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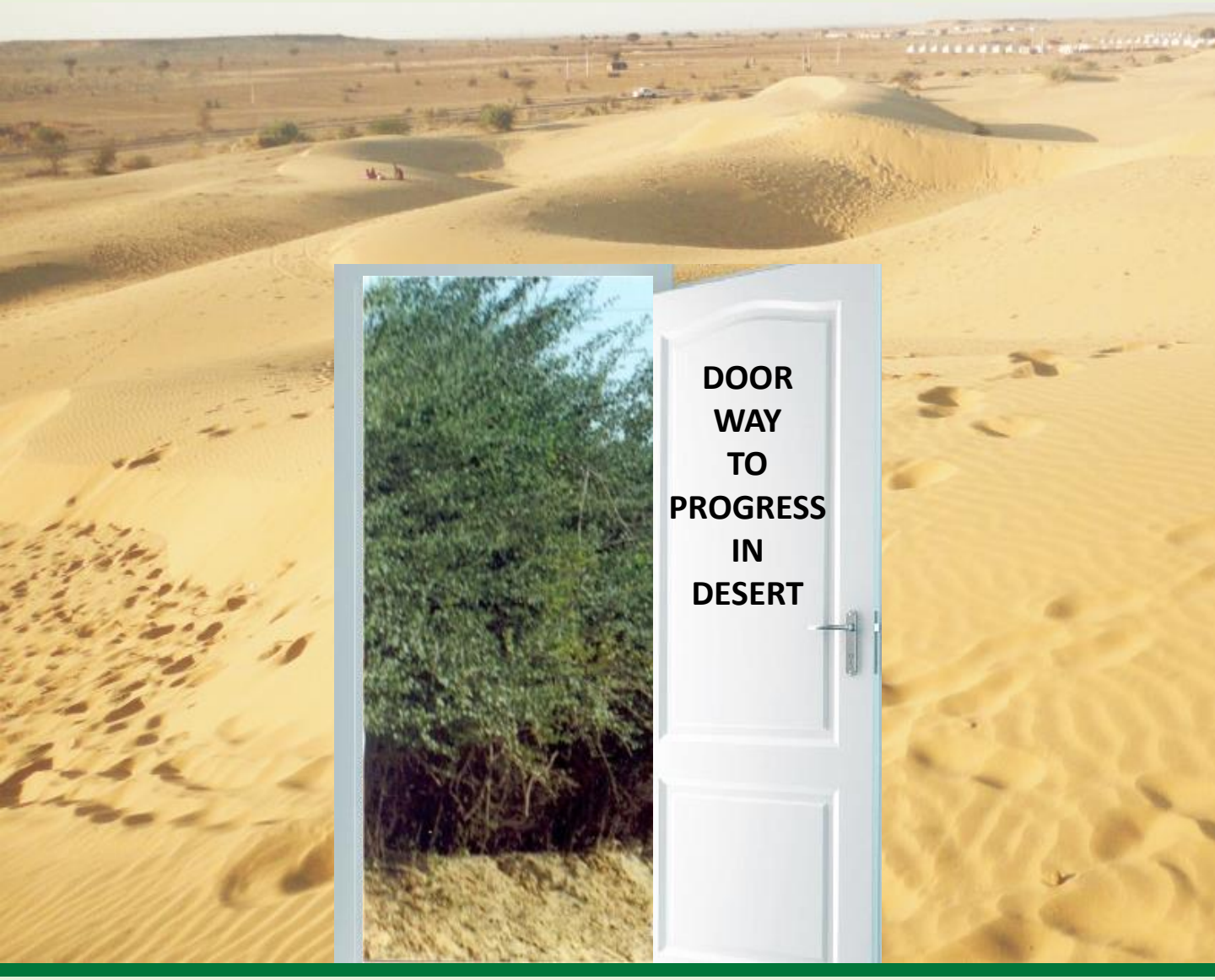
DESERT ENVIRONMENT NEWSLETTER

ENVIS Centre on Combating Desertification
ICAR-CAZRI

In this issue :



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From the desk of chairman

Dear Readers,

Wind erosion is an active and dominant land degradation process in the 20.8 m ha desert areas of Rajasthan resulting in loss of nutrient rich soils, decrease in crop productivity and many forms of aeolian hazards. At present, about 14.84 m ha area of Rajasthan is still affected by wind erosion driven processes. Over the ages, there have been research efforts along with indigenous knowledge to reduce the menace of wind erosion. Shelterbelt plantations are one such technology involving longitudinal vegetative barriers of tree/shrub/bushes to minimize such adverse effects in sandy areas. Depending on the magnitude of wind erosion hazard, CAZRI's recommendation of five-row or three-row shelterbelt models has been quite effective. Also the live fence and brushwood fences have been used as an integral component of traditional farming systems of this region. The planting of indigenous trees and shrubs based on their protective roles in such bio-fences also provides ecosystem services like continuous supply of fodder and fuel and also role in improving micro-climatic conditions.

