

Forest resources and their nutritive worth

for arid livestock

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The hot arid zone of India is situated between 24° and 29° N latitude and 70° and 76° E longitude, and covers an area of 31.70 million ha. The arid areas of western Rajasthan, Gujarat, Punjab and Haryana together constitute the great Indian desert, better known as the Thar Desert, which accounts for 89.6% of the total hot arid zone of India. Arid western Rajasthan constitutes ~ 61.8 % of the entire hot arid region of country. Animal Husbandry is not only a subsidiary source of livelihood in rural Rajasthan, it is a major economic activity, especially in the arid- and semi-arid regions of State. This sector plays a vital role in the rural economy of the State and has significant impact on employment generation for marginal, sub-marginal and landless farmers. The western districts of the State are famous for indigenous cattle breed.

Key words: Arid livestock, Forest, Nutritive, Resources

A total of 682 species in 352 genera are found in the zone, of which only 9.4% are endemic. These forests are highly degraded due to severe biotic pressure and occur scrub forests in most of the areas. In general, vegetation is very sparse and inhospitable environmental conditions do not support the required natural regeneration and subsequent growth of plants. Table 1 indicate stop ten tree species present in tropical thorn forests, some of them are good fodder producing species.

Increase in livestock population and dwindling fodder resources of western Rajasthan leaves vast gap in demand and supply of fodder. This chronic deficiency of fodder needs to be corrected by stepping up fodder production from tree-based land use system. The production and life support systems in the hot regions are constrained by low and erratic precipitation (100 to 420 mm/year), high evapo-transpiration (1,500 to 2,000 mm/year), and poor soil physical and fertility conditions. Livestock in these regions

predominantly derive their feed from grazing on natural pastures. However, in the last few decades, the carrying capacity of grazing lands and nutritional quality of the pasture has been deteriorated to alarming extent due to recurrent droughts, continuous over-grazing and lack of range improvement interventions. Tree leaves make a big contribution to improved diets and nutritional quality, by adding variety to diets, improving taste and palatability of staples and providing essential vitamins, protein and energy. To achieve nutrition and income security for the people, particularly in arid region, suitable species from forests are of vital importance. Arid zone vegetation comprises a wide range of fodder tree species. In the present paper key species, fodder production and nutritive value of trees of hot arid regions are discussed (Table 2).

Prosopis cineraria trees are ready to provide animal feed from the 10th year onwards and, if properly managed, may be kept in production for 2 centuries. This thorny evergreen tree has slim branches with bluish



Fig. 1. *Prosopis cineraria*

green leaves and yellow or cream coloured flowers that bloom between March and May. Leaves contain 11 to 13% crude protein, and 19 to 20% crude fibre. Calcium (Ca) and phosphorus (P) contents are 1.92% and 0.18%, respectively. Total digestible nutrients are 40%. The leafy portion, known locally in India as 'loong' is available for 4 to 5 months (June-October), which is used as dry fodder for animals and loong can be give with animal feed also.

Prosopis juliflora is an evergreen tree with a large crown and an open canopy, growing to a height of 5 to

Table 1. Top ten tree species present in Tropical thorn forests.

Species name	Forest Type Group (%)	Dia-class wise distribution (%)						
		10-20	20-30	30-40	40-50	50-60	60-70	70+
<i>Anogeissus latifolia</i>	7.59	83.57	12.81	3.34	0.28	0.00	0.00	0.00
<i>Albizia amara</i>	6.83	78.02	17.03	4.02	0.62	0.31	0.00	0.00
<i>Chloroxylon swietenia</i>	5.83	92.76	6.52	0.36	0.36	0.00	0.00	0.00
<i>Hardwicki abinata</i>	3.36	57.23	21.38	14.46	1.89	2.52	1.26	1.26
<i>Canthiumd icocum</i>	3.30	85.26	12.82	1.92	0.00	0.00	0.00	0.00
<i>Wrightia tinctoria</i>	3.25	93.51	5.19	1.30	0.00	0.00	0.00	0.00
<i>Lannea coromandelica</i>	2.51	73.95	15.13	7.56	3.36	0.00	0.00	0.00
<i>Pterocarpus santalinus</i>	2.28	97.22	2.78	0.00	0.00	0.00	0.00	0.00
<i>Eucalyptus species</i>	2.18	86.41	10.68	2.91	0.00	0.00	0.00	0.00
<i>Grewia species</i>	2.09	95.96	4.04	0.00	0.00	0.00	0.00	0.00

Source: ISFR, 2015

Table 2. Chemical composition (%) of some important forest tree leaves/pods from arid zone.

