

concept - Horticulture Based Crop Production Site Management Approach (HBCPSMA) as an innovative tool for breaking up the yield gaps.

Based on SWOT analysis for desert horticulture, some principles have been recommended under the concept (HBCPSMA) for the development and management of crop production sites. The production sites should be developed in accordance to the topography of sand-dune landscape and soil conditions. Fencing of production site and development of multi-tier rows of seedling plantation of native species such as khejri, lasora, rohida and bordi alongwith desert shrub florals all-around the field blocks is the prime consideration for the creation of favourable micro-climate which is must for the protection of crop production site. The innovative technologies under HBCPSMA includes selection and development of khejri based crop production sites, preparation and maintenance of production sites for *in situ* rain water harvesting and soil moisture conservation, and crop cultivation. Keeping of crop field fallow for 1-2 months from April - June or October - November, and is an important practice for soil health security and development. Adoption of pre-monsoon field ploughing during June prior to rainy season crop sowing and post-monsoon field ploughing during November after crop harvest as techniques resulted into more *in situ* rain water harvesting, moisture conservation and weed free field in the production site. Besides, seed selection, sowing time and techniques, maintenance of plant population and crop protection measures are good management practices and suggested for improving marketable yield of crops and productivity of resources.

The successful cultivation of agronomic crops such as bajra, guar, moth, mung, cowpea and groundnut during kharif and wheat, mustard, gram, etc. during rabi season, and excellent plant growth, development and yield potential of most of the vegetable crops and fruit

trees such as ber, aonla, bael, kinnow, lime, etc. and also desert plant species of commercial significance such as jharber, ker, lasora, pilu, rohida, kumat, phog, khimp and grasses like sewan, dhaman, bharut, etc. in association with the natural plantations exhibited the significance of khejri trees on this landscape. Therefore, the systematic and long term research work on khejri based crop production site management approach is required for technological improvement and this could be an innovative tool to break-up the yield gaps in crops over the conventional or intensive crop production systems.

The potential khejri based conventional crop combinations under rainfed situations would be such as i) Khejri + traditional arid zone farming, ii) Khejri + ker or jharber (as sole intercrop) and iii) Khejri + cluster bean or moth bean, bajra, kachri, snap melon, mateera, tumba, sewan (as sole intercrop). The khejri based non-conventional crop combinations under irrigated situations would be such as i) Khejri + pomegranate or lime, ber, aonla (as sole intercrop) and ii) Khejri + groundnut or cotton, wheat, barley, mustard, gram, cumin, rainy/winter season vegetables (as sole intercrop). The khejri can be with varying planting models such as KM-1 (4x4m), KM-2 (6x6m), KM-3 (8x8m), KM-4 (8x4m), KM-5 (8x4x4m), KM-6 (16x4m), KM-7 (16x4x4m), KM-8 (24x4m), KM-9 (24x4x4m), KM-10 (48x4m), KM-11 (48x4x4m) and KM-12 (scattered). On the basis of crop potentialities and diversification, so far, two horticultural combinations have been recommended for better resource utilization and regular income to the farmers. These rainfed cropping systems are (i) organic Panchkuta (khejri, ker, lasora, kumat and kachri) production and (ii) vegetable (mateera, kachri, snap melon, round melon and cluster bean) production with wide spacing khejri planting models (paired row of 4mx4m khejri plantation at 24m or 48m distances).



Nursery raised seedling for budding or field planting, *in situ* orchard establishment and orchard of var. Thar Shobha



*in situ* established plant of var. Thar Shobha, and training and pruning operation technique in budded plants



Inter-cropping of cluster bean variety Thar Bhadavi and kachri variety AHK-119 with wide spacing khejri planting model - KM-11 (48 x 4 x 4 m) under rainfed conditions

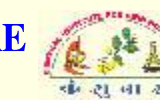
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 Citation : **Khejri : Thar Shobha - grow for horticultural exploitation (2015), Technical folder**  
 Printed by : Kalyani Printers, Bikaner (Raj.) Tel. : 0151-2526890

## Khejri - Thar Shobha

### Grow for horticultural exploitation



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## Khejri - Thar Shobha : Grow for horticultural exploitation

The Indian Thar Desert is a marginal zone for agriculture production. The extremes of high (March-October) and low (December-January) temperature conditions alongwith associated abiotic stresses in the hot arid region limiting the choice of crops, quality of produce and productivity. Horticultural exploitation with native crop species is generally found to be potential and stable in the arid and semi-arid areas that receive about 150-500 mm of rainfall and which is concentrated between the months of June-September. Out of 9 - 12 mean rainy days/annum in the hot arid region, much of the rain often comes in only a few (1-3) heavy rainfall events during the monsoon season, which can be erratic and unpredictable. The high temperature (35 - 46 °C from July-October) conditions and prolonged period of drought in combination with sandy soil creates an environment where few rainfed crops can survive. The native crop species both annual and perennial plays an equally vital role for food and fodder especially in the state of Rajasthan, where the livestock population is an important element of the agricultural system.

