization of equine power during idle hours.
- **Utilization of equine dung for preparation of vermi-compost:** To overcome the problem of dung disposal, vermi-compost is being prepared using equine dung in readymade vermi-beds successfully and it is being applied in agricultural fields, lawns and plants.
- **Treatment of equine diseases:** Various formulations for the treatment of proud flesh, warts and sarcoid have been prepared and a patent has also been filed for the novel drug. Herbal medicine for habronema infection in horses and donkeys has also developed. A package of practices has been prepared for the management and treatment of colic in equines. Herbal disinfectant against *Rhodococcus equi* has also been developed. The Campus has a toll-free number for the farmers to consult the scientists for equine health and production issues.

Initiatives

- **Equine ecotourism:** A disconnect between general public and the equines was perceived by the analyses of equine census figures of last few decades of the country. In order to overcome this, the Equine Ecotourism has been initiated at the campus with creation of several new attractions like the Souvenir Shop Complex, Herbal Park, Desert Photo shoot Point, Information Centre and the Museum. The impact of this initiative has so far been excellent in terms of our efforts of sustaining the species *in situ* condition.

- **Country-Wide Network for genetic improvement of indigenous horses:** Mating of mare to a priced stallion is a matter of money in equine industry. The stallion or jack semen is being cryo -preserved only at Bikaner campus of ICAR-NRCE and it is available to only those equine owners who are bringing. their animals to this place. The artificial insemination and pregnancy diagnosis in mares is little different from that in the cattle and buffalo. The veterinary graduates across the country do not have enough practical exposure of the equine health and management practices. In order to address these issues, an initiative has been taken by the Centre to train the veterinary doctors of the country in equine breeding, health, reproduction and production. Also, a network for the supply of semen across the country has been initiated. In this direction, so far, 30 veterinary officers of 11 states trained in the country.

Extension programmes

The Campus is regularly organizing various programmes, health camps and exhibitions focused on doubling the livestock owners' income by addressing the issues of infertility, innovation, entrepreneurship development, skill development etc. in the *Mera Gaon Mera Gaurav*, Scheduled Caste Subplan, Animal Fairs and Institutional Celebrations.

S. C. Mehta

ICAR - National Research Centre on Equines, Equine Production Campus, Bikaner

Technological options

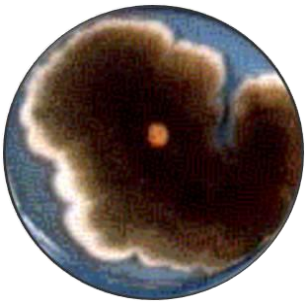
Bio-control potentials of microorganism of arid zone in managing plant pathogens

Arid soils are inhibited by a large variety of flora and fauna, some of which are beneficial to human beings, while the rest are enemies. Of the soil inhibiting microorganisms that are pathogenic to plants, include bacteria, actinomycetes, nematodes, fungi and some other microbes. Microbes naturally present in soil and root rhizosphere are not always harmful by causing diseases to plants but sometimes serve as biological control agents of various significantly important plant pathogens. Among the soil inhibiting antagonistic fungi like species of *Trichoderma, Gliocladium* and *Aspergillus* are widely used for control of diseases in various cultivated crops. Bacterial genera such as *Bacillus* and *Pseudomonas* may be the potential reservoirs of bio-control agents for effectively suppress soil inhibiting root pathogens. The mechanisms through which these bio agents operates is either by direct action against the pathogen i.e. antagonism which includes parasitism, antibiosis, competition and/or indirectly by reducing host susceptibility (host mediated interaction) and includes exudation, altered rhizosphere, induced resistance, hipovirulence, plant growth promoting rhizobia (PGPR), etc.