Tree species	Dry matter	Crude protein	Crude fibre	Ether extract	Ash
<i>Prosopis cineraria</i>	35-38	11-13	19-20	03-04	16-20
<i>Prosopis juliflora</i> pods	60-75	11-13	12-19	03-04	05-12
<i>Acacia nilotica</i>	35-60	11-18	10-19	3.2-5.8	05-15
<i>Leucaena leucocephala</i>	25-30	14-28	19-20	1.5-6.0	10-11
<i>Acacia tortilis</i>	35-55	12-14	10-13	2.2-7.3	10-12
<i>Ailanthus excelsa</i>	65-70	16-19	12-21	03-04	11-19
<i>Azadirachta indica</i>	30-35	12-18	11-23	04-05	08-15
<i>Salvadora species</i>	30-35	15-17	08-10	1.1-2.6	15-18
<i>Albizia lebbeck</i>	40-50	16-23	30-32	03-04	07-8

10 m. It is fast growing, nitrogen-fixing and tolerant to arid conditions and saline soils. It has survived where other tree species have failed and in many cases become a major nuisance. For dairy cows, its pod flour may make up 40 to 60% of concentrate rations. In South Africa, it is fed unmixed to sheep. *Prosopis juliflora* leaves are unpalatable for most livestock but mature pods (with or without seeds) are highly palatable. An average plant starts fruiting by 3 to 4 years of age and yields annually 10 to 50 kg pods/ tree, which can be collected between April-June and December-January. Ripe pods are attractive to animals as they contain free sugars (15% of DM), which have a sweet taste. The seed has a high level of protein (31-37%) and energy. Pods contain high levels of energy (75% TDN) and moderate levels of protein (12% CP, 7% DCP), so they could be used as the sole feed supplement during flushing and early lactation to improve production performance of sheep, goat and cattle.

Acacia nilotica is a medium-sized, thorny, nearly evergreen tree that can reach a height of 20 to 25 m. *Acacia nilotica* is a useful fodder source, and

sometimes a very important one, especially in dry regions. The trees are browsed by livestock or lopped for fodder. The foliage and the pods dropped during the dry season can be an essential source of nutrients in periods of feed scarcity. The trees begin fruiting within 5 to 7 years and yield about 18 kg pods/year. DM yield of tree leaves varied from 0.2 to 2.0 tonne/ha/year. Crude protein content of the leaves is between 11-18%, and 11-16% for the highly palatable pods. Pods and shoots are used as forage for camels, sheep and goats, especially in Sudan, where it is said to improve milk yield from these animals. In India, it constitutes a chief diet for goats and sheep, and seeds are a valuable cattle food.

Leucaena leucocephala is one the highest quality and most palatable fodder tree of the tropics, often being described as the 'alfalfa of the tropics'. The leaf quality compares favourably with alfalfa or lucerne in feed value except for its higher tannin content and mimosine toxicity to non-ruminants. Livestock feed should not contain more than 20% of *Leucaena leucocephala*, as the mimosine can cause hair loss and stomach problems. Leaves have a

high nutritive value (high palatability, digestibility, intake and crude-protein content), resulting in 70 to 100% increase in animal live weight gain compared with feeding on pure grass pasture. Herbage taken at peak quality has 55 to 70% digestibility and 14 to 28% crude protein. Besides, it is very persistent over several decades of cutting or grazing, is highly productive, recovers quickly from defoliation, combines well with companion grasses and can be grazed with minimal losses from trampling or grazing. Forage, packed in pellets and cubes, is internationally marketed as animal feed.

Acacia tortilis is an important source of fodder for cattle in India, West Africa, Somalia and Ethiopia. Foliage and fruits form important browse. The leaves are fed green as well as dry. A 10-year-old *A. tortilis* yields about 4-6 kg dry leaf and 10-12 kg pods per year. The green foliage is fed between February and May, whereas to store dry leaves, they are collected in October. Fruits are preferred for stall-fed animals and should be ground to make them more nutritious. Crude protein and digestibility coefficients of *A. tortilis* are about 12 to 14% and 46.2%, respectively. Over 90% of the flowers abort and drop to the ground, providing additional important forage. Moreover, water content of the fresh leaves of *Acacia tortilis* is about 60% which is helpful in partially meeting the water requirement of animals in water deficit region of Thar desert. Some chemical ingredients interfere the digestion of fodder when fed to animals. They are present in lower proportion (within permissible limits), such as tannin 6.4%, lignin 9.7%, and cutin 0.4%.

