

# **Overview of Use of *Prosopis juliflora* for Livestock Feed, Gum, Honey, and Charcoal as Well as Its Role in Combating Drought and Desertification: Regional Case Studies from Gujarat, India**

Ashok Varshney  
Deputy Conservator of Forests  
Vadodara, Gujarat, India

## **Introduction**

*Prosopis juliflora* is an aggressive and invading species that has spread rapidly due to its great tolerance to the extremely refractory conditions in the northwestern arid zone of the Gujarat state. Consequently, it constitutes about 30% of the vegetation cover in this unique and diverse ecosystem. It is the only promising species capable of supplying a renewable source of raw materials used in various cottage and small-scale industries. The high inherent coppicing capacity of *Prosopis* is a major factor contributing to the renewable nature of this resource. Regarding the use of *Prosopis juliflora*, some studies have been conducted for livestock feed by Gujarat Agriculture University, Anand, and Vivekanand Research and Training Institute, Mandvi-Kachchh. Gujarat State Forest Development Corporation, Ltd. (GSFDC), has used this species since 1981 for forest products: pods, gum, honey, wax, and charcoal. Moreover, this species has been chosen by the Forest Department for intensive afforestation programmes under different schemes to check desertification in the refractory areas.

## **Use of *Prosopis juliflora***

The usefulness of *Prosopis juliflora* has long been recognized (Muthana and Arora, 1983; Silva, 1986; Silva, et al., 1986). It is considered to be a valuable tree species of the desert ecosystem. Its multiple-use possibilities have attracted growing interest in this species, especially in arid zone covering eight districts of the northwestern region of the Gujarat state (Singh, et al., 1996). This arid zone occupies a geographical area of about 3,500,000 ha, of which, a large portion is covered by a saline desert called the Rann of Kachchh. Here, *Prosopis juliflora* constitutes a large percentage of vegetative cover, extending over an area of about 500,000 ha. In this desert ecosystem, this species is one of the most efficient species to convert energy into biomass as a primary producer. It produces about 25 to 30 tons/ha/year at the short rotation age of 4 to 5 years (Patel, 1986). It is, therefore, necessary to improve the management of this natural resource through scientific and technical studies to obtain various raw materials in perpetuity for agro-industrial utilization. GSFDC, Gujarat Agricultural University, Anand, Vivekanand Research and Training Institute, Mandvi-Kachchh have been active in developing management techniques for this species. For example, GSFDC has undertaken a programme of collection, processing, and marketing of various minor forest products from different parts of *Prosopis juliflora*. The following forest products have been collected from different parts of the northwestern arid zone of Gujarat: pods, gum, honey, and wood for charcoal production. *Prosopis* has also been used to combat desertification.

## ***Pods collection for livestock feed***

*Prosopis juliflora* trees have a tremendous potential for pod production. The pods are collected twice a year (winter and summer). The maximum pod production is between March and June. GSFDC has collected about 2000 metric tons of pods and generated about 100,000 man-days (a man-day refers to a daily wage of Rs.40.00, equivalent to US\$1.20) of labour (approximately US\$125,000) during the last five years (GSFDC, Vadodara's records). Pod production is estimated to be about 20 kg/tree/year (Shukla et al., 1984), thus, about 10 metric tons/ha (500 trees/ha). It is estimated that about 5 million metric tons of pods could be collected from an estimated area of about 500,000 ha

in the entire northwestern arid zone of Gujarat. If 40% of the pods were actually collected, the estimated yield would be about 2 million metric tons, which could provide employment to millions of people and earn hundreds of millions of Rupees as state income. Vivekanand Research and Training Institute, Mandvi-Kachchh, has installed a livestock-feed manufacturing plant. The Institute has succeeded in preparing highly nutritive livestock feeds from these pods after seed separation. The whole project provides employment to the rural poor through collection of pods. The project also provides a highly nutritive cattle feed that is cheaper than other available cattle feeds.