There has been large upsurge in interest in biological disease control recently, reflecting increasing environmental concern over pesticide use. This interest has been further stimulated by the occurrence of fungicide resistance in some pathogens, and for some soil-borne diseases due to lack of reliable chemical controls or resistant varieties. Studies were initiated to explore biocontrol potentials of microorganism in order to develop a cost effective and practical management strategy in augmenting disease control. Analysis of large number of soil samples collected from different parts of the region led to isolation of native bio-control agents viz., *Trichoderma harzianum, T. longibrachiatum*, *Aspergillus nidulans, A. versicolor*, *Penicillium oxalicum*, *Bacillus firmus*, *B. tequilensis* and *Streptomyces mexicanus* from different agricultural systems. These bio-control agents have proved their antagonistic ability in repeated laboratory tests. In the next step, information was required to be generated for their field efficacy on most commonly grown crops, trees and their effect on resident micro flora in order to ascertain whether any bio-agent has adverse effect on native organisms. Several physical, chemical, and biological factors affect the survival and functioning of bio-agents in the soil. Soil moisture stress

Penicillium oxalicum

Aspergillus nidulans



Aspergillus versicolor

and high temperature are the major abiotic factors that affect their performance in arid ecosystem. Inadequacy of soil organic matter further aggravates the problem as the bio-agents depend on organic matter for energy and growth. Microbial inoculation in soil also influences the activity of indigenous micro flora, ultimately having a bearing on their own survival. This is because the introduced biocontrol agents must adhere to the plant roots, compete for space and nutrients released through root exudation, and must be able to occupy the new niche in sufficient numbers so as to exert its effect on the host plant. Often, the native inhabitants of soil, which are better adapted to the environmental conditions, out compete the inoculated population. Development of effective native microbial inoculants thus requires the presence of multiple fitness traits that can facilitate its colonization and survival under harsh environmental conditions. An effort has been made to summarize the research carried out at the ICAR - Central Arid Zone Research Institute, Jodhpur for the last two decades to isolate, identify and investigate role of biocontrol potential of native microorganism in managing important plant pathogens.

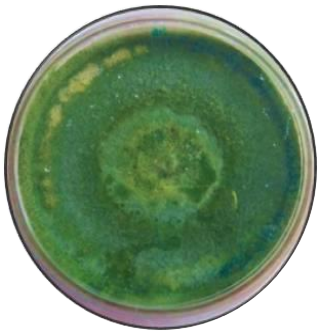
Fungal antagonists

Trichoderma

Among various fungal bio agents, *Trichoderma* is the most studied genus and widely used biocontrol agent (BCA) world over due to its wide spectrum activity. Several economically important plant diseases of crops are now effectively controlled by using *Trichoderma* based bio- fungicides like *Phytophthora* foot rot of betel vine, seedling rot of cardamom, stem rot of cauliflower, dry root rot of legumes and oil seeds, grey mould of chickpea, wilt of many crops, rhizome rot of ginger, root rot of groundnut, collar rot of lentil etc. *Trichoderma* as a bio control agent, acts antagonist to several pathogens. As soon as it finds a plant pathogenic flora and fauna, its mycelium quickly grows towards the pathogen, entangles it or curls around it and penetrates the pathogen by its haustoria / apisoria and cause lyses. The lyses results by extra cellular secretion of lytic enzymes by the bio-agents. The antagonist is known to release antibiotics like alkyl pyrones, isnitriles, polyketides, peptiabols, diketopiperaz, sesquiterpenes, steroids,etc. These antibiotics are harmful to pathogen and such mechanism is called antibiosis. Once *Trichoderma* is introduced into soil, it grows rapidly by consuming essential nutrients from the soil environment that other soil inhibiting organisms fail to compete with it and finally are killed due to competition and scarcity of food. Another mechanism of BCA by *Trichoderma* is induced resistance in plants. Species of *Trichoderma* are known to solubilize rock phosphate, metallic zinc, manganese, iron and copper, and also enhances the nitrogen use efficiency in plants. Because of these properties, the *Trichoderma* not only becomes a bio agent for disease control but also an agent which enhances the growth of plants by providing soil nutrition in soluble forms for absorption by the roots resulting in better health of plants. In arid region,

native heat tolerant strains of *Trichoderma* viz., *T. harzianum* and *T. longibrachiatum* have been isolated from arid soils. These isolates were found effective against pathogens like *Macrophomina phaseolina* causing charcoal root rot in legumes and oilseed, *Fusarium oxysporum* f. sp. *cumini* causing wilt of cumin and *Ganoderma* species causing basal stem rot mortality in many trees and shrubs in several studies conducted at CAZRI, respectively. Formulations of these strains are making available to the researchers and growers of the region.