The present issue mentions various aspects of indigenous plant species having ecological, economical, and aesthetic value used as live fence and working, designing of shelterbelts that have been implemented and serve as a key role in improving desert environment of western Rajasthan.

I wish the information provided in this issue of DEN will be beneficial to academicians, researchers, other stakeholders and farmers.

O.P. Yadav
Director, ICAR-CAZRI

Address for Correspondence
Dr. P.C. Moharana
ENVIS Coordinator
ICAR - Central Arid Zone Research Institute
Jodhpur 342003, INDIA

Phone
+91 291 2786931

Visit us at
http://www.cazrienvis.nic.in

Email at
cazri-env@nic.in

Editors: Dr. O.P. Yadav, Dr. P.C. Moharana
Dr. J.P. Singh and Dr. Vipin Choudhary

Know Your Desert

Shelterbelts to Combat Sand Spread and Protect Crop Lands

Planting trees around habitation and along roadsides to provide shelter and shade to human being and livestock is as old as the history of mankind. The noble work done on plantation by various kingdoms in India has been well documented. However, the approach of systematic plantation to improve climatic conditions and protection of agricultural land and crops has emerged in past few decades only. Shelterbelt plantations have been widely adopted in recent years in regions of China, Australia, Japan, and New Zealand. Recently, the motivational message (*Har Med Par Ped*) and a big tree plantation campaign initiated by Indian Council of Agricultural Research (ICAR) on 16th July 2021 was a big inspiration for all the countrymen to realise the importance of boundary plantations for improving climatic conditions, providing shelter to living beings and acting as a wind break for protection of agricultural land and crops from high wind speeds.

Windbreaks vs Shelterbelts

Windbreaks are structures that control the flow of air and reduce the wind speed. They protect the soil against wind erosion by reducing wind speed by 60 to 80 percent especially when the soil is not protected by vegetation cover. Shelterbelts are rows of trees and or shrubs erected to protect crops against wind. Wind breaks or shelterbelts are commonly used to protect the adjacent areas from adverse effect of winds. Such plantations are designed for useful functions like reducing wind erosion, protecting growing plants (crops and fodder), providing shade to humans and a variety of other environmental benefits. Shelterbelts play an important role in preventing soil erosion, controlling desert spread, improving irrigation efficiency, and increase crop yield by 10-15 percent by providing shield to soil surface.

Benefits of Shelterbelts

The beneficial effects of shelterbelts are more clearly seen in dry areas. The main purpose of installing a shelterbelt is to filter and break the force of wind. The desired permeability can be achieved by carefully selecting the suitable species of trees and shrubs. Permeable shelterbelts and windbreaks, which allow some part of the wind to pass through, are most suitable. Wind breaks and shelterbelts have the following advantages:

- Preventing soil erosion by reducing wind speed
- Protect field crops from the effects of hot air by shielding the leeward areas
- Reducing evaporation from the field
- Providing fuel, fodder, wood and other necessities
- Improvement in microclimatic condition
- Demarcation of boundaries and fencing

Working of shelterbelts

Shelterbelts prevent wind erosion by blocking the wind. As air passes near the shelterbelts, some of it expands around the end of the shelterbelts, some passes through the shelterbelts and most of it rises to the top of the belt. Air pressure builds up from the windward side and decreases on the leeward side. This pressure determines how much wind speed get decreases. Even a slight decrease in wind speed can significantly reduce soil erosion. Reducing the wind speed by half can reduce the rate of erosion up to 1/8.

Designing of shelterbelt

Shelterbelts usually consist of several rows of trees and shrubs. The shrubs are planted in the outer rows and tall trees in the inner. The first step in designing a shelterbelt is to understand its purpose because the shelterbelts can also have a detrimental effect on agricultural productivity. The elements that should be considered when designing a wind barrier are height, density, location, number of rows and the plant species. The shelterbelt's efficiency can also be improved by paying attention to its length, orientation and continuity.

Height and length: The length of the wind break combined with its height determines the extent of the protection provided to the soil against wind erosion. Maximizing the height of a windbreak is important, as its height will determine the area over which the windbreak has a positive effect. In order to counter the wind direction, the height of the wind break needs to be high, so that the speed of breaking of the wind is faster. Longer trees are more effective than shorter blockers. A wind break protects an area from 2 to 10 times its height. This means that windbreaks up to 5 meters high can protect an area up to 50 meters from its planting point against wind erosion. A 10-11 meters long windbreak, when facing a wind speed of 45-50 km h^{-1}, is reduced to 20-30 km h^{-1} towards the wind direction and 10 km h^{-1} towards the leeward side. For good protection, the length of a wind break should be up to ten times of its height.