### The Khejri

Khejri (*Prosopis cineraria*), also known as shami (Sanskrit), janti and jand (Delhi, Haryana, Punjab), sumi (Gujarat), banni (Karnataka), kandi (Sindh) is a leguminous tree species of arid and semi-arid regions of India. It not only tolerates the extreme edapho-climatic conditions of these regions but also bears flowers and fruits and that too during the driest period from March-May. Khejri is a tree having multipurpose uses, viz. nutritious rich pods and fodder and valuable fuel, besides its favourable effects on ecology and soil fertility. It is an important perennial component compatible to almost all companion crops grown under the traditional cropping systems in the hot arid eco-system. Khejri is a focal component of the flora of *Thar* Desert. It readily perpetuates itself from the dispersed seeds giving rise to a widespread seedling population. It is a sacred tree and widely protected for

socio-economic and cultural benefits. Besides, its seedling plantation is also promoted under social and agro-forestry systems. The density of plants varies with the rainfall pattern, range management, farming and utilization systems on farm lands, non-culturable wastelands and barren lands. In general, the seedlings ranged from 15 - 165 trees/hectare from arid to semi arid areas, and is scattered.

This versatile tree is the lifeline of Indian desert. It grows luxuriantly under the extremely adverse agro-climate of the hot arid region and that too without much cultural care. It is a major source of leaf fodder (loong) and its tender pods (sangri) are used as vegetable, and the produce is nutritious and high valued. Traditionally, due to edible pod quality, the rural people collect it for fresh or dehydrated use. There is no quality standard and so far what-ever produce of sangri is available and the same is being harvested and used it by the desert dwellers. The ripen pods (khokha) with full of seeds are protein rich and is good source of animal feed. The ripen pods can be powdered for preparation of bakery items such as biscuits and cookies. From a mature tree (20 years age), 25 - 30 kg loong and 10 - 15 kg tender pods can be harvested annually. The sangri is sold at high cost both fresh and dehydrated (50-80 and 300-500 Rs/kg, respectively) and is eye-catching vegetable. The leaf fodder is also sold at high price (10-15 Rs/kg) and has excellent market opportunities.

The recent years technological advancements in khejri (bud grafting as vegetative method of propagation and variety Thar Shobha) at CIAH, Bikaner resulted into wide spread popularization of this indigenous tree for its diversified exploitation. For the commercialization as horticultural crop, CIAH has developed and recommended production techniques such as budding for multiplication of plants in nursery, *in situ* orchard establishment, thornlessness and crop regulation in plant. The recommended technologies

have now been widely adopted for establishing plantations for uniform sangri production as horticultural crop and also in cropping systems for diversified potentialities under resource constraints arid environment. The systematic production of standard product from such plantations would add value to the already existing lucrative trade in dehydrated pods (sangri) and provide assured income to the farmers and quality produce to the people.

### Varietal development

Being a cross pollinated, considerable genetic variability do exists in the widespread seedling population of khejri and reported for plant and pod characters. Wide range of variations were recorded in immature pod traits such as taste (bitter, acrid, sweet), tenderness (hard, semi-hard, less-tender, tender), shape (round, flat, flat-round or straight, wrinkled), fibre content (fibrous, less fibrous, fibreless), colour (green, light green, dark green) and length (6 - 39 cm) for horticultural exploitation. From the intensively studied natural seedlings showing wide genetic variability, 16 genotypes were collected from 2002 for *ex situ* conservation at CIAH. Till the development of first variety in khejri by CIAH, there was no named variety for uniform sangri production in the traditional systems and also no systematic orcharding for its commercial cultivation. In the past, due to non-availability of production techniques in khejri, no much progress was made for varietal development too and it was the first of all started at CIAH and variety Thar Shobha was recommended in 2007 and popularized for orcharding.

### Thar Shobha

Plants of the variety Thar Shobha are vigorous in growth and thornless in nature. It tolerates extremes of high (> 48 °C) and low (- 4 °C) temperature and aridity conditions. It is extremely drought tolerating and therefore, it has high potentiality of production under rainfed conditions of the hot arid and semi-arid areas.