Trichoderma harzianum



Trichoderma longibrachiatum

Bacterial antagonists

Bacillus

Bio-control using antagonistic endophytic and rhizosphere bacteria has been considered as an alternative strategy to agrochemicals, which are harmful to human health and the environment. Native heat tolerant strains of *Bacillus* viz*., B. firmus* and *B. tequilensis* have been isolated from arid soils. These isolates were found effective against soil borne plant pathogens particularly *Macrophomina phaseolina* and *Ganoderma* species causing root rot mortality in many crops and trees in arid region. Use of BCAs suffers an attractive alternative to manage *Ganoderma* induced diseases in Khejri (*Prosopis cineraria*) tree, without any negative impact on the environment. Therefore, efforts were made to isolate antagonistic bacterial isolates from the soil. Several soil samples were analysed and one bacterial isolate, AZ-11 was selected as potential antagonists against *G. lucidum* from arid soils. Taxonomic identity of this strain was ascertained using 16S rRNA in EzBioCloud. The strain showed over 99.7% similarity and was identified as *Bacillus tequilensis* strain AZ-11(MH304296). Several species of the genus *Bacillus* have been reported as potential BCAs. For instance, the bacterium *B. tequilensis* is reported to manage root knot nematode when co-inoculated with *Trichoderma harzianum.* Thus, this bacterium can have dual advantage in irrigated pockets where several vegetables suffer from root knot nematode. Incidentally, *B. tequilensis* is also known to solubilize zinc for increased yield of wheat and soybean. In arid region, one strain of *B. firmus* has also been reported as specific antagonist to *Macrophomina phaseolina* in earlier studies. Many species of *Bacillus* viz., *B. subtilis, B. cereus, B. pumilus* and *B. sphaericus* isolated from hot arid region having biocontrol potential against plant pathogenic fungi. Therefore, the isolated antagonistic bacterial strains will be potentially very useful and yield effective results in further field studies for management of this terrific pathogen. Success in establishing bacterium in arid soils depends on number of microorganisms present in soil, and on the quantity of inoculum introduced and its competitive

Bacillus firmus

Bacillus tequilensis

saprophytic ability. Species of *Bacillus* have characteristics particularly suited for studies on biological control: omnipresence in soils, high thermal tolerance, rapid growth in broth culture and ready formation of resistant spores. They are uniformly distributed through soil rather than concentrated in the plant rhizosphere.

Antagonistic actinomycetes

Streptomyces mexicanus

In addition to fungal and bacterial antagonists, there is ample scope of utilizing native strain of actinomycetes in biological control of soil borne plant pathogens in the region. Within actinomycetes, *Streptomyces* spp. have been investigated predominantly, mainly because of their dominance on, and the ease of isolation from, dilution plates and because of the commercial interest shown on the antibiotics produced by certain *Streptomyces* spp. Several bacteria actinomycetes and fungi inhibiting the growth of *Fusarium* spp. have been reported from soil of Rajasthan. In a laboratory study, twelve species of *Streptomyces* were evaluated against *Fusarium oxysporum* f. *sp. cumini* and *Ganoderma lucidum*. Maximum inhibition of *Fusarium* was observed with *S. fasciculus* and *S. phaeochromogenus.*

In case of *Ganoderma*, *Streptomyces mexicanus* was selected as potential antagonists. The foregoing reveals that even under harsh climate of Indian hot arid region some native bio control exists as temperature often reaches 55°C of top soil layer during summer period. Resting structures like chlamydospores and sclerotia of soil borne plant pathogens withstand this temperature but concurrently propagules of beneficial native microorganisms also survives in this condition. However, there is a need to improve their population to the extent these can fight well with plant pathogens. Our efforts to work out suitable food substrate for survival and multiplication of these BCAs have been achieved to a large extent. Amending soil with composts or suitable weed residues can also be an easy option for improving activity of beneficial microorganisms.