Density and continuousness: The density of the shelterbelt can affect the extent and level of shelter provided. It can be managed by the selection of plant species, the spread of the tree species and total number of rows. To achieve an ideal density, shelterbelts should be established using shrubs and ground cover species as well as tall species. Medium density shelterbelts with a density of about 40-60% should be preferred for the design. The gaps between plants in a shelterbelt will act like wind tunnels and concentrate the force of the wind through a small area. Hence continuity in the structure of shelterbelt is essential.

Design and orientation: Multiple rows with uniform growth of plants are more effective for shelterbelt plantations. An effective windproof design often consists of 2 to 4 rows of shrub species placed on the outer rows of a shelterbelt along with tall tree species in the middle. The ICAR-Central Arid Zone Research Institute (CAZRI), Jodhpur has recommended that in the areas where wind speed does not exceed 20 km h^{-1}, the shelterbelt may be raised by 3 to 5 rows, but in some cases even up to 7 rows can also be raised by maintaining the row spacing as 4 meters. Single row plantations may be effective only if they are established using a species that has a uniform foliage density from ground level to the top of the shelterbelt. One or two row shelterbelts can also be effective and economical if they are well designed with suitable species. Shelterbelts are often erected in several directions in L, U or E shape. Rows of trees and shrubs planted perpendicular to the wind direction is most effective. This reduces the wind speed on the leeward side by 60-80 percent. Reducing wind speed reduces evaporation losses and makes more water available to crops.

Management and care: Keeping a shelterbelt highly effective may require implementing practices such as animal control, pruning and pest management. Newly established shelterbelts are generally the most vulnerable, as they are most susceptible to grazing by animals. Both domestic and wild animals can damage the shelterbelt. Therefore, they should be observed regularly. Dead plants should be replaced as soon as possible to maintain the uniform height and density of the shelterbelt, as it becomes very difficult to establish new plants in an older shelterbelt because of shading and water competition by older plants.

Plant spacing within the shelterbelt: When deciding the spacing between plants, the time taken for the plants to reach the desired density level and the size of the selected species should be included. Medium to tall trees are usually planted at 3-4 meter. The larger bushes can be spaced at 2.5-4 meter apart and smaller bushes generally 1.5-2.5 meter apart.

Species selection: The selection of plant species also plays an important role as a wind barrier. The following points should be taken into account while selecting the plant species:

- Native species may be preferred as they have high survival and establishment rates
- Tall and fast growing species should be used for one or more rows
- The species should have dense foliage and complement to achieve the same height and density as that of other selected species
- Use of economically beneficial species that provide firewood, fence posts or wood for commercial value may be desired
- Species competing for soil moisture and crop yield should be avoided
- Shrubs giving other useful products can also be included

Suitable species for shelterbelts:

Five row shelterbelt	Middle row	*Dalbergia sissoo*, *Tamarindus indica*, *Tecomella undulata, Prosopis cineraria*, *Azadirachta indica*, *Eucalyptus* spp. etc.
	Flank row	*Moringa oleifera*, *Cassia siamea, Acacia senegal*, *Casuarina equisetifolia* etc.
	Outer row	*Capparis decidua*, *Calligonum polygonoides*, *Ziziphus* spp., *Acacia jacquemontii* etc.
Three row shelterbelt	Middle row	*Dalbergia sissoo, Tecomella undulata, Tamarindus indica, Prosopis cineraria, Azadirachta indica, Eucalyptus* spp. etc.
	Outer row	*Capparis decidua, Calligonum polygonoides, Acacia jacquemontii, Ziziphus* spp. etc.
Single row shelterbelt	Single row	*Dalbergia sissoo, Casuarina equisetifolia*, *Tamarix* spp., *Parkinsonia aculeata* etc.

Structural Management: The overall structure of a shelterbelt determines its effectiveness. Therefore, the ideal height and density should be taken into account for the structural management of the shelterbelt. As the trees grow, their competition with the crops of the surrounding areas also changes. The effect of tree crown density and position on surrounding spacing changes over time. A high-density shelterbelt may not cover as large an area as a medium-density shelterbelt can. The original design can be regained through pruning some plants. The low-density shelterbelts can be improved by harvesting tree trunks to achieve regrowth.

