THEME:
CLIMATE CHANGE AND ENVIRONMENTAL MANAGEMENT

Title of the technology

Use of surface vegetation in sand drifts control and sand dune stabilization hot arid region

A: Nature of technology

Wind erosion control & sand dune stabilization

B: Process in brief

The soils of western Rajasthan are lesser in nutrients and experiences soil and water erosion of varying intensity. Community suffering from fodder and fuel wood scarcity in the region, whereas, high human and livestock population are leading to mismanagement of the sandy terrain causing reactivation of sand dunes and land degradation resulting of sand movement. This moving sand encroach productive agricultural fields, human habitation, canal, road, railway tracks and water body. Plantation of only tree species may not solve the problem. Involvement of surface vegetation may be one of the best techniques for effective control of sand drift and reducing reactivation of sand dunes. For this an experiment was laid out in a split plot design with three replications. Different plant species viz. *Acacia tortilis*, *Prosopis juliflora* and *Calligonum polygonoides* of about 20 cm, 40 cm and 15 cm in height, respectively were planted in September, 1996 at a spacing of 5 m x 5 m and in a pit size of 45 x 45 x 45 cm^3. Species were considered as the main plot with 75 plants per species. 9.0 g of DAP (di-ammonium hydrogen phosphate) was spread in each pit as basal dose and about 20 g of BHC (y-hexachlorobenzene) was used by thoroughly mixing with the soil to protect the seedlings from termite attack at the time of planting.

Cassia angustifolia (one meter away from the seedlings and at 60 cm interval between the tree rows i.e., six rows) under shrub and *Cenchrus ciliaris* grass (60 x 20 cm spacing and similar to *C. angustifolia*) were sown in the monsoon season of 1997 to provide surface vegetation (Fig. 1a & b). In addition to the *C. angustifolia* and *C. ciliaris* plots, there was a control plot. Thus, there were nine plots (three species x three vegetation type) in each replication, with 25 plants in each plot.

Calligonum polygonoides was the most suitable species, which provided better microenvironment and helped in developing effective surface vegetation to control sand drift. Combination of *C. polygonoides* with *Cassia angustifolia* was the best to control sand drift and to improve biodiversity and ecology of the arid areas (Fig 2a)**.** Introduction of under shrubs like *Cassia angustifolia* and grasses (i.e., *Cenchrus ciliaris*) along with the tree species could provide

beneficial effects in controlling sand reactivation and drift, particularly, at the time when planted seedlings attain the size of a tree facilitating free air movement under the canopy resulting in reactivation of sand drift. Further, dunes are also deficient in soil organic matter and nutrients, particularly nitrogen. This study suggests that the micro-windbreaks of *C. angustifolia* can be raised in advance or simultaneously with plantation during onset of monsoon to provide effective surface vegetation.

(a)

(b)

Fig 1. Traditionally used mulches of (a) dead organic material of *Leptadenia pyrotechnica*/*Crotalaria burhia*, (a) and live micro-windbreak of *C. angustifolia* (b).

(c)

(d)

Fig 2. *Calligonum polygonoides* with *C. angustifolia*- best surface vegetation and remain green during summer when maximum sand drift takes place (a), and clumps of *C. ciliaris* grass with *C. polygonoides* during summer (b).

C. Beneficiaries of the technology

1. Prominent beneficiaries/user groups: Farmers and State Forest Departments of Rajasthan and Gujarat, non-government organization working in the area, industries i.e., wind energy.

2. No. of clients to whom technology has been transferred

This practice is a government led initiative by the Arid Forest Research Institute. State Forest Department of Rajasthan and Ministry of Rural Development, Government of India are linked directly/indirectly in this technology development programme. State forest department and farmers of the region are the main beneficiaries to whom this technology was demonstrated through field visits and onsite demonstration. This technology has been discussed at many forums such as workshop/conferences, meeting/ stakeholder meetings, public forum, etc. Forest department of Rajasthan has adopted this in many places in sand dune area of western Rajasthan.

3. Potential for further dissemination

Moving sand encroach productive agricultural fields, human habitation, canal, road and railway tracks. Stabilization or control of sand drift includes the activities like reduction in wind velocity and availability of sand prone to erosion. Introduction of undershrubs and grasses along with the tree species provides beneficial effects in controlling sand reactivation and drift, particularly, at the time when planted seedlings attain the size of a tree facilitating free air movement under the canopy resulting in reactivation of sand drift. This study covers shifting dune, semistabilised dune and the inter-dune. Selected species were *Acacia tortilis*, *A. nilotica*, *A. senegal*, *Azadirachta indica*, *Prosopis juliflora* as the tree species, *Calligonum polygonoides* and *Ziziphus mauritiana* as the shrubs, *Cassia angustifolia* as the herb and *Cenchrus ciliaris* as the grass species. Introduction of surface vegetation does not leave soil surface bare hence control sand drift effectively. For example *Cassia angustifolia* remains green even during summer when maximum sand drifts takes place and most of the vegetation dries out (Figure 1a & b). The biomass from surface vegetation in the form of fodder from *C. ciliaris* and medicinal leaves of *C. angustifolia* are additional benefits. Further, *Calligonum polygonoides* is the most suitable species, which provide better microenvironment than *A. tortilis* and *P. juliflora* or other tried species i.e., facilitative effects and facilitate regeneration of other species like grasses and *C. angustifolia* thus helpful in developing effective surface vegetation to control sand drift in addition to improve biodiversity and ecology of the arid areas. This may also be beneficial in establishing wind mills for power generation in such areas. Further, this practices/sowing of leguminous and / or non-leguminous under shrubs or grasses increase nitrogen and organic matter increasing the soil nutrient status and provide fodder for livestock in addition to sand drift

control. Therefore, further replication will be more beneficial in terms of both economic and environmental.