Ritu Mawar

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Knowledge Corner

Spineless cactus as a fodder crop for the arid regions of Gujarat

The unsustainable use of groundwater, low rainfall, land degradation, overgrazing etc. are the major concerns in arid regions where harsh climate and problematic soils are prevalent. With these challenges, the food security of a densely populated country such as India has to be compromised owing to low productivity of ruminants due to shortage of proper feed during dry seasons. As livestock is an important component of livelihood in the arid regions of India, small scale farmers find difficulties in cultivating their fodder crops in driest season of the year. Further, water scarcity in arid regions can negatively affect feed intake, digestion and body weight of the animals. As the climate change seems unavoidable, it is the call of the hour to find the alternative sustainable production systems in drier areas to meet the fodder demands and provide optimum animal nutrition especially during drought periods. Kachchh is one of the most

arid and dry districts of Gujarat with an extreme climatic environment. The prevalence of problematic soils such as saline soils, alkaline soils, water-deficit soils and compact soils add more challenges. The small-scale farmers of Kachchh seek for alternatives and supplements for fodder resources that could grow in these soils with minimum inputs and high productivity. Therefore, with the intervention of ICARDA and ICAR-CAZRI, RRS-Bhuj, cactus pear (*Opuntia ficus-indica*) was introduced in Kachchh district with the main objective of solving the problem of fodder unavailability and animal nutrition, especially during the driest seasons of the year.

Unlike other crops, cactus pear is a CAM (Crassulacean Acid Metabolism) plant that allows its high survival rate in harsh climate and offers high tolerance to water scarcity. The strong adaptability of cactus pear could be observed from its high survival rate in different types of soil. However, high soil salinity (generally greater than 50 mM NaCl) and water logging may hamper the growth of the cactus pear since its root system is very sensitive to anoxia conditions. The growth and quality of the fodder significantly improves with the ample supply of calcium and potassium. Cactus pear responds well to sunlight and the fruits do not grow on shaded cladodes because such conditions prevent accumulation of sufficient dry weight to support reproductive development. In terms of productivity, biomass generation by CAM plants such as cactus pear per unit of water is five to ten times greater than C_4 and C_3 plants. Its horizontal root system rarely penetrates deep into the soil and therefore remains within 30 cm of soil depth. It has a peculiar characteristic of producing numerous extra roots called “rain roots” during rainfall that hydrates the cactus more than the soil. Besides the high water use efficiency, the cactus pear possesses other adaptations that can conserve soil water. The thick waxy cuticle on its stems (5-30 µm) helps in preventing loss of water from the plants. Moreover, the number of stomata per unit leaf area is usually low for cactus pear (20-530 per square millimetre). The large volume of water-storage parenchyma contained in the stem acts a water reservoir for the chlorenchyma, where the CAM pathway initiates and photosynthesis process occurs.

From farmers’ point of view, cactus is an “easy to cultivate type” of crop as it is easily propagated through cladodes. The cost of cultivation will be highly minimized as it does not require frequent irrigation, fertilization, special instruments and labour. It also reduces the water intake rate of the cattle because of its high water content in the cladodes and enhances the milk quality and quantity (Fig. 1). The low water intake of the ruminants after the consumption of fresh cactus cladodes is attributed to high water content (more than 90 percent water) in the cactus pear and can serve as an emergency source of water in arid areas. The spineless cactus is palatable and digestible although it must be supplemented with other feed as cactus cladodes are poor in protein but rich in carbohydrates and calcium.