Regarding the composition of dried pods, Vimal and Tyagi (1986) have reported that the pods contain: protein, 16.5%; fat, 4.2%; carbohydrate, 57%; fibre, 16.8%; ash, 5.4%; calcium, 0.33%; and phosphorus, 0.44%. Moreover, Gujarat Agricultural University, Anand,, determined the trace-element composition of *Prosopis* pods as 12.46 to 15.51 ppm copper, 22.11 to 22.30 ppm manganese, 18.30 to 28.01 ppm zinc, and 203 to 638.8 ppm iron (Shukla, et. al., 1984).

Because of the high carbohydrate content and good amount of protein, the spongy walls of ripe pods are highly nutritive and used in making meal for humans (pinole) and alcoholic beverages (Mesquitabole, mesquite wines, etc.). The husk of pods is used for dyeing; they contain tannin (1.9%). Raizada and Chatterjee (1959) have noticed that the ripe pods are said to have high nutritive value, i.e., rich in sugar and nitrogen and are greedily eaten by most of the herbivorous animals and livestock. Further, the pods may yield a substitute for wood shavings used in various industries for thermal insulation and acoustic control (Narayanmurti, 1955). Studies on palatability and nutritive value of pods and their source as livestock feed and milk production, particularly goats, sheep, and camels, have been conducted by Gujarat Agricultural University, Anand,.

*Prosopis* pods provided good fodder without causing any digestive adverse effect. For cattle and buffaloes, the pods were not regarded as good fodder because of the high sugar content and indigestibility of raw seeds. (Shukla, et al., 1984). When fed in the dried and crushed state in the form of powder, the pods did not show any deleterious effect on cattle and, in fact, resulted in good animal performance.

Further, 50% wheat and rice-straw, molasses and ground-nut cake can also be mixed with this powder to make it more nutritious, palatable, and valuable. This powder contains 13% glucose which can be utilized in making biscuits after adding to it 50% wheat fine flour. During drought and scarcity, the pods are even used as food items by poor people. (VRTI, Kachchh-Mandvi).

To use *Prosopis juliflora* pods as a livestock feed, GSFDC has proposed a scheme for manufacture of livestock feed in Kachchh district to take advantage of the quantities of pods that are available. The seeds will be sold to the Forest Department and other agencies for raising plantations.

### ***Gum production***

*Prosopis juliflora* exudes gum from the sap wood. On average, about 40 g of gum is produced from one plant. However, under drought conditions more gum is exuded. During 1991-1992, the maximum production of more than 1000 metric tons was obtained. This compares to the normal yield of about 300 metric tons/year (GSFDC, Vadodara's records). In the last five years, the corporation has collected about 2000 metric tons of gum and generated more than 1 million man-days of labour (approximately US\$1 million). The gum forms an adhesive mucilage, with favourable physical and chemical properties, that can be used as an emulsifying agent. *Prosopis* gum also finds use in confectionery, mending pottery, and as an adulterant and substitute for gum arabic. (Krochmal et al., 1954). Owing to the high content of arabinose, which is easily separable, the gum has proved to be an excellent source of this sugar. Moreover, the gum is used in industries, etc. If additional utilization of this gum can be found, it would further enhance the value of this already economically important tree (Ganguly and Kaul, 1961). Furthermore, the gum contains: D-galactose, 45%; L-arabinose, 24%;

L-rhamnose, 13%; and glucuromic acid, 13.7%. It possesses fairly good adhesive strength and can be used as paper adhesive for brown paper and wall paper. The gum has also been used in treating eye infections (Vimal and Tyagi, 1986).

### ***Honey collection***

*Prosopis juliflora* flowers profusely twice a year and produces sweet nectar that gives excellent honey. In the last five years, about 300 metric tons of honey has been collected, processed, and marketed by GSFDC, which has generated about a half million man-days of labour. *Prosopis* honey accounts for about 90% of the total production of the state in the Kachchh district (GSFDC records). The honey is produced by a rare species of honeybee, *Apis florica*, that is found in large numbers in Kachchh district due to its peculiar climatic and environmental conditions. The honey produced by *Apis florica* is regarded as one of the best quality of honey from the medicinal point of view, with an "A" grade by researchers at the Central Bee Research & Training Institute (CBRTI) in Pune.

