Direct sowing and planting of *Salvadora persica* (Linn.) and *Salvadora oleoides* (Decne.) for Ecological Restoration and Livelihoods Improvement in Thar Desert

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***Salvadora persica* Linn. and *Salvadora oleoides* Decne. are two important species of western Rajasthan. In Thar desert, their wide ranging ecological, social and economic importance on the one hand and declining population on the other necessitates that the species are included in restoration programmes. Taking stock of the new advances in research and field experience on both the species, this technical note provides guidelines for raising *S. persica* and *S. oleoides* in Thar desert. In particular, both the species are capable of regenerating through direct seeding and planting of nursery-raised seedlings in the field. Thus, we need to enhance our efforts in incorporating these species in afforestation and restoration in Thar desert. This document is the first in a series of technical notes to support connecting science to decision making aimed at bridging the science—management divide.**

Salvadora persica, a medium-sized tree, is commonly called as *khari jaal* in Rajasthan. It is a characteristic desert tree of the Indian arid zone[1]. Together with other species (*S. oleoides*) these are the only plants that keep their green foliage even during the hot summers[2]. The leaves are smaller and more in number in *S. persica* compared to *S. oleoides*. In some natural habitats *Salvadora* can form up to 10 percent of the local vegetation[3]. In Thar desert, a high proportion of root to shoot in perennials is a rule. Thus, the roots of *Salvadora* are very deep which reach the water table and because of continuous supply of water, there did not appear to be any need for shedding of the leaves. Both the *Salvadora* species could be classified both as deep rooted

[1] Meher-Homji, V. (1970). "Some phytogeographic aspects of Rajasthan, India." *Vegetatio* **21**(4): 245-254.
[2] Sen, D. (1973). "Ecology of Indian desert. III. Survival adaptations of vegetation in dry environment." *Vegetatio* **27**(4): 201-265.
[3] Kumar, S. (1996). "Trends in structural compositional attributes of dune-interdune vegetation and their edaphic relations in the Indian desert." *Vegetatio* **124**(1): 73-93.

mesomorphic xerophytes as well as facultative halophytes as they are highly salt tolerant[4].

Around the world *S. persica* is famous by the brand name of miswak and the tree is referred as the toothbrush tree. The ethnobotanical and ecological values of *Salvadora oleoides* are well known. Salvadora persica is culturally important both in local knowledge systems and major religions. It is one of the identifiable plants from among the seventeen plant families that are cited in the Holy Quran[5].

Salvadora oleoides Decne locally known as *mithi jal* is also a multipurpose tree. The tree grows in dry and desert areas of Uttar Pradesh, Rajasthan, Haryana, Punjab, Gujarat and Madhya Pradesh. Its seeds are rich in non-edible oil. Fruits are relished by local people, leaves are excellent source of fodder and stem and branches are used for fuel. Seeds are also a rich source of non-edible oil. The seed oil content is about 45 to 50% in Gujarat and Rajasthan. Likewise, the dried seeds of *Salvadora persica* contain 30 to 40 per cent oil which is of great economic significance. Purified oil is used in soap making and detergent industries as a substitute for coconut oil. The oil of Salvadora is being exploited by various companies like, Godrej Soaps Ltd., Tata Oil Mills, and Hindustan Lever Ltd. etc[6].

Fruits of *Salvadora oleoides* are a delicacy in rural areas, eaten locally, and have been found to be rich sources of calcium[7]. *S. oleoides* also provides a model shelter for domestic animals and wildlife in the heat and dust storms of the summer months. Summer temperatures inside the *Salvadora* canopy are often up to 8°C lower than that the open environments (48°C). It provides a habitat for a variety of birds (nesting), rodents (burrows), snakes and lizards (hollow stems) and mammals (thickets). The fruit

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[4] Rao, G., A. K. Nayak, A. Chinchmalatpure, A. Nath and V. Babu (2004). "Growth and yield of *Salvadora persica*, a facultative halophyte grown on saline black soil (vertic haplustept)." *Arid Land Research and Management* **18**(1): 51-61.

[5] Khafagi, I., A. Zakaria, A. Dewedar and K. El-Zahdany (2006). "A voyage in the world of plants as mentioned in the Holy Quran." *International Journal of Botany* **2**(3): 242-251.