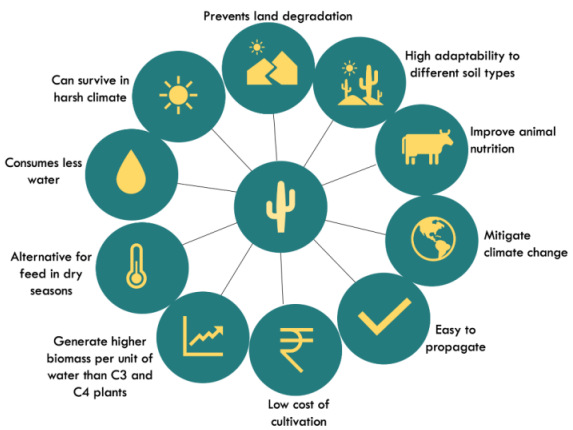

Fig.1. The multifaceted potential of cactus farming in arid regions (Source: Author)

In order to test the effect of limited irrigation on cactus pear growth, five accessions were tested namely seedless Santa Margherita Belice, Algerian, seedless Roccapalumba, Morado and CAZRI Botanical Garden. Among these, only Algerian showed higher survival rate in limited irrigated treatment than the rainfed condition. This depicts that cactus pear can survive without irrigation but provision of limited irrigation during the driest seasons can effectively increase the crop growth and yield. Cactus pear can be considered as a miracle crop through which the problem of livestock feed and conservation of soil and water can be successfully carried out. It needs to be studied and understood to explore its potential in arid regions to mitigate climate change and desertification. The succulence and nutritive value of cactus pear could provide attractive platforms for the farmers. It is the high time to explore the alternatives and unconventional form of resources in order to feed the growing population and cactus pear (*Opuntia ficus-indica*) might help us out in some possible ways.

Anandkumar Naorem

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Events

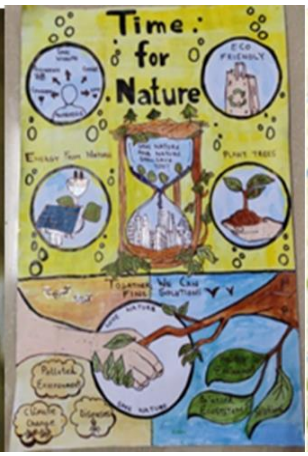
National Science Day

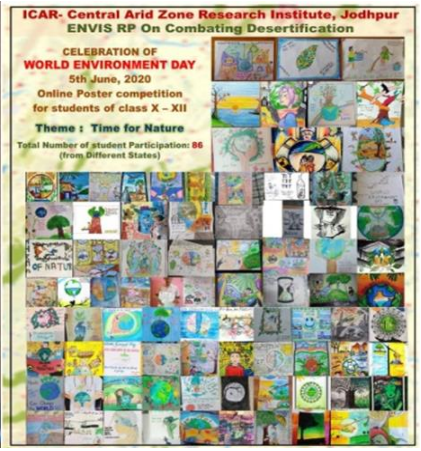
Celebrated National Science Day on 28th February, 2020 on the theme *"Women in Science"*. Dr. Pankaj Bhardwaj, Additional Professor, AIIMS, Jodhpur was the Guest of Honour who delivered a special lecture on *'Corona virus'*: present status in the world, causes and the precautions. Dr. P.C. Moharana, Coordinator, ENVIS RP briefed about ENVIS activities while Dr. C.B. Pandey, PS & Head, Division of Natural Resources, CAZRI, spoke about present scenario of women's involvement in various fields of science. The Chief Guest, Dr. O.P.Yadav Director, ICAR-CAZRI gave his views on the women's status and motivated them to think of imaginations which has no limits. A speech competition on the theme *'Innovative ideas from young brains'* was conducted for the college students. The programme was attended by Scientists, Technical officers, Officials from Administration and the students & faculties from Lucky Institute of Professional Studies, Jodhpur. Dr. Vipin Chaudhary, PS & Member ENVIS, coordinated the programme.



