

***Pilu* (*Salvadora oleoides*): A protector of Thar desert bio-diversity and fruit crop for commercial promotion**

Thar desert is the home for many unique crop-plants and the ecosystem farming has evolved to survive them in the harsh conditions. Among the ancient plant species that thrive well in this challenging environment, *Salvadora oleoides* Decne commonly known as *pilu*, *jaal* or *meethijaal* tree stands out as a vital contributor to the bio-diversity and livelihood protector. This long-lived tree not only plays a crucial role in supporting ecosystem balance but also serves nutritious fruits to local communities and feed to domestic and wild animals. In recent era, the natural population of this species is decreasing drastically owing to rampant increase in urbanization, expansion of farming area, commercial infrastructures and lack of trees regeneration efforts. Now, this multi-function species is in IUCN red list of threatened species. Therefore, systematic documentation and technological advancement steps have been taken by ICAR-CIAH to conserve and utilize the *Salvadora* variability for horticultural promotion.

INDIAN Thar desert has unique bio-diversity including native fruit crop-plants for the eco-system services and the vegetation is adapted to the xerophytic conditions. Several lesser-known fruit tree species which have the potential for commercial significance are yet to be utilized for native food. Among those, indigenous fruits such as *jharber*, *bordi*, *pilu*, *gundi*, *gunda*, *ker*, *rayan*, *dasra*, *kainth* and many-more are playing a specific role in the livelihood of the local inhabitants in the arid region where the annual crops failures often led to nutrition shortage. These un-tapped fruit trees contribute significantly to native horticulture and serving as essential genetic resources to preserve the global bio-diversity. These perennials are capable of withstanding with challenging climatic adversity such as drought, heat, cold and salinity stress and one of such climate resilient species is *pilu*

(*Salvadora oleoides* Decne). Now, this species is on the IUCN Red List of Threatened Species (IUCN 2021: T164052709A164059400). Thus, ICAR-CIAH, Bikaner has taken all-sided efforts to conserve and promote the scientific plantation of *pilu* owing to its multiple benefits to the society.

SIGNIFICANCE OF PILU

Ecological

Pilu is well adapted to the extreme climatic and soil conditions of the Thar desert including extremes of high temperatures (day time 50–55° C), scanty rainfall (less than 250 mm/year) and problematic saline soils. Its deep and extensive root system allows it to access water from deep sources and making it drought-resistant and



Extensive root system of *pilu* tree (A, B) helps in sand-dunes stabilization (C)



Pilu - A life-line tree for shade in Thar desert during hot summer months

capable of surviving under abiotic arid environments. This resilience makes *Salvadora oleoides* a keystone species and helping to prevent soil erosion, stabilizing sand dunes and contributing to the overall health of desert ecosystem.

Canopy of *pilu* trees create and maintain a microhabitat that support a wide-range of living species-stocks and thereby contributing to the conservation of biodiversity in desert. Summer-green and dense canopy of the *pilu* trees reduces direct sunlight, solar intensity and lowers soil temperatures beneath it and thus, creating a cooler and more humid environment compared to the open surroundings. This moderated microclimate helps in the survival of fauna that would otherwise struggle in the inhospitable hot and dry conditions of desert. Canopy and under-story environment created by the *pilu* trees serve as habitats for diverse animal species from insects to birds and small mammals. Birds nest in the tree branches ensures shelter from predators and steady food supply in the form of insects, flowers and fruits. Small mammals and reptiles take refuge in the shade of trees.

Leaves, flowers, fruits and seeds of *pilu* are relished food source for insects, birds, rodents and animals. *Pilu* tree produces fruits during the peak summers that are consumed by wildlife and herbivores. This fruit-bearing capacity contributes to the nutraceutical rich diet to animals and supporting the broader food web within the eco-system. Fresh and dried leaves of *pilu* consumed by sheep, goat and camel.

Environmental

In the present global concerns, imbalance of carbon

in natural ecosystems in particular to the urban areas is the challenge and therefore, tree species is evaluated for their potential role in carbon storage and sequestration. Carbon sequestration capacity of tree species depends upon its age, height, girth, size, biomass accumulation, canopy diameter, wood density and rotation length. The long-lived, slow-growing and high-density hard-wood trees store more carbon and thus, *Salvadora* fulfill all the criteria even under the extremes of arid climate.

Cultural and economic

Pilu tree holds cultural and economic value for communities living in the Thar desert. The tree has been used for centuries in traditional medicine for its various therapeutic properties. The fruits are edible and generally, used fresh and dried. The wood of *pilu* is highly valued for its durability and used in construction, making tools and also fuel. The tree's ability to thrive in harsh conditions without requiring extensive care makes it an ideal candidate for social and agro-forestry plantations. By integrating it into the horticultural systems, *pilu* acts as additional fruit source and improve income, minimized ill-effects of environment and increase resilience to climate change.

Nutritional

Pilu is an important tree plant of hot arid region and two recognized species namely *Salvadora persica* L. (*kharijaal*) and *Salvadora oleoides* (*meethijaal*) found naturally. *Salvadora persica* is widely distributed in the central and eastern part of Rajasthan and many clinical



Pilu tree - A vital refuge for birds in the desert ecology



Pilu - A particular food source for domestic and wildlife in arid region



Fruits and leaves of *Salvadora persica* and *Salvadora oleoides*

studies has proven that each part of this plant is useful in treatment of human ailments. *Salvadora oleoides* is widely distributed in the hot arid region in particular to Barmer, Jaisalmer, Jodhpur, Bikaner and Churu, and is only species of genus which produce sweet and edible fruits.

