

Khejri: A wonder tree for nutritional value

Khejri (*Prosopis cineraria* (L.) Marbride) is an important component of farming system and plays a significant role in the economy of Indian desert. Belonging to sub family Mimosoidae Fabaceae (Leguminoceae) family, the tree is found growing in arid and semi-arid parts of Rajasthan, Gujarat, Haryana, Punjab, Delhi and some parts of southern India. Its highly nutritious leaves constitute important source of fodder for livestock while nutritious pods are valued as vegetable for human beings. The immature pods are used as vegetables both fresh as well as after dehydration, while ripe dried pods can be powdered and used in the preparation of bakery items such as biscuits and cookies. The Khejri tree plays a vital role in maintaining the ecosystem of the dreary Thar region because of its ability to survive in such tough conditions and the different ways in which it can be used by the farmers. Monetary advantage obtained through cultivation of Khejri by adopting improved production technologies can be very well assessed through comparison between other plants and crops on the average yield, resources/inputs used and prevailing price of inputs and produce.

ARID is a term applied to land that is dry, parched and often devoid of vegetation. It is usually applied to a climate or region where rainfall is barely sufficient to support vegetation. Rajasthan is a land of diversities. However, desert remains dominant, besides the mountains. India arid zone covers seven states viz. Rajasthan (62%), Gujarat (19.4%), Haryana (6.3%), Punjab (5.6%), Maharashtra (4.7%), Karnataka (3.1%) and Andhra Pradesh (1%). The cold arid zone is found at Laddakh of Jammu and Kashmir. The arid zones are characterized by scare, highly erratic and low rainfall days per year. Extreme variation in annual temperature (-2.5°C in winter and 49.9°C in summer), high potential evaporation rate (6 mm/day) and wind velocity (30 km/hr) are other characteristics. The whole tract of Rajasthan desert is sandy with unfavourable physical condition of soil and ground water. In general, the soils are poor in organic matter and high infiltration rate (15-30 cm/hr). The coarse textured soils of sandy plains are called as 'Desert Soils'. Jodhpur and Barmer district of Rajasthan have the largest duration of sunshine hours (9.30 hr/day). Rajasthan is endowed with very strong natural resources base. Arid fruits and vegetables are chief source of supply during seasonal short falls or hunger periods at the beginning of the rainy seasons, before the crops are ready to harvest or during famine period. The *khejri* is known as *Kalp Taru* in Thar Desert in Rajasthan. The oldest name of this plant is *Mimosa cineraria* (Linn.) and later called as *Prosopis spicigera* which was validated by the Code of Botanical Nomenclature '*Prosopis cineraria*' (Linn.) Macbride. It is also described as *Mimosa suma* or *Acacia suma* by some European Sanskrit Scholars.

Khejri is an important component of farming system and plays significant role in the economy of Indian desert. Belonging to sub family *Mimosoidae Fabaceae* (*Leguminoceae*) family, the tree is found growing in arid and semi-arid parts of Rajasthan, Gujarat, Haryana, Punjab, Delhi and some parts of southern India. This tree grows well in all sorts of climatic constraints which is evidenced by the fact that new foliar growth, flowering and fruiting occur during extreme dry months (March-June) when most other tree of the desert remain leafless or dormant. Because of its multiple economic value and suitability in agro-forestry systems, it is conserved in arable land where its population is regulated by the farmer. Owing to deep tap root system, monolayer canopy and atmospheric nitrogen fixing ability, the tree has favourable effect on companion crop and therefore, remains natural choice in agro-forestry systems in arid ecosystem. All arid land forms except hills and saline depression receiving an average rainfall of 150-500 mm have good density of *khejri* trees.