[6] Zodape, S. T. and V. K. Indusekhar (1997). "*Salvadora persica*: A Boon to wasteland development." *Journal of Scientific and Industrial Research* **56**(11): 657-661.

[7] Duhan, A., B. Chauhan and D. Punia (1992). "Nutritional value of some non-conventional plant foods of India." *Plant Foods for Human Nutrition* **42**(3): 193-200.

of the tree is also relished by a variety of insects, birds and rodents[8]. *Salvadora* is also a good source of seed oil. Recently, *Salvadora persica* has been found to be the source of benzylamides from a natural source[9].

Both species contribute to litter formation and standing biomass, thus, establishing a reserve of fertility in the sandy soils deficient in organic matter and nutrients. The vegetative regeneration from the root suckers of established trees results in large thickets of the species in landscape. The density of the canopy and the lateral and vertical extensions of the root system protect the soil from wind erosion and act as a windbreak in Thar desert.

S. oleoides and *S. persica* are very useful species in restoration of the fragile arid tract and provides fodder and shelter to the wildlife and livestock, and fruit, medication and recreation to the inhabitants of the surrounding areas. Interestingly, *Salvadora oleoides* can also survive even prolonged stagnation of floodwaters for several months[10]. Likewise, *Salvadora persica* can be cultivated for restoration of highly saline soils.

Most-large irrigation schemes face the threat of waterlogging and increased salinity. Removal of excess ground water through appropriate plantations by transpiration (bio-drainage) is very useful. Trees planted for bio-drainage are also able to take care of the salt balance in case of most irrigation schemes in dry arid regions[11]. Biodrainage is considered to be a cost effective process of reclamation of waterlogged areas. *Salvadora* , thus, has been suggested for plantation in the affected areas for reclamation purpose[12].

Seeds of *Salvadora persica* can be sown in the month of June-July immediately after seed collection and drying in shade. Seedlings may emerge 3 days after sowing and 98.0% seedling emergence can be achieved over a period of 13 days under control (4.3

[8] Khan, A. U. (1996). "Appraisal of ethno-ecological incentives to promote conservation of *Salvadora oleoides* Decne: The case for creating a resource area." *Biological Conservation* **75**(2): 187-190.
[9] Khalil, A. T. (2006). "Benzylamides from *Salvadora persica*." *Archives of Pharmacal Research* **29**(11): 952-956.
[10] Tomar, O. S., R. K. Gupta and J. C. Dagar (1998). "Afforestation techniques and evaluation of different tree species for waterlogged saline soils in semiarid tropics." *Arid Soil Research and Rehabilitation* **12**(4): 301-316.
[11] Kapoor, A. S. (1998). "Prevention of soil salinisation of irrigated lands in dry arid regions with the help of plantations." *Water and Energy International* **55**(4): 27-35.
[12] Tewari, V. P., M. L. Arrawatia and V. S. K. Kumar (1997). "Problem of soil salinity and waterlogging in Indira Gandhi Canal area of Rajasthan State." *Annals of Biology* **13**(1): 7-13.

dS m-1 salinity, i.e. low salinity) conditions. Emergence can last for 13, 12, 12, 11 and 10 days in soils with salinities of 6.1, 8.4 10.3, 12.5 and 14.9 dS m-1, respectively, with percent seed germination of 86%, 70%, 42%, 28% and 16%, respectively[13]. Seed germination in case of *Salvadora oleoides* can be up to 80%[14]. An important issue that should be kept in mind when raising the species is the low-viability of seeds.

Thus, if the soil is less saline (due to addition of monsoon rain or irrigation water) then a good germination percent is possible in the direct seeding. Under field conditions, maximum soil salinity is found during dry period and minimum during rainy season (wet period) in the year. In general, salinity for 0–10 cm layer of soil varies from 4.3 to 6.1 dS m-1. As a result, seeds of *S. persica* can germinate during rainy season and grow without adverse effect of salinity during post monsoon period. Similar is the case with *S. oleoides*[15].