Shelterbelt *of Azadirachta indica* protecting cotton crop

Shelterbelt of *Dalbergia sissoo* protecting wheat crop

M.L. Soni, N.D. Yadava, Birbal, Sheetal, K.R., J.P. Singh* and Subbulakshmi, V.
ICAR-Central Arid Zone Research Institute, Regional Research Station, Bikaner
* ICAR-Central Arid Zone Research Institute, Jodhpur

Live fence: A Vital Component of Traditional Farming Systems in Hot arid Regions

Since ages live fence and brushwood fence are integral component of traditional farming system of arid regions in India to delineate the boundary and protect the crops from stray and wild animals. In western Rajasthan, use of brushwood fences is a common practice for protecting the home yards, crop fields, and grassland/pastures by utilizing thorny branches of indigenous shrubs and trees. The thorny branches of Bordi (*Ziziphus nummularia*) after threshing the leaves locally known as Pala are the important material for brushwood fencing. Practice of using thorny branches of *Z. nummularia* for fencing purpose has been declining during last two decades because of scarcity of material for fencing due to decreasing density of shrub along with requirement of periodical (1-2 year) repairing and replacement of such fences.

Live fences are one of the important components of the traditional farming system in the region. A number of shrubs/tree species are used in north western hot arid region for live fence (Table 1).

Table 1 Major species used for live fence in north western hot arid region.

S.N.	Common Name	Botanical Name	Family
1.	Arni	*Clerodendrum phlomidis*	Verbenaceae
2.	Hingot	*Balanites aegyptiaca*	Balanitaceae
3.	Bawli	*Acacia jacquemontii*	Mimosaceae
4	Gangeran	*Grewia tenax*	Tiliaceae
5	Thor	*Euphorbia caducifolia*	Euphorbiaceae
6	Kankera	*Maytenus emarginatus*	Celastraceae
7	Hathathor	*Opuntia elatior*	Cactaceae
8.	Kheep	*Leptadenia pyrotechnica*	Asclepiadaceae
9.	Phog	*Calligonum polygonoides*	Polygonaceae
10.	Mural	*Lycium barbarum*	Solanaceae
11.	Jinjva	*Mimosa hamata*	Mimosaceae

Farmers select the species based on their protective roles along with economic usages as a life support system for fodder and fuel wood supply during prolonged drought and famines. Earlier in Bikaner district, the Phog (*Calligonum polygonoides*) was the most common species used as live fence material in rainfed areas. Now, Kheep (*Leptadenia pyrotechnica*) has replaced the Phog, due to indiscriminate cutting of Phog for fuel wood supply. In Nokha tehsil of Bikaner District, Arni (*Clerodendrum phlomidis*) is widely used as live fence. In this area, Kankera (*Maytenus emarginatus*) is found to be widely used for live fence. In Pugal tehsil of Bikaner, Bawli (*Acacia jacquemontii*) is an important live fence species. Other species like Mural (*Lycium barbarum*), Jinjva (*Mimosa hamata*), Gangeran (*Grewia tenax*), Gundi, (*Cordia gharaf*), Hathathor (*Opuntia elatior*), Hingot (*Balanites aegyptiaca*), etc are also used as live fence. Easy establishment, tolerance to biotic and abiotic stresses, wider adaptability, quick regeneration capacity, high persistence, fast growth, dense canopy, biotic interaction with other plant community, economics and social acceptability are major determinants for choice of species for live fence.

Live fence of Phog (*Calligonum polygonoides*)

Live fence of Arni (*Clerodendrum phlomidis*)

Live fence of Bawli (*Acacia jacquemontii*)

Live fence of Hathathor (*Opuntia elatior*)

Significances of live fence

Apart from delineation of the boundary and protective functions, the live fence provides many others benefits, which vary according to species, height, density and management practices. Some of important significances of live fence are:

(A). Ecological significances

Microclimate: Live fence system in the crop lands modify microclimate of the field. These fences moderate the extreme temperatures and effects of high wind velocity and thus support the plants in area protected. For example, the shrub like Bordi (*Ziziphus nummularia*) has a spreading canopy; it brings about a change in the micro-climate.

Soil fertility: Live fence enrich the soils through addition of organic matter and plant nutrients. Nutrient absorption and utilization of space by live fence is compensated by transferring the biomass accumulated in fencing materials in the form of green manure. Moreover, the competition for water and nutrients does exist in live fences with crops but it varies according to species. Traditionally, the foliage from the live fences also has been used by the farmers as mulch in crop fields. For example, Phog (*C. polygonoides*) is used as mulch in the field by farmers in Bikaner region. The *in-situ* green manuring of volunteer grown *C. polygonoides* plants in groundnut crop is practiced and supposed to increase fertility of soil and yields of crops.