Paper Published

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4. Singh, G. (2003). Windblown wonders: bio-productivity and economic returns from sand dune stabilization. *Wasteland News*, 19(2): 32-35.
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6. Singh, G. (2004). Influence of soil moisture and nutrient gradient on growth and biomass production of *Calligonum polygonoides* in Indian desert affected by surface vegetation. *J. Arid Environment* 56(3): 541-558.
7. Singh, G. (2004). Growth, biomass production and soil water dynamics in relation to habitat and surface vegetation in hot arid region of Indian desert. *Arid Land Research and Management*. 17(2): 1-17.
8. Singh, G., Rathod, T.R. and Chouhan, S. (2004). Growth, biomass production and the associated changes in soil properties in *Acacia tortilis* plantation in relation to stand density in Indian arid zone. *Indian Forester*, 130: 605-614.

D. Economic significance

1. Potential to address livelihood issues and generate additional income

Involvement of under shrubs and grasses as the surface vegetation along with the planted tree species provides beneficial effects in controlling sand drift and sand dune movement. *Cassia angustifolia* utilized as the surface vegetation is a medicinal plant. Increased income through harvesting of leaves of *Cassia angustifolia* and fodder from *Cenchrus ciliaris* grass and decrease in time of collections of fuel wood and fodder are some of the benefits related to development of livelihood and human resource. Environmental benefits and productivity enhancement from the agriculture land due to control of sand deposition are the additional benefits.

2. Productivity enhancement and economic benefits over replaced technology

A combination of *Calligonum polygonoides* with *Cassia angustifolia* was the best combination to control sand drift and increasing socio-economic benefits for the desert dwellers. At the age of 50 months, *A. tortilis* produced 5.2 tones ha^{-1} fuel wood as compared to 7.00 tones ha^{-1} from *P. juliflora* and 7.15 tones ha^{-1} from *Calligonum polygonoides*. *Cenchrus ciliaris* produced green fodder of 1.22 tones ha^{-1} $year^{-1}$ with *A. tortilis*, 1.58 tones ha^{-1} $year^{-1}$ with *P. juliflora* and 2.23 tones ha^{-1} $year^{-1}$ with *C. polygonoides*. *Cassia angustifolia* produced dry leaves of 0.76 tones ha^{-1} $year^{-1}$ with *A. tortilis*, 0.96 tones ha^{-1} $year^{-1}$ with *P. juliflora* and 1.39 tones ha^{-1} $year^{-1}$ with *C. polygonoides* with market cost of Rs 9120, 11520 and 16720, respectively @ Rs 12 kg^{-1}. State Forest Department of Rajasthan and Ministry of Rural Development helped in funding as well as dissemination of this practice. The local people offered the labour required for the implementation of this practice.

Benefits associated with this practice

Environmental	**Economic**	**Social**
Improvement in soil nutrient status and productivity.	Increased land value.	Improvement in social status.
Increase in carbon stock by 3.72 tones C ha^{-1} with *A. tortilis*, 5.24 tones C ha^{-1} with *P. juliflora* and 5.66 tones C ha^{-1} with *Calligonum polygonoides*.	Increase in fuel wood production.	Reduced time in fuel wood collection by the villagers and diversion to education.
Increase in diversity and land productivity.	Increased income by harvesting grasses and leaves of *C. angustifolia* for medicinal use.	Reduced time in fodder collection and diversion of children towards education.
Increased vegetation cover for effective control of sand drift.	Fuelwood from adultneighbour and fodder & medicinal leaf of *C. angustifolia.*	Increase in social status.

3. Impact of the Technology

Introduction of surface vegetation along with tree plantation improved soil nutrient status and increase in diversity and land productivity. Application of this practice increased carbon stock by 3.72 tones C ha^{-1} with *A. tortilis*, 5.24 tones C ha^{-1} with *P. juliflora* and 5.66 tones C ha^{-1} with

Calligonum polygonoides. Increase income by harvesting grasses and leaves of *C. angustifolia* for medicinal use and has enhanced vegetation cover for effective control of sand drift. From *C. angustifolia* leaves a farmer can get Rs 16720 ha^{-1} $year^{-1}$ from *C. polygonoides* plot as compared to 9120 ha^{-1} $year^{-1}$ from *A. tortilis* based system.

E. Technology developed by {Name of Scientist(s)/officers(s)}

G. Singh, Forest Ecology Division, Arid Forest Research Institute, Krishi Upaj Mandi, Basni, New Pali Road, Jodhpur – 342 005, Rajasthan, India
Website: www.afri.res.in; Email: gsingh@icfre.org