In dry regions where the available monsoon rainfall can wet the surface soil, *S. persica* seedlings can utilize this moisture for the extension and proliferation of roots into the deeper layers of soil to achieve establishment over the rainy season. However, if the irrigation is possible (for example, in canal-side plantations) then direct sowing may provide much better result because *Salvadora persica* responds very well to irrigation[16]. Research suggests that application of nitrogen and gypsum enhances the establishment and growth of *Salvadora persica* on a sandy loam, saline alkali soil - waterlogged during the monsoon. The application of nitrogen in combination with gypsum (gypsum + 9g N) gave the best results, 41% for height and 35% for crown diameter more than the untreated plants. Crescent shaped drainage trenches for individual plants helped in

[13] Ramoliya, P. J., H. M. Patel and A. N. Pandey (2004). "Effect of salinization of soil on growth and macro- and micro-nutrient accumulation in seedlings of *Salvadora persica* (Salvadoraceae)." *Forest Ecology and Management* **202**(1-3): 181-193.
[14] Jindal, S. K., M. Singh and R. Sivadasan (2006). "Variability for seed size, oil content, seed germination and juvenile traits in germplasm collections of *Salvadora oleoides* Decne from arid parts of Gujarat." *Annals of Arid Zone* **45**(1): 53-58.
[15] Ramoliya, P. J. and A. N. Pandey (2002). "Effect of increasing salt concentration on emergence, growth and survival of seedlings of *Salvadora oleoides* (Salvadoraceae)." *Journal of Arid Environments* **51**(1): 121-132.
[16] Kasera, P., J. Prakash and D. Chawan (2003). "Effects of spacing and irrigation levels on growth and biomass production in *Salvadora persica*." *Journal of Tropical Forest Science* **15**(4): 626-629.

plant establishment and growth, serving the dual purpose of harvesting water and leaching salts[17].

Technique to increase the germination rate of *Salvadora oleoides* seeds involves depulping of seeds by hand-rubbing or gunny-bag rubbing of seeds in bucket filled with tap water followed by shade drying for a day and then pretreatment of seeds with cold water (by soaking of seeds in cold water for two hours) and 0.5-cm depth sowing are more efficient in increasing the germination rate of *S. oleoides* seeds[18]. Majority of large seeds get germinated within 96 hours of sowing while medium-sized and small seeds may not give more than 80% germination. Seed sowing depth is also important. Germination is delayed and decreased with increase in sowing depths. For best results seeds should be sown at a depth ranging from 0.5 to 1 cm. Similarly, large seeds must be collected for *S. persica* as germination is very poor if low weighing seeds are taken for restoration programme. Heavy and larger seeds can give almost 100% germination[19]. In irrigated plantations, *Salvadora persica* performs best at a spacing of 5×5 m in terms of plant height and collar diameter[20]. For enhanced plant percent, sowing of seeds in mother bed, keeping in mother bed for 10 days, and transplanting in poly bags provides best results.

Reduction in the growth of seedlings was also recorded in response to increasing salt stress. In general, salinity can reduce the plant growth or damage the plants through: (i) osmotic effect (causing water deficit), (ii) toxic effects of ions, and (iii) imbalance of the uptake of essential nutrients. Research results suggest that there is a reduction of shoot growth and leaf area development of *S. persica* with increasing salt concentration.

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[17] Arya, R., K. R. Chaudhary and R. R. Lohara (2005). "Effect of nitrogen and gypsum on the establishment and early growth of *Salvadora persica* L.) on salt affected soils under hot arid conditions in India." *Forests Trees and Livelihoods* **15**(3): 291-306.

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[19] Dagar, J. C., H. Bhagwan and Y. Kumar (2004). "Seed germination studies of *Salvadora persica* and *Jatropha curcas*." *Indian Journal of Forestry* **27**(3): 283-289.

[20] Kasera, P. K., J. Prakash and D. D. Chawan (2003). "Effects of spacing and irrigation levels on growth and biomass production in *Salvadora persica*." *Journal of Tropical Forest Science* **15**(4): 626-629.

Salvadora persica is also one of the most suitable species for rehabilitating gypsum mined surfaces (other species include *Acacia nubica*, *A. tortilis*, *Azadirachta indica*, *Cercidium floridum*, *Dichrostachys nutans*, *Prosopis cineraria*, *Salvadora oleoides*, *S. persica* and *Tamarix aphylla*)[21,22].

In conclusion, *Salvadora persica* Linn. and *Salvadora oleoides* Decne. are ecologically, economically and socially important species of western Rajasthan. The species need to be included in restoration programmes. Both the species are capable of regenerating through direct seeding and planting of nursery-raised seedlings in the field. Thus, we need to enhance our efforts in incorporating these species in afforestation and sand dune stabilization in Thar desert.

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