Biodiversity Conservation: Live fence has vital role in conservation and promotion of both floral and faunal diversity in the region. Moderation of microclimate, improvement in soil properties along with protection from herbivorous, the live fence augments phyto-diversity. It has been

observed that live fence had more plant communities compared to mechanical fencing. Particularly in grassland/pastures, many grass species find the shelter in hedges amongst the spiny bushes. In western Rajasthan, climbing species especially members of plant families like Asclepiadaceae, Convolvulaceae, Cucurbitaceae need the support of live fences for their survival. Spiny shrubs used as live fence protects many species of grasses. Live fences as mini-ecosystem also provide both shelter and food to wild fauna. Many of the shrubs used in live fences are the good source of bee forage.

(B). Economic Value

Food: The flower buds of Phog (*C. polygonoides*), unripe fruits of Kheep (*Leptadenia pyrotechnica*), fruits of Kair (*Capparis decidua*) and Bordi (*Z. nummularia*) are nutritious, and used as food, and have demand in market.

Fodder: Many of the species used as live fence provide nutritious fodder/browse to livestock. The foliage of Phog (*C. polygonoides*) is harvested, stored and used as fodder in normal and drought years. The species like Arni (*C. phlomidis*) used to feed camel, sheep and goats in times of drought.

Medicine: The species like Arni (*Clerodendrum phlomidis*), Hingot (*Balanites aegyptiaca*), Kankera (*Maytenus emarginatus*), Kheep (*L. pyrotechnica*), Kair (*C. decidua*) etc posses medicinal value and can be exploited for supplying the raw material to the pharmaceutical.

Gum: Bawli (*A. jacquemontii*) provides high quality edible gum which has medicinal value and fetches good price in the local market.

Ropes, cordage and baskets: Kheep (*L. pyrotechnica*) provides fiber and used in making ropes. The branches of Bawli (*A. jacquemontii*) are used for making baskets in tribal and rural areas. The potential of these species may be exploited through establishing small cottage industries in rural areas.

Thatching Materials: Kheep (*L. pyrotechnica*), Aak (*Calatropis. procera*), Phog (*C. polygonoides*) etc. are widely used as a thatching and construction material of huts in western Rajasthan.

(C). Aesthetic Value

Live fence improves natural beauty of the countryside and it requires minimal maintenance with low cost. The presence of live fence around a dwelling or livestock pens can shade the structure from the direct sunrays. Phog (*Calligonum polygonoides*), Arnni (*Clerodendrum phlomidis*) Nagphani (*Opuntia* spp.), Thor (*Euphorbia caducifolia*) Kankera (*Maytenus emarginatus*), Gangeran (*Grewia tenax*), Gondi (*Cordia gharaf*) etc serve this purpose.

Live fence consisting of indigenous plant species is a vital component of traditional farming system. The system effectively protects the crops against stray and wild animals, high wind velocity and also checks soil erosion. Apart from protective function, live hedge can play a vital role in improving the quality of life to small farmers by providing variety of economic products e.g. food, fodder, fibre, medicine, gum etc., and enhancing the sustainability of ecosystem through promoting biodiversity and improving soil health.

V.S. Rathore and J.P. Singh*
ICAR-Central Arid Zone Research Institute, Regional Research Station, Bikaner
*ICAR-Central Arid Zone Research Institute, Jodhpur

Know Your Desert Plant

Barleria prionitis – A Useful Live Fence Species in Arid Region

The genus *Barleria* belongs to family Acanthaceae and it was dealt by Linnaeus on the basis of specimens collected from India. It is a pantropical but predominantly an Old World genus, with its greatest centre of species diversity in tropical East Africa, followed by South Africa and Asia. It is the third largest genus in the family Acanthaceae with 300 species. Out of these, 29 species, one subspecies and six varieties occur in India. *Barleria prionitis* L. locally known as Bajardanti is one of the important species of the arid region. Two varieties of *Barleria prionitis* reported from Rajasthan i.e. *B*. *prionitis* L. var. *dicantha* Blatt. & Hallb. and *B. prionitis* L. *var. prionitis. B. prionitis* var. *prionitis* has 4-4.5 cm long corolla and corolla tube is shorter, however, variety *B*. *prionitis* var. *dicantha* has long corolla tube up to 6 cm long, lower lobe up to 3 cm long and total corolla length is 6 cm.