In view of the increasing honey demand, the corporation has proposed a scheme for honeybee rearing to increase honey production in the Kachchh district. GSFDC honey enjoys high acceptability in the local market due to its purity and reasonable price. By rearing the domesticated variety of honeybee in selected areas of Kachchh district, the production can be increased. In this new process, modern methods of extraction from combs will be applied using new technology developed by CBRTI.

During purification of the honey, the wax is separated through filtration. In the last five years, about 15 metric tons of wax have been collected by GSFDC that has found good markets for creams, pain balms, and medicines.

### ***Charcoal preparation***

GDFDC has been entrusted with manufacturing charcoal from *Prosopis juliflora* by the government of Gujarat. This activity has given significant employment opportunities to the local people. In the last five years, the corporation has manufactured about 300,000 bags of charcoal (1 bag = 30 kg) and generated about 300,000 man-days of labour (approximately US\$350,000). The corporation has also delivered charcoal to the Forest Department for meeting the bonafide needs of the local population of the district. As a result, with its one million population, Kachchh is the only district in India that is self-sufficient in its fuelwood requirements. *Prosopis* charcoal from Kachchh is also sent to other districts of Gujarat state to meet their fuelwood requirements.

It is useful to estimate the total resources potential from *Prosopis* charcoal in the entire northwestern arid zone of Gujarat.

Assuming that

500 trees/ha produce 24 kg dry biomass at end of five years (12 dry metric tons/5 years = 2.4 tons/year)

16.6% wood-to-charcoal yield for 0.4 tons of charcoal/ha-year

100,000 of the 500,000 ha of the area covered by *Prosopis* is harvested and processed into charcoal each year

then, the approximately 500,000 ha of *Prosopis juliflora* would yield about 200,000 metric tons of charcoal per year in perpetuity on a five-year cycle. Thus, annually 6.66 million bags of charcoal worth Rs. 500 million (approximately US\$15 million) would be available (one 30-kg bag of charcoal costs Rs.75). In this way, millions of man-days of labour could be generated for employment.

Charcoal is prepared by burning thick stems and roots of trees under anaerobic conditions. Only one-third of the total quantity of fuelwood processed becomes charcoal. The wood is hard and heavy

(specific gravity 0.70). It is excellent firewood (calorific value is 4800 k cal/kg) that burns slowly and evenly and holds heat well. Because of its superior quality, it is considered to be one of the best charcoals (Vimal and Tyagi, 1986). Dry wood, on destructive distillation gives 33.9% charcoal, 1.24 methanol and 124.8 litre/kg of gas. *Prosopis* wood, together with rice husk and other agro-wastes, can be briquetted to form a good quality white coal. Other forms of charcoal can be used for household purposes. The pellets are prepared from twigs, powder from *Prosopis* pods, and charcoal waste particles. This mixture is bound together with a mixture of agro-wastes under specific temperature and pressure conditions. Briquettes are prepared from crushed green, dried (with supplemental heat) twigs that are mixed with *Prosopis*-pod powder, wooden chips and a binding material like rice husk and other agro-wastes. When hydraulic pressure is applied to this mixture, gum contained inside the wood chips comes out and mixes with the rice husk layer surrounding the wood chip. The resultant product is a briquette, in which *Prosopis* wood forms a core and rice husk forms an outside layer. These briquettes have better breathing action, and hence, better combustion characteristics than those of other types, and are used in furnaces.

Charcoal-manufacturing activities have been carried out in remote and backward areas of the districts like Kachchh, Banaskantha and Surendranagar by forming co-operatives and societies. The District Rural Development Agency, Banaskantha, has sponsored the scheme of Development of Women and Children in Rural Areas (DWACRA) to generate employment and income for poor people. Under this scheme, thousands of families have been benefitted by preparing charcoal in *Prosopis juliflora*-dominated areas.

