In contrast, populations with higher genetic distance represent genetically distinct resources and are ideal for mixing to enhance plantation diversity and long-term resilience. Notable genetically distinct pairs include Naguar–Junagarh (0.847), Barmer–Bikaner (0.706), and Ahmedabad–Jhunjhunu (0.723), highlighting significant differentiation. Using seeds from such distinct populations in combination, while considering ecological suitability, can improve adaptability and stability of Khejri plantations across arid regions.

AMOVA analysis showed that 65% of genetic variation occurs among populations, indicating that different regions harbor distinct genetic components that should be included in conservation and plantation programs. The remaining 35% of variation exists within populations, highlighting the importance of collecting seeds from many well-spaced trees within each population to capture the full genetic diversity of Khejri.

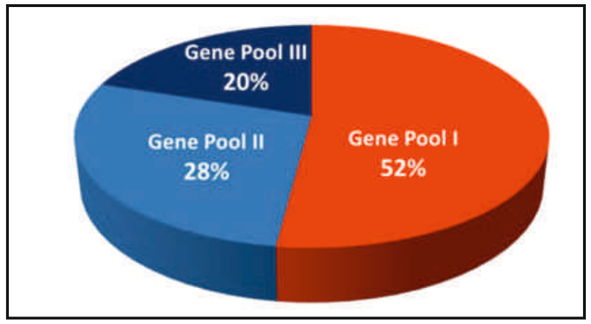
Gene pools of *Prosopis cineraria*

Population structure analysis identified three major ancestral gene pools (K = 3) shared among the studied populations that indicates that *Prosopis cineraria* populations contain three main genetic lineages, with several populations showing mixed ancestry due to past gene flow (Fig. 2). The gene pools includes:

- Gene pool-I includes populations from Ajmer, Dwarka, Hanumangarh, Himmatnagar, Jaipur, Jaisalmer, Jamnagar, Jodhpur, Patan, Sikar, Somnath, Surendra Nagar, and Tonk, mainly distributed across western and central regions.
- Gene pool-II comprises Bikaner, Churu, Jalore, Jhunjhunu, Junagarh, Pali, and Sree Ganganagar, mostly in the northern and western regions.
- Gene pool-III consists of Ahmedabad, Barmer, Deesa, Nagaur, and Sirohi, located primarily in the southwestern region.

For conservation, populations representing distinct clusters should be prioritized as seed stands to preserve unique genetic resources. For plantation programs, including seeds from all three clusters, along with populations showing admixture, can help maintain broader genetic diversity, improving long-term adaptability, resilience to environmental stress, and stability of Khejri plantations.

Fig 2: Gene pools of *Prosopis cineraria*



Key Future Recommendations

- Use high-diversity populations for seeds (Barmer, Bikaner, Sirohi, Deesa, Nagaur, Pali, Sree Ganganagar); mix moderate-diversity sources if needed.
- Collect seeds from 30–50 well-spaced trees per population to capture full genetic variation.
- Combine genetically distinct populations where ecologically suitable to improve resilience and adaptability.
- Include all major gene pools and admixed populations to maintain broad genetic representation.
- Conserve low-diversity populations (Dwarka, Somnath, Himmat nagar, Sikar, Tonk, Junagarh, Jaipur, Patan, Ajmer, Jaisalmer) through *in situ* protection and enrichment planting.

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Genetic Diversity for Conservation and Plantation Planning of *Prosopis cineraria* (Khejri)

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INDIAN COUNCIL OF FORESTRY RESEARCH & EDUCATION, DEHRADUN

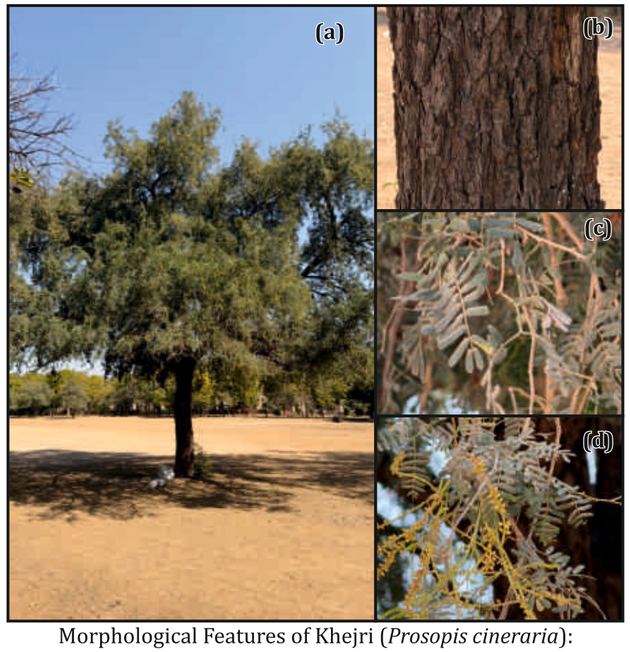
(AN AUTONOMOUS BODY OF MOEF & CC, GOVT. OF INDIA)

Khejri: The Lifeline of the Desert

Prosopis cineraria (Khejri) is an iconic tree of the Thar Desert and arid regions of Rajasthan and Gujarat, valued for its ecological, economic, and cultural significance. It provides fodder, fuelwood, soil fertility enhancement through nitrogen fixation, and shade in harsh desert environments, while also supporting biodiversity and sustaining local livelihoods. Beyond these benefits, Khejri is a hardy species adapted to extreme drought and temperature, making it central to desert restoration efforts. Successful conservation and plantation of Khejri require maintaining its genetic diversity. However, natural populations of Khejri have declined in several areas due to habitat degradation, overexploitation, and limited natural regeneration. Therefore, scientifically planned restoration and plantation activities are essential for both conservation and sustainable utilization of this species.