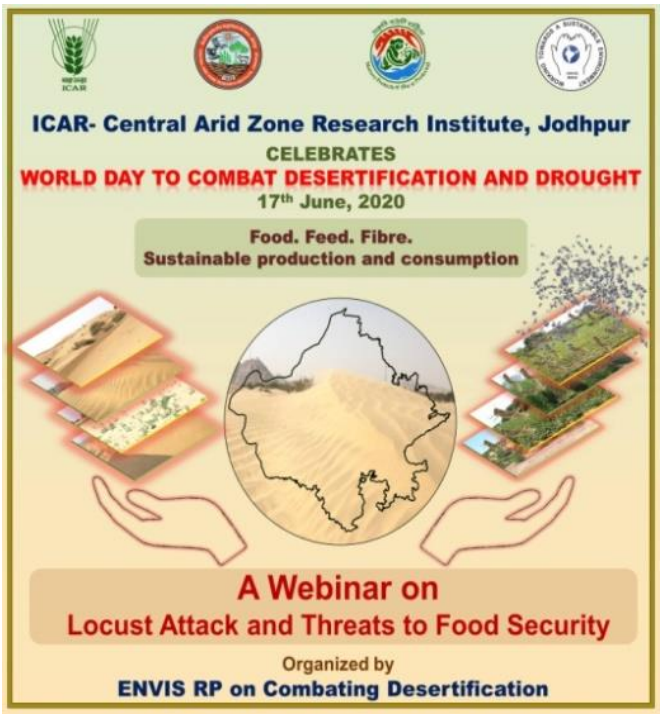
World Environment Day

This year due to COVID-19, World Environment Day on 5th June, 2020 was celebrated by organizing an online poster competition on the theme *"Time for Nature"* for school children (10th - 12th class). Detailed schedule was widely circulated to schools on their respective e-mail Ids and social media platform. 86 students from various schools of 9 states (Rajasthan, Haryana, Uttar Pradesh, Goa, Punjab, Gujarat, Bihar, Delhi and Odisha) participated. E-certificates were sent to the winners as well as certification of participation to all the participants.