Distribution: *Barleria prionitis* is commonly found in tropical Africa, tropical Asia include India, Malaysia, Pakistan, Philippines, Sri Lanka and in Yemen. It is distributed throughout India include Andaman & Nicobar Islands, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Daman & Diu, Goa, Gujarat, Jharkhand, Karnataka, Kerala, Lakshdeep Islands, Madhya Pradesh, Maharashtra, Orissa, Puducherry, Rajasthan, Tamil nadu, Uttarakhand, Uttar Pradesh and West Bengal and commonly grown in gardens as a hedge plant.

Taxonomic characters: : It is a perennial shrub, erect, up to 1.1 m high, much branched, armed. Stems 4-angled, glabrous; thorns simple, 6 or more per node, 1-3 cm long, whitish. Leaves elliptic, 3-11 × 1.4-3.5 cm, attenuate at base, ciliate at margins, cuspidate at apex; lateral veins 3-5 pairs; petioles 0.5-2.5 cm long. Flowers sessile, often solitary in lower axils, becoming spicate above, rarely in simple dichasial cymes, up to 6 cm long; bracts linear-lanceolate, up to 2 cm long, cuspidate at apex. Outer sepals linear-lanceolate, subequal, up to 2.2 cm long, cuspidate at apex, appressed-hairy inside; inner sepals linear-lanceolate, up to 1.5 cm long, cuspidate at apex. Corolla bilipped (4⁄1), pubescent outside, pale to golden yellow; tube up to 4 cm long, swollen, curved and glabrous at base. Fertile stamens 2, exserted; filaments up to 3 cm long, glandular-pubescent at base, yellowish; anthers c. 5 mm long, yellow; sterile stamens 2, up to 2 mm long; anthers c. 1 mm long; staminode absent. Ovary ovoid, up to 4 mm long, glabrous; style terete, up to 3.5 cm long, hirsute at base; stigma linear, up to 1 mm long, sticky, pinkish. Capsules ovoid, up to 2 cm long, compressed, 2-seeded. Seeds ovoid, up to 9 mm long, sub-cordate at base.

Barleria prionitis* var. *prionitis

Flower close-up

Barleria prionitis* var.*dicantha

Flower close-up

Barleria prionitis* var. *prionitis

Leaf & spine

Barleria prionitis* var.*dicantha

Leaf & spine

Hedge of *Barleria prionitis* developed at office premises in Botanical Survey of India, Jodhpur

Economic importance: *B. prionitis* is a multi-use species and can be very well utilized as live fence in the garden. It develops easily, a low cost fence and also having ornamental and medicinal value. Further, presence of thorns/spines, strong soil binding roots and profuse branching are the important characteristics of its live fence. It is also a well known, ayurvedic under- shrub and its plant parts (root, stem, leaf, bark, flower, seeds) are used to cure toothache, catarrhal infections, whooping cough, inflammations, glandular swellings, urinary infection, jaundice, fever, gastrointestinal disorders etc.

C.S. Purohit and *V. Maina

Botanical Survey of India, Andaman & Nicobar Regional Centre, Port Blair

*Ex Botanical Survey of India, Arid Zone Regional Centre, Jodhpur

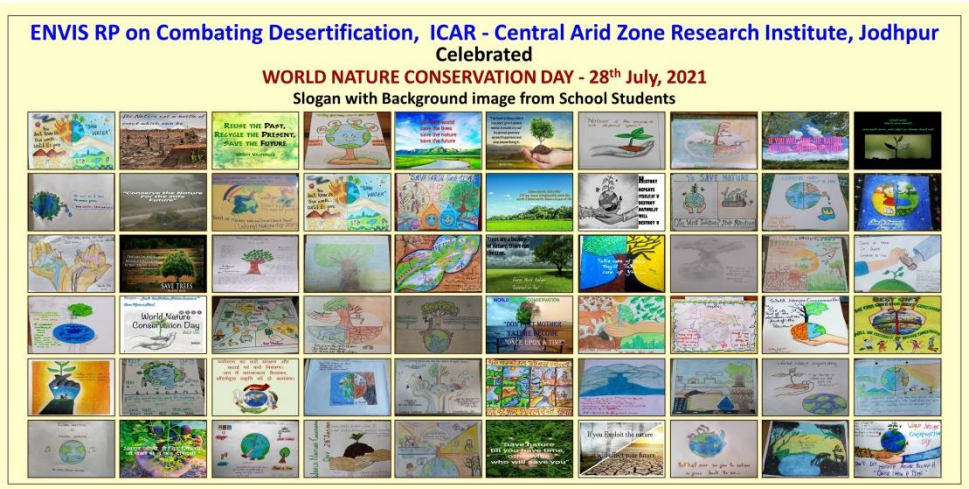
ENVIS Activities

International Plastic Bag Free Day

ENVIS-CAZRI celebrated International Plastic Day on July 03, 2021 by releasing a poster on the hazardous effect of plastic on environment and living organism.