Genetic Diversity in *Prosopis cineraria* (Khejri) - Why It Matters

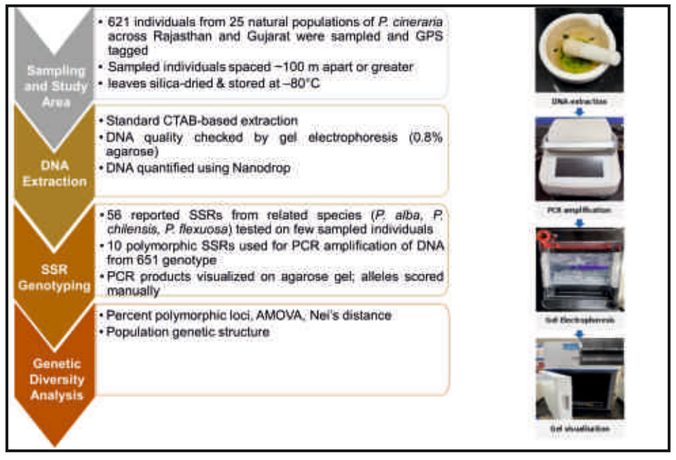
Genetic diversity in Khejri refers to the variety of genes present within and among its populations, shaping traits such as growth, drought tolerance, and disease resistance. This diversity is crucial for the species' long-term survival in harsh arid environments, where climate extremes, overgrazing, and habitat fragmentation can threaten its persistence. Maintaining genetically diverse populations ensures Khejri can adapt to changing conditions, supports ecosystem stability, and enhances the success of restoration and plantation programs. For forest managers and conservation planners, understanding genetic diversity helps in selecting seeds and planting material that maintain resilience and ecological function across Rajasthan and Gujarat's desert landscapes.



Morphological Features of Khejri (*Prosopis cineraria*):
(a) Tree, (b) Bark, (c) Leaves, (d) Flowers

Therefore, scientific assessment of genetic diversity and population structure was carried out across 25 representative populations of *Prosopis cineraria* in Rajasthan and Gujarat to generate information useful for conservation planning and selection of suitable seed sources for plantation programmes.

Methodology



Results

Genetic analysis of twenty five populations across Rajasthan and Gujarat revealed the following:

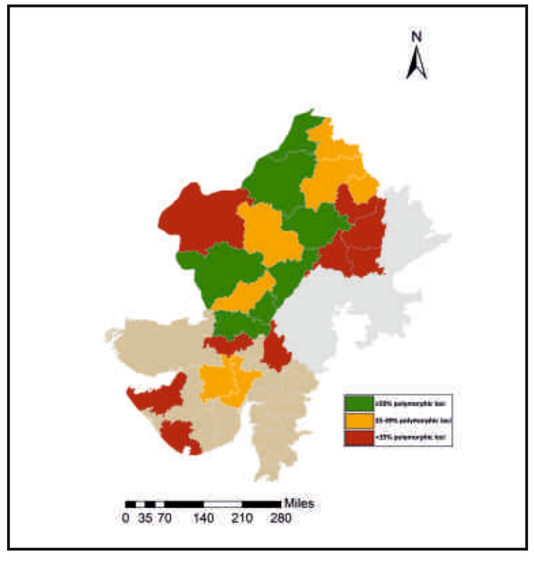
Overall Genetic Diversity

Genetic analysis of *Prosopis cineraria* populations reveals clear differences in their suitability as seed sources for plantations (Table 1; Fig 1). Populations with high genetic diversity are especially valuable for producing healthy, resilient plantations, while those with moderate or low diversity should be used cautiously to maintain overall genetic balance. The table groups populations into high, moderate, and low diversity categories and provides practical recommendations for seed collection and plantation planning to ensure long-term success.

Table 1: Plantation recommendation based on percentage poly morphic loci (PPL) of *Prosopis cineraria* populations

Genetic Diversity	Populations	Recommendation
High (=50% PPL)	Barmer, Bikaner, Sirohi, Deesa, Nagaur, Pali, Sree Ganganagar	Ideal for seed collection and plantations
Moderate (35–49% PPL)	Ahmedabad, Jodhpur, Jalore, Jhunjhunu, Hanumangarh, Surendra Nagar, Churu	Can be used, preferably mixed with high-diversity seeds
Low (<35% PPL)	Dwarka, Somnath, Himmatnagar, Sikar, Tonk, Junagarh, Jaipur, Patan, Ajmer, Jaisalmer, Jamnagar	Conservation priority; use for *in situ* protection and enrichment planting

Fig 1: Genetic diversity across sampled populations of Prosopis cineraria



Genetic Differentiation and Population Relationships

Based on pairwise Nei's genetic identity values, some *Prosopis cineraria* populations show very high genetic similarity and can therefore serve as alternative seed sources for each other. For example, Junagarh–Jamnagar (0.921), Himmatnagar–Jaipur (0.891), and Ajmer–Dwarka (0.875) are genetically very similar making them suitable as substitute seed sources where local seeds are limited, provided ecological conditions match, ensuring healthy and resilient plantations.