### ***Combating drought and desertification***

The entire northwestern zone of Gujarat is facing the grim prospect of drought and desertification. A recent survey has revealed alarming facts about border areas that the process of desertification, which is, by and large, man-made, can play havoc with the ecological order (Varshney, 1995). The data collected from local inhabitants and government records show that the neglect of popular mechanisms had paved the way for the fast movement of the desert at an alarming rate of about a half-kilometer a year (Varshney, 1995). Consequently, the villages bordering western Rajasthan and Rann of Kachchh were the worst hit. The once fertile lands of those border areas have turned into barren wastelands. Over exploitation of ground water and vegetation, as well as mining activities, have resulted in a sharp increase in salinity levels. The study further revealed that the soil thermal regime, frequencies of salt sprays, and change in rainfall patterns have affected the soil moisture. Rapidly disappearing forest cover, lack of environmental consciousness among the people, accompanied by a blind race for rapid economic returns, have aggravated the situation in this zone. Some of the main reasons for desertification, outlined in the report were:

- Escalation in population of both humans and livestock
- Mobility of saline dust from the broken and cracked coastal area
- Salt spray and velocity of the wind during summer
- Increased salinity due to submergence of the fertile areas of this arid zone with saline water during the rainy season.

All these factors have contributed to the relentless march of the desert. Additionally, the Aravali hills have also been eroded and denuded, but due to different causes of over-grazing and other biotic pressures.

To combat desertification and check drought, afforestation programmes have been carried out under different schemes, viz. Desert Development Programme, Afforestation on Desert Border, and Border Area Plantation. These schemes have created shelterbelts and windbreaks on the periphery of agricultural land and wasteland as well as barren and saline areas under forests. No doubt, due to its tolerance to refractory environmental conditions, after successful introduction, *Prosopis juliflora* has been spread extensively and given excellent results in plantation activities carried out in about 20,000

ha in desert areas of Banaskantha and Mehsana district under the Desert Development Programme in the last 18 years. The practice of nomadic pastoralism with free grazing has stimulated the distribution of this species because the undigested, but treated seeds, pass through the digestive system of the livestock and are disseminated by migratory animals. This seed dispersal on vast areas has helped natural regeneration and naturalization of this species. Consequently, the desert is blooming and eroded, denuded Aravalli Hills are also becoming green due to its fast growth and drought-hardy inherent capacity. Further, a 4- to 6-year-old stand of *Prosopis juliflora* has reclaimed salt affected soils by enriching them with 6 to 8 tons/ha of air-dry leaf litter containing sufficient quantities of both macro- and micro-nutrients (Forest Department records). Last, but not the least, the seed cakes of this tree species that have been sown on contour trenches and excavated soil of water-retaining structures, such as check dams across the desert lands, have produced significant results in creating green belts and windbreaks to check the rapidly spreading devil of desertification - a problem of international dimensions.

### **Future Prospects**

*Prosopis juliflora* is the only tree species utilized for its each and every part in various ways on a commercial basis. Due to its multiple uses, it has gained public acceptance as a plant of recognized economic value. This inherent capacity and potentiality of *Prosopis* can be converted into an even greater asset through application of scientific and technical methods. These new *Prosopis* technologies can accrue numerous benefits besides generating tremendous local employment opportunities.

It is necessary to explore the feasibility of obtaining new products from *Prosopis* such as activated carbon, gas, organic acids, acetic acids, methanol, acetone, etc. through wood distillation. There is also a possibility of extracting carotene from its green leaves. The foliage, along with other organic matter, could be used as a green manure or compost. In summary, this tree has played a pivotal role in combating desertification and drought through its intensive plantation on refractory areas to enhance their ecostability. Hence, time has come to pool the scientific and research findings for multiple agro-industrial uses of *Prosopis juliflora* and to name it “KALP-VRAKSH”, i.e., a tree that fulfills each and every desire and demand.

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