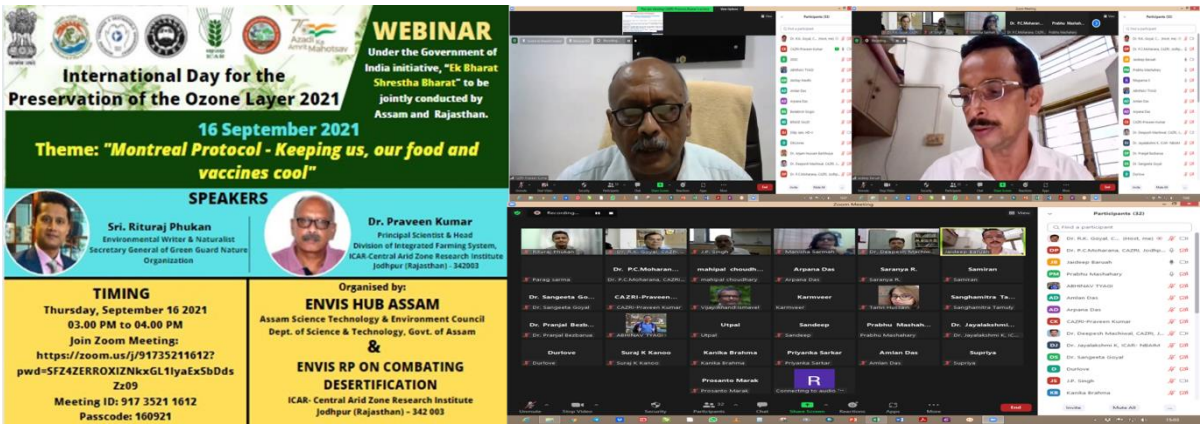
World Nature Conservation Day, 2021

Celebrated the World Nature Conservation Day on July 28, 2021 by conducting a Slogan competition for school children of class VIII – XII of Jodhpur district. A total of 78 students from different schools participated in this competition. E-certificates were sent to the winners as well as certification of participation to all the participants. The results were also uploaded on the ENVIS website.