CONSERVATION CHALLENGES AND SCOPE

Despite its vital significance, *pilu* faces several threats including overgrazing and deforestation owing to expansion of agricultural and developmental activities. Loss of *pilu* trees could have a devastating impact on the Thar ecology leading to increased desertification and loss of bio-diversity and greenery. Conservation efforts are essential to protect and restore *pilu* tree population. Systematic efforts are needed to categorise it as component plant of horticulture, agro-forestry, reforestation through block or road-side plantations and establishment of *pilu* based protected areas for wildlife and bio-diversity conservation. In addition, awareness programmes with local communities as the ecosystem supporting tree for ecological and economic benefits. Promoting the *pilu* fruits and its product marketing through community-based conservation plantation can ensure economic sustainability. By involving local communities in plantation management and protection of *pilu*, it is possible to ensure the long-term survival of this species and the biodiversity. Further option for promotion is to bring it in commercial cultivation and thus, intensive research is needed.

Scope for commercial cultivation

Edible fruits: *Pilu* tree produces vibrant red and yellow fruits that are highly cherished by local inhabitants for their delicious sweet taste and numerous health benefits. During the morning hours, native people harvest the fruits individually or in groups, selling them in local

markets and drying them for off-season uses.

Resilience nature: Thriving and long-lived in the hot desert which is known for extremes of adverse climatic and soil situations, *pilu* demonstrates remarkable resilience to environmental stresses. It is well-adapted to xerophytic conditions and thus, tolerating both high ($\pm 50^{\circ}\text{C}$) and low (-3°C) temperature extremes. This adaptability is largely attributed to its deep tap-root system, fleshy drooping leaves arranged vertically to minimize heat exposure and its ability to tolerate drought and saline conditions. *Pilu* trees accumulate high salt level in their cells and tissues and thus, mitigating the harmful effects of excessive salt through evolved succulence. Consequently, they grow efficiently with limited water availability including saline ground water.

Organic or nature's resilient farming: Apart from its abiotic stress resilience, *pilu* tree also exhibits resistance to biotic factors. No serious pest or disease issues have been observed on *pilu* trees under natural habitats. Its deep tap-root system enables it to extract nutrients from sub-soil layers and contributing to nutrient recycling in the ecosystem. This feature combined with its natural hardiness makes *pilu* an excellent candidate tree for organic or chemical-free farming and thus offering the opportunity to harvest nature's resilient fruits in arid climate.

Considerations for horticultural harnessing

Explorations: A systematic surveys and exploration programme should be initiated to assess the extent of genetic diversity of *Salvadora* and identify elite germplasm with desirable horticultural traits to establish field gene-banks. This will help in selecting superior genotypes and developing varieties for cultivation.



Harvesting and marketing of *pilu* fruits

Propagation: One of the big challenges in promoting *Salvadora* is the uniform plantations for horticultural harnessing and thus, vegetative propagation is the primary requirement. In general, it is easily perpetuated from seeds. ICAR-CIAH is chiefly focusing for most efficient and simple methods that could enable large-scale vegetative multiplication of genotypic saplings.

Nutritional profiling: *Pilu* has the potential to serve as a natural and alternative food source in remote villages. However, a comprehensive nutritional and medicinal profiling of its fruits is necessary to facilitate its commercial values. ICAR-CIAH is assessing the variability components in *pilu* fruit and also product analysis for distant marketing and consumer's acceptance.

Research on fodder values: *Salvadora* is high biomass producer tree and capable to convert into summer greens for animals in arid region. Investigating the nutritional quality of leaves as fodder can open new opportunities for its utilization in livestock feed and enhancing its economic viability and sustainability of plantations.

Variety development: Systematic evaluation of collected germplasm is essentially needed to identify superior genotypes with horticultural attributes. ICAR-CIAH has initiated the basic research work for collection of the best performing selections from the areas of diversity, *ex-situ* evaluation and identification of superior varieties for supporting commercial plantations.

Development of SoP's for plantation management: To maximize the genetic potential in *pilu*, a comprehensive package of practices should be developed in the SoP's mode so that resource based plantations can be managed effectively. This will include orchard floor and tree canopy management, rain-water utilization, pre and post harvest crop management and on-farm market-chain to ensure optimal productivity of resources.

Post-harvest and value-addition: Efficient post-harvest handling of fruits, storage, processing and product formulation techniques should be developed to promote quality harvest with extended shelf-life. In addition, research on diverse value-added products including herbal extracts and nutraceuticals can enhance market potential and economic returns.

Market development: Unlocking the full horticultural potential of *pilu* requires dedicated efforts in market intelligence for fruits and value-added products. This requires modern investments in value-chain, quality standards and marketing to open-up demand and ensure viability.

Social responsibility: Raising awareness among plantation-lovers, farmers, policy-makers and stakeholders about the socio-economic benefits of *pilu* trees is essentially needed for its wide-spread adoption. Projects on massive field demonstration for block and megha-highways plantations, training to environmental scientists and developmental services persons can play a critical role in promoting its diversified use for sustainable horticultural and ecological benefits.

CONCLUSION

Salvadora trees are more than just a life-line and it is a protector of the Thar desert bio-diversity, and also source of sustenance for its people and surroundings. Its ability to thrive in one of the most inhospitable environments on the earth makes it an invaluable asset to the ecosystem. Conservation of this species is not only crucial for maintaining the ecological balance but also for preserving the cultural heritage, livelihoods benefits and future food sources. By exploring the diversity and investing in its propagation, cultivation and market development research can contribute towards more resilient horticultural production systems, green healthier landscapes and sustainable livelihoods. As we are continuing asking solutions for the challenges of environmental degradation, *pilu* offers a promising avenue for climate smart farming innovative horticultural crop production models.

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