The development of the Thar Shobha would results into systematic cultivation in the farming systems of crop production, and it would ensure good harvest of both fodder and pods from khejri plantations even when there is a complete failure of monsoon rains during current kharif season of the year. Thar Shobha is the first variety for developing plantations of uniform, better quality and high sangri production on commercial scale. A five year old bud grafted plant yield to harvest of 4.25 kg sangri and 6.25 kg loong in a year with improved production technology, and the bio-mass production is in increasing order with plant age. The tender pods at marketable stages are 13.1 - 20.2 cm in length, 0.17 - 0.42 cm in width, 0.97 - 1.75 g in weight and seeds not-separable in the stages of vegetable use. Tender pods are light green in colour, straight, roundish-flat, soft and sweet. The ripen pods are 13.5 - 22.5 cm in length, 0.49 - 0.65 cm in width, 1.65 - 2.15 g in weight with 11.15 - 16.85 seeds/pod. The weight of 100 seeds is 6.66 g.

### Production technology

#### a) Orchard establishment:

To develop true-to-type plantations of khejri variety Thar Shobha, vegetative propagation technique is necessary either budding on nursery raised rootstocks 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 ease germination and healthy growth of seedlings, prior to sowing seeds should be soaked in water for 4 - 6 hours and also treated with fungicide. In nursery filled poly-bags, sowing of seeds should be staring from October - February, and 2 - 3 seeds should be sown in each bag. 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 and it gave 80 - 90 % establishment. Since, the success in bud grafting (budding) and subsequent rate of sprouting of scion depends on the vigour of rootstock,

it is therefore, proper care is required in the saplings either raised in nursery for budding or field planting and developed *in situ* followed by *in situ* budding. On an average, 76 per cent success is obtained with patch budding, and the best time for budding is from April - October. In nursery, the good results of budding are obtained on 12 - 15 months old rootstocks. The *in situ* budding is most successful on 12 - 24 months old rootstocks for orchard establishment and also effective in top-working the wild sapling of 3 - 4 years age.

#### b) Training and pruning:

Training and pruning are essential practices for plant structure, canopy management and harvest of crop produce in 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. The wild sprouting below the graft should be removed regularly through pruning operations using sharp cutter. For better frame work of bud grafted trees, training operations should be done twice in a year i. e. November and June months and should be continue up to four years from budding. The regular training and pruning operation should be started after age of five years for better canopy management and yield potential of plantation keeping the objectives of crop production.

#### c) Growth regulation for annual production of both sangri and loong:

In general, the khejri trees are lopped (pruned) during November - December to harvest the leaf fodder (loong). These pruned trees do not flower as the new shoots sprouting after the pruning are still immature during the flowering time of khejri in February-March and thus do not produce sangri. When sangri is desired to be harvested from a particular tree, it is not lopped during November - December, but then the tree would not yield any loong. With technological recommendations, systematic plantations would be developed for sangri production and these will have to be left unlopped. Consequently these trees would not yield loong. The

studies on growth and fruiting regulation conducted at CIAH revealed that the plantations developed primarily for sangri production, the traditional practice of lopping during November - December could not be adopted. Now, lopping can be done during June month to obtain loong and it can be done after the harvest of ripen pods. The pruning of plants at this time synchronizes with the start of the second growth flush in khejri during June - July. This growth flush gets sufficient time (6 - 7 months) to mature and differentiate floral buds which develop into flowers and produce good crop of pods. Thus, June pruning is recommended to harvest both loong and sangri annually as a technique of crop regulation.

#### d) Development of khejri based crop production sites:

The traditional cropping systems have provided sustenance to the desert dwellers. In vast arid farm lands, cultivation of pearl millet, cluster bean, moth bean, sesame and native cucurbits is done as component crops between the natural plantations of khejri, and in addition some native trees/shrubs/grasses (jharber, bordi, lasora, pilu, ker, phog, sewan, etc) are the part of traditional agri-horti-silvi-pastoral system prevalent under rainfed situations in the hot arid region of India. This system of harvesting of agricultural produce can provide sound farm economy, improved nutrition and health standards of the livelihood and stability when the monsoon rains is good during the kharif season. Under the changed scenario, now the focus has shifted from sustenance to remunerative farming but the mono-cropping is much risky for the development of desert horticulture. This is mainly because of scanty, uneven and regular failure of monsoon rains and also environmental restrictions prevailing in the hot arid region. Therefore, the traditional farming systems of arid region pre-dominantly mixed cropping needs multi-dimensional exploitation through interventions between the native crop species and newer technological advancements, and this can now potentially be exploited under the