Importance of khejri

Different parts of *khejri* plants have long been used by desert people in a variety of uses. Its highly nutritious leaves constitute important source of fodder for livestock while nutritious pods are valued as vegetable for human beings. The immature pods are rich in crude protein, carbohydrates and minerals. About 18% crude protein, 56% carbohydrates, 0.4% each of phosphorus and calcium and 0.02% iron in immature pods. The immature pods are used as vegetables both fresh as well as after dehydration, while ripe dried pods having 9-14%

Table 1. Nutrient content of *khejri* fruits (pods) from arid zone

Name of nutrient	Quantity
Protein	23.2%
Carbohydrate	56.0%
Fat	2.0%
Fibre	20%
Vitamin 'A'	-
Vitamin 'B2'	-
Vitamin 'C'	523.0 (mg/100g)
Calcium (Ca)	414.0 (mg/100g)
Phosphorus (P)	400.0 (mg/100g)
Ferrous (Fe)	19.0 (mg/100g)
Energy (Kcal/gm)	334.8 (Kcal/gm)

crude protein and 6-16% can be powdered and used in the preparation of bakery items such as biscuits and cookies. The fruits from arid zone are nutritionally far more superior to the commercially available fruits viz. apple, banana, grapes etc. They are rich in carbohydrates and protein which are present in negligible amounts in commercial fruits. Also, they have higher mineral contents. *Prosopis cineraria* fruit is very rich in vitamin C and calcium and phosphorus contents. Other important roles of *khejri* whole plant are:

- Khejri tree plays a vital role in maintaining the ecosystem of the dreary Thar region because of its ability to survive in such tough conditions and the different ways in which it can be used by the farmers.
- Apart from being a source of firewood and fodder, the *Khejri* also helps in sustaining the nutrient value of the soil and ensuring a good yield.
- In addition, the fruit is used to make the very popular local dish 'Sangri' and can fetch up to ₹ 300 per kilo for the farmers. The flowers make an amazing bee-fodder. Even the timber is useful.
- The *khejri* tree is adapted to withstand both frost and drought, and survives both high temperature and low.

It is known to improve soil fertility; it aids nitrate retention in soil.

- The tree contributes to the micro-flora in desert soil. Its tap root goes deep into the earth, to depths of about 25 feet, seeking water. Wells are often dug close to the tree, for one can be sure of finding water near it. When vultures were more common in the desert, they would roost and nest in its branches.

Production Technology

Plant propagation

Attempts have been made in the past to propagate *khejri* through micro-propagation and air layering but those could not be commercially viable. A patch budding technique has been successfully used in top working to convert wild trees of *khejri* into more improved ones that bear good quality pods with more nutritive value. The improved cultivar 'Thar Shobha' of *khejri* developed by Central Institute of Arid Horticulture (CIAH), Bikaner is very good bearing in one year after budding in *deshi* root stock.

However, we have developed a technique for production of transplantable budded plants on one year old seedling rootstock for producing true-to-type and uniform stands of *khejri*. Raising of rootstock seedlings and budding technique, the seeds from ripened pods of *khejri* are extracted during May-June. The seeds are treated with Thiram @ 3 g/kg before sowing to control the seed borne disease in the nursery. They are then sown in polythene bags (10×25 cm, 200 gauge) filled with standard nursery mixture of sand, clay and goat manure (3:1:1) in the month of July. The seedlings are raised in sunken nursery beds with proper drainage facility. A year later, the seedling rootstocks with diameter of 0.4–0.8 cm are selected. The bud wood is collected from juvenile branches of selected plus trees. The bud sticks should have plumpy, slightly swollen and green buds. The rootstocks are prepared by removing all the side shoots and heading back at the height of 25-30 cm from the base. The method of budding during July to September gives about 60% success. In this method, a vertical incision is given in the bark of the rootstock to a length of 2-3 cm

Table 2. Production economics of Khejri in dryland farming in Rajasthan

Particular	Quantity	Rate (₹/unit)	Amount (₹)
Land preparation	Twice	1750	3500
Plants/planting materials	278/ha	30/plant budded	8340
Manure and fertilizers (Deshi/vermicompost)	5 kg/plant (278 plants)	5/kg x 278	1390
Others (insecticides, irrigation, training/pruning, watching, fencing etc.)	25/plant x 278	25x278	6950
Total cost (₹)	-	-	20180
Gross return (₹/ha), per plant	Income from loom (dry leaf) 25 kg dry leaf/plant	25x278x5	34750
	Income from tender pods 15 kg/plant	20x278x15/ha	83400
	Income from dehydrate pods 5.5 kg/plant	5.5x278x60	91740
Gross income from Khejri/ha	-	-	175140
Net return (₹/ha)	-	-	154969
B:C ratio	-	-	8.6