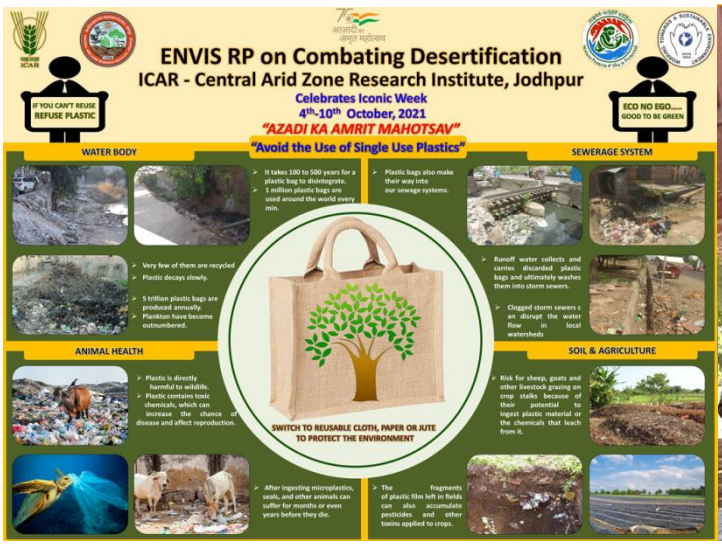
World Ozone Day

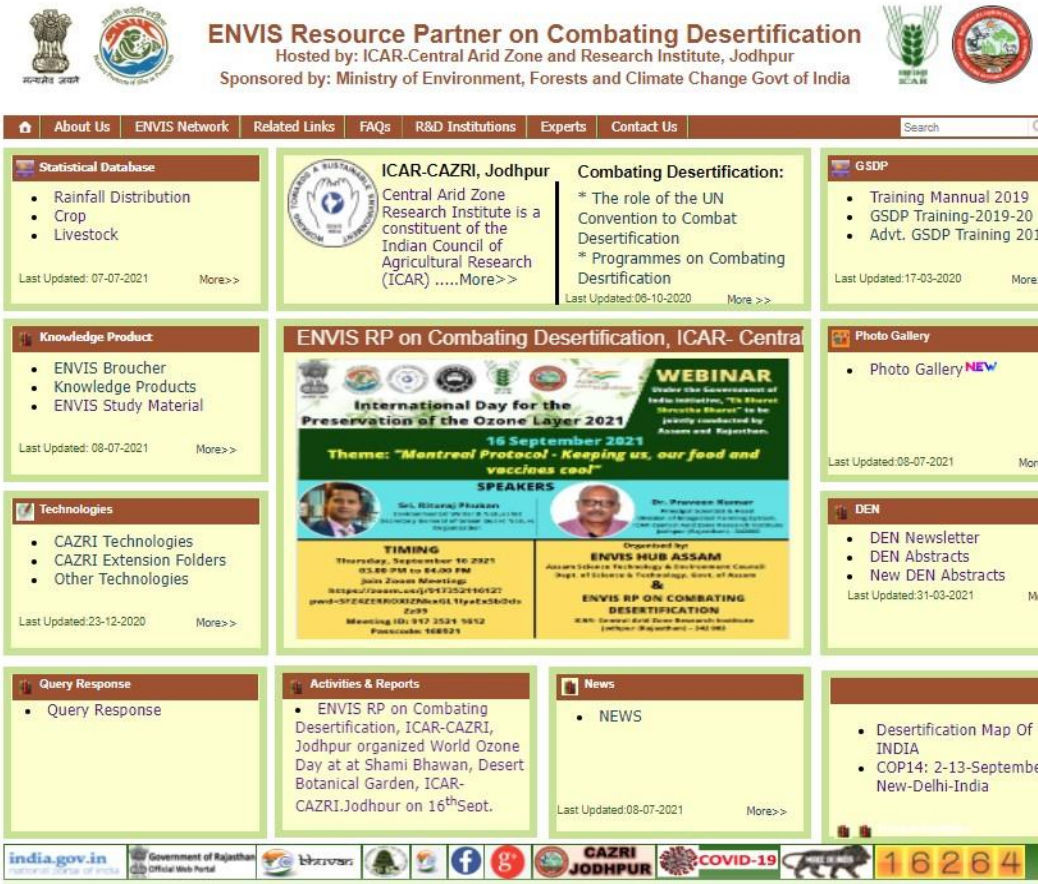
Celebrated World Ozone Day on September 16, 2021 jointly with ENVIS Hub, Assam through webinar under the initiative "Ek Bharat Shresth Bharat" and also "Amrit Mahotsav" on this year's theme "*Montreal Protocol: Keeping us, our food and vaccines cool*". The Guest Speaker from Rajasthan, Dr. Praveen Kumar, Principal Scientist and Head at ICAR-CAZRI, Jodhpur delivered a lecture on the theme "*Montreal Protocol: Keeping us, our food and vaccines cool*". The Guest Speaker from Assam Sh. Ritu Raj Phukan, Environmental Writer & Naturalist Secretary General of Green Guard Nature Organization, Assam gave lecture on "*Montreal Protocol to Paris Agreement: Expectations from COP 26 and UNFCC COP 26*". The webinar was attended by 62 participants which include scientists, officials and other participants from both the states.



Iconic week

Celebrated Iconic week during October 04-10, 2021 allocated by The Ministry of Culture, Government of India, to the MoEFF&CC, under "Azadi ka Amrit Mahotsav" for holding paradigmatic and impactful events. An awareness field programme was conducted at our ENVIS Centre and Desert Botanical Garden, ICAR – CAZRI, Jodhpur through poster which highlights the awareness drive against single use plastic along with elimination and reduction of single use plastic.





Information Around

The LDN Response Hierarchy

Maximize conservation of natural capital

AVOID 1

AVOID: Land degradation can be avoided by addressing drivers of degradation and through proactive measures tp prevent adverse change in land quality of nondegraded land and confer resilience, via appropriate regulation, planning and management practices

REDUCE 2

REDUCE: Land degradation can be reduced or mitigated on agricultural and forest land through application of sustainable management practices (sustainable land management, sustainable forest management).

REVERSE 3

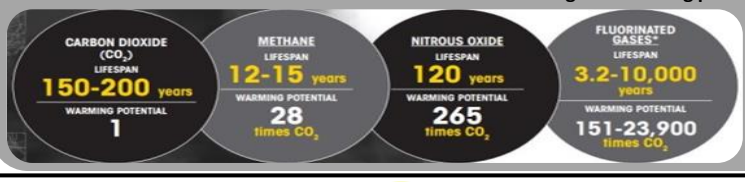
REVERSE: Where feasible, some (but rarely all) of the productive potential and ecological services of degraded land can be restored or rehabilitated through actively assisting the recovery of ecosystem functions.

Source: Orr et al., 2017

WARMING POTENTIAL OF GASES

UNSPARING GASES

While CO_2 is the most emitted greenhouse gas, there are several others with a higher warming potential



*It is a family of gases containing fluorine
Worming potential values are for 100 year time horizon
Source: UN IPCC report