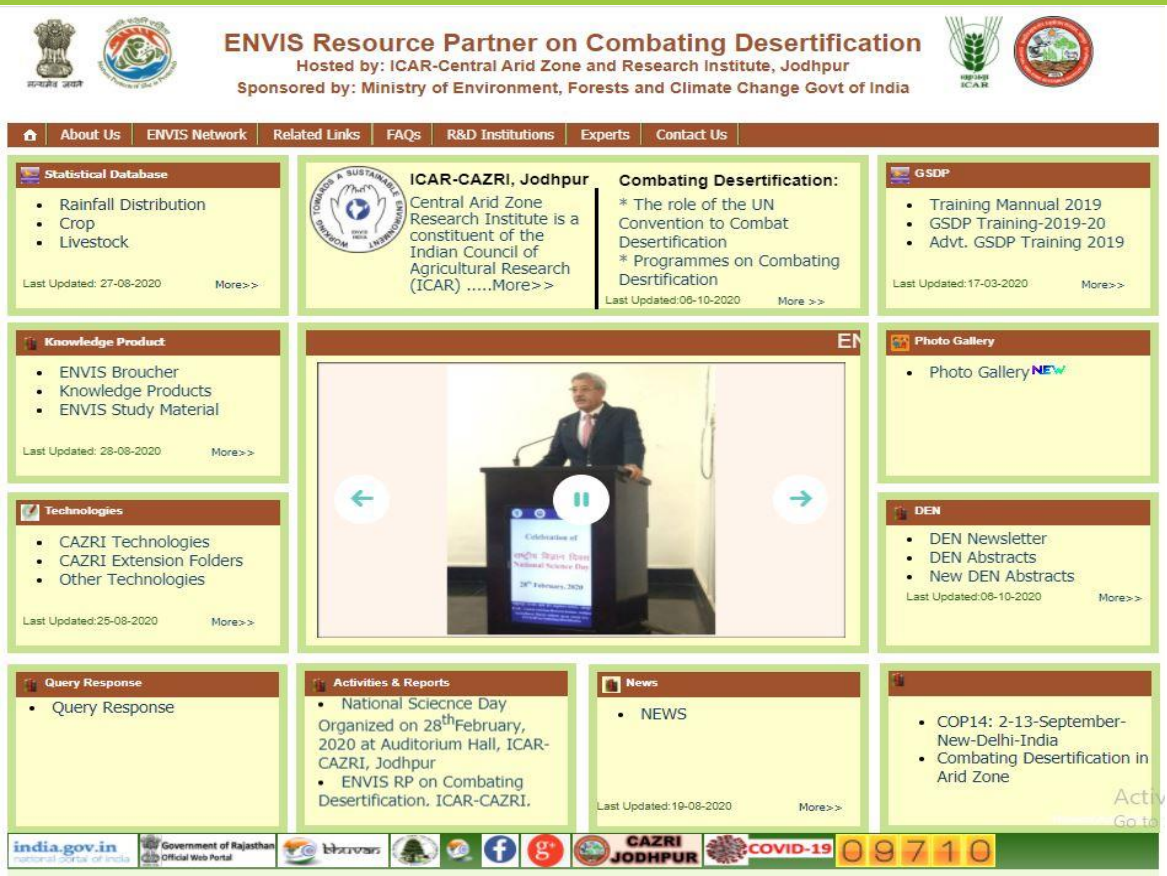




World Day to Combat Desertification and Drought



A webinar was organized on 17th June, 2020 on the occasion of World Day to Combat Desertification and Drought on the theme "*Food.Feed.Fibre*. *Sustainable production and consumption"*. Dr. O.P. Yadav, Director, ICAR-CAZRI, chaired the event. Dr. R.S. Tripathi, Coordinator, (AINP, VPM) introduced the Guest Speaker, Dr. K.L. Gurjar, Dy. Director, Plant protection, Directorate of Plant Protection Quarantine & Storage (Govt. of India) who spoke about *"Locust attack and threats to food security".* He elaborated on the occurrences, life cycle, recent threats and summary of locust control in Rajasthan, Madhya Pradesh, Gujarat, Punjab, UP and Maharashtra states followed by various operations made to control their spread in the scheduled desert area in India. Dr. O.P. Yadav highlighted theimportance of this day and suggested that since the magnitude of the locust problem has increased, there is a need to explore new avenues to control and provide solutions to the farmers. Dr. P.C. Moharana, Coordinator, ENVIS informed about the recent activities of the centre. Dr. Vipin Choudhary, Member, ENVIS Centre proposed the vote of thanks. The event was attended by 40 participants.



Conferences

DATE	TOPIC	ORGANIZATION	PLACE
National			
6-7th February, 2020	National Conference on "Recent Trends in Environmental Pollution and Disaster Risk Reduction (RTEPDRR)".	Department of Environmental Science and Engineering (ESE), IIT(ISM) Dhanbad in collaboration with FICCI, New Delhi	FICCI, Federation House, Tansen Marg, New Delhi
21st February, 2020	National Conference on Biodiversity, Ecosystem & Climate Change - NCBECC	Hillgrove Research Pvt. Ltd., Coimbatore & Symbiosis Law School, Pune	Ooty, Tamil Nadu, India
12-13th March, 2020	National Conference on Climate Change NCCC-2020	Center of Excellence in Environment, Climate Change and Public Health, Utkal University	Bhubaneswar, Odisha, India
International			
6-7th February, 2020	International Conference on Biodiversity Conservation and Management	World Academy of Science, Engineering and Technology	Mumbai, India
20th March, 2020	IV. International Conference on Ecology, Ecosystems and Climate Change	BILSAS (Science, Art, Sport Productions).	Nippon Meeting Halls Istanbul
16-19th March, 2020	The International Conference on Water Resources in Arid Areas	Water Research Center, Sultan Qaboos University	Oman, Muscat