Heavy growth of cotton crop under Khejri shed



Full mature khejri plant for cutting loom



Intercropping with khejri and henna



Khejri pods



Full bearing of tender pods



Tender pods for dehydration

at about 15 cm height from the ground level. The bark is slightly loosened from the sides with the help of budding knife and a piece of scion having plumpy bud is inserted into the loosened bark of the rootstock. It is then tied with a polythene wrap. Proper aftercare regarding timely watering, removal of side shoots, weeding etc. are taken. The bud sprouting start in about 20-25 days after budding and the budded plants are ready for out planting in the field after 40-50 days of budding (Fig. 1). The out planting in the field may be done during September October before the advent of low temperature.

Orchard establishment

To development true-to type plantation of khejri variety, Thar Shobha vegetative propagations technique is necessary either budding on nursery raised root stocks or *in situ* budding in field established rootstocks. The bud grafted plants have vigorous growth, thornless, precocious flowering, high pod yield and bio-mass from 3-4 years of establishment. For easy germination and healthy growth of seedlings, prior to sowing, seeds should be soaked in water for 4-6 hours and also treated with fungicide. For field planting, 9-10 months old seedlings should be used and it should be started with the on-set of monsoon rains from July-September which gives 80-90% establishment.

Training and pruning

Training and pruning are essential practices for plant structure, canopy management and harvest of crop produce khejri. After successful intake of scion buds on the rootstocks either in nursery raised or *in situ* established seedlings, the upper portion of the stocks should be removed or pruned so that growth of sprouted scion

bud may faster.

Lopping

In western Rajasthan and adjoining areas of Haryana, the lopping of trees starts from mid-November and continues up to January. The leaves and pods constitute a major source of fodder. The dried leaves of *khejri* called as loom or long are used as quality fodder for the animals during lean period. There is contrary report about lopping practices. It is reported that if trees are lopped at 3 years intervals, they produce 172-242% more leaf fodder by weight than those recurrently lopped. In general, annual lopping is common practice of *khejri* by the farmers, though annual lopping is not suggested for sangria production. The tree may be lopped after harvesting of the pods, in order to promote physiological maturity of the shoots for production of sangria next season. These observations must be verified by conducting field experiments.

Harvesting

The trees of seedlings origin come in bearing after 8-10 years but the vegetatively propagated plants came in fruiting after 3rd year and thus the gestation period reduced markedly. The plants flower during February-March and fruit setting takes place in April-May. Only immature tender pods are used as vegetables, hence stage of harvesting is very essential, which should be done within fortnight of fruit setting in two-three consecutive operations. It is very difficult to assess the yield of *khejri* growing under natural conditions due to variation in age, site conditions, uncontrolled lopping and other biotic and abiotic interferences. As an estimate, a fully grown

up tree (> 12 years old) gives on an average 7-8 kg green tender pod yield per year. The recovery is about 25-30% after dehydration of fresh sangria. However, there is high variation in market price of fresh sangria (₹ 20-25/kg) and dehydrated sangria (₹ 150-200/kg). Therefore, setting of dehydrated sangria is more economical than the fresh ones. Ripe pods may be collected by hand picking or by shaking/beating the branches. Nearly 1.4 quintals of pods/ha with a variation of 10.7% in dry location can be obtained. The pod yield is significantly correlated with diameter at breast height of the tree. One tree of Khejri gives at least 5 kg of ripe pods.

Production economics

Since profitability is the prime concern of farmers, hence the economic analysis of the production of pods, leaf, bark, sticks and roots is compared on the basis of feedback received from the farmers. Monetary advantage obtained through cultivation of Khejri by adopting improved production technologies can be very well accessed through comparison between other plants and crops on the average yield, resources/inputs used and prevailing price of inputs and produce. Table 2 shows that net return obtained ₹ 154968/ha (B: C ratio of 8.6) from Khejri than other crops and fruit plants. Thus by cultivating such arid plant through adoption of suggested scientific ways will surely uplift the economic status of farmers of western Rajasthan.

Utilization

Each and every part of the *khejri* including root, stem, bark, leaf, flower, fruit, seed and gum are being used in one or the other way (Tables 1 and 2). The main uses are thickening wood as timber, lopped branches as fuel, leaves as fodder, green tender and dehydrated pods for vegetables, dried pods (*khokha*) for fresh consumption and flour of dried pods are used by the rural people for making chapatti to limited scale and also as cattle feed. The immature pods of *khejri* (*sangria*) are rich in protein content (15%). The gum, inflorescence and bark have various medicinal uses adopted by rural communities as indigenous practices. The seeds obtained from dried pods are oil yielding.

As agro-forestry component

Khejri is compatible perennial component of various agro-forestry systems in arid ecosystem because of its deep root system, leguminous nature, prone to lopping and capacity to tolerate various biotic and abiotic stresses. Farmers have retained the *khejri* plants in their fields and bunds as the trees have least or no adverse effect on several ground story crops. In arid region of western Rajasthan, moth, *guar*, *bajra*, mixed with *kachri*, *mattera*, *tinda*, *kakri* etc. are being grown in association with natural growing *khejri* under rainfed condition since long back. The effect of *khejri* tree on vegetative vigour of fruit trees like anola, ber, guava, pomegranate and bael grown under shade and in open conditions was also assessed. It was observed that the fruit trees grown under shade produced more vigorous growth with respect to plant height,

canopy spread and tree volume as compared to those growing in open. The percentage increase in tree volume was highest with ber followed by anola, bael, pomegranate and minimum in guava plants. The observations indicated that the *khejri* tree has not only positive effect on annual crop but it also improves the vegetative vigour of several fruit trees planted in their proximity.

Dehydration of sangria

The tender pods of *khejri* both fresh and dehydrated are utilized as vegetable. Now-a-days, *khejri* dishes are very popular in some of top class hotels in Jaipur, Jodhpur, Jaisalmer, Jalore, Pali and Barmer of Rajasthan. However, the dehydrated *Sangria* available in the market are not of ideal quality because of improper harvesting stages, uncleaned and un-blanching before dehydration. Therefore, an experiment was initiated to see the effect of blanching treatment on dehydration quality of *sangria*. It has been found that 5 minute blanching in 2% salt solution gives light green colour after rehydration and liked by the people on organoleptic scoring as compared to either un-blanching (control) or blanching in boiling water only. However, the product of prolonged blanching (10 minutes) both in water and in 2% salt solution also was not liked by people.

Preparation of khejri cookies

A preliminary attempt was made to prepare cookies from dried *khejri* pods (*khokha*). After proper cleaning and drying, the powder of *khokha* was made with and without seeds. Thereafter the *khokha* powder was mixed with wheat flour by replacing 10, 20, 30 and 40% wheat flour while other ingredients remaining almost constant and its biscuits were prepared. By scoring, the 10% replacement of wheat flour by *khokha* powder without seeds was the best among all other treatments. With increasing ratio of *khokha* powder, the taste of biscuits becomes bitter. The interesting point was that the highest organoleptic score was secured by control (without *khokha* powder) indicated that colour and taste were more important than nutritive value from marketing point of view. The extraction of seeds from *khokha* was the other limitation.

SUMMARY

The importance and prospects for further use of *Prosopis cineraria* (L.) MacBride is reviewed. This leguminous tree species is common in the arid and semi-arid zones of the Indian state of Rajasthan, and is of great economic importance as almost every part of the tree is utilised. It is extremely drought resistant, supports a higher understorey plant population than other dryland tree species and has a major role to play in agri-silvicultural and silvo-pastoral systems.

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