The leaves of *Ailanthus excelsa* are rated as highly palatable and protein rich nutritious fodder for sheep and goats, and are said to augment milk production. The tree is therefore largely planted on farm lands. An average tree yields about 5 to 7 q of green leaves twice a year. Some trees are lopped for green leaves, while others can be dried and stored for feeding during scarcity period. The green leaves in some places are even

marketed. The leaves are rich in crude protein, ether extract and calcium (Ca), but poor in phosphorus (P) when dry or when chaffed with twigs. The green leaves are highly palatable and digestible, animals relish them better than the dry leaves even when the latter are treated with molasses to improve their palatability. The animals have to get used to acrid smell of these leaves. The digestibility coefficients are fairly high for all the nutrients except for ether extract whose digestion from leaves in the ruminants is generally low. The digestibility of different nutrients from green leaves is generally higher than that of dry leaves. Treatment of dry leaves with molasses improves the digestibility of crude protein, ether extract and crude fibre. The green leaves can serve as a maintenance ration for livestock, but leaves need supplementation by feeds rich in phosphorus. The tree starts giving fodder in the fourth year and onwards.

Azadirachta indica grows all over India. The plant remains green throughout the year and is drought resistant. Tree may start flowering and fruiting at the age of 4-5 years, but economic quantities of seed are produced only after 10-12 years. Fruits ripen in about 12 weeks from anthesis and are eaten by bats and birds, which distribute the seed. The leaves, though very bitter, are used as a dry season fodder. Large quantities of leaves become available, if judiciously collected. The neem leaves are not relished by the animals. The nutritive value is 6.19% DCP and 50% TDN. After the oil has been pressed from the seeds, the cake is used as fertilizer, but it can also be used as feed. Up to 10% neem-cake may be included in concentrates for

cattle and up to 5% for poultry. The oil-cake has a very bitter taste. Leaves and cakes are used as anthelmintic for goats and is said to give healthy looking animals when fed.

Salvadora persica is an evergreen shrub or small tree to 6-7 m. The tree is able to tolerate a very dry environment with mean annual rainfall of less than 200 mm. Highly salt-tolerant, it can grow on coastal regions and inland saline soils. Leaves and young shoots are browsed by all stock, but normally cattle do not occur in the driest part of the *Salvadora persica* distribution range and hence it tends to be valued more as a camel, sheep and goat forage. Leaves make good fodder as their water content is high (15 to 36%). The high salt content of the leaves is said to affect the taste of milk, but the leaves are said to increase lactation in cows.

Albizia lebbek can attain a height of 30 m and a dia of 1 m; more often it is 15 to 20 m tall with a dia of 50 cm. It can withstand long, hot, dry periods and cold winters. After attaining age of two years, it can tolerate droughts and to some extent frost also. In its natural habitat, flowering occurs from September to October; mature pods remain on the tree for long periods and are available from May to July. *Albizia lebbek* is grown in some areas primarily as fodder for camels, water buffalo and cattle. The leaves are reported to be good fodder with 16 to 23% crude protein; 100 kg of leaves yield 11-12 kg of digestible protein, and 37 kg of digestible carbohydrates. The pods contain saponin and are not eaten in large amounts by sheep, although cattle eat them readily. Suitable species from forests can play important role to achieve nutrition

and income security for the people in arid region. Forests are endowed with a number of plant species of food value, which yield edible leaves, fruits, seeds, roots, rhizomes etc. Some of the common forest fruit with their nutritive value are given in Table 3.

Balanites aegyptiaca is known as the date of the desert. *B. aegyptiaca* is a slow growing small tree about 20 ft. (6 m) high with bifoliate ashy green leaves. It is sporadically distributed on sandy soils under rainfall of 250 mm. The fresh and dried leaves, fruit and sprouts are all eaten by livestock. *B. aegyptiaca* contributed up to 38% of the dry-matter intake of goats in the dry season. It is mainly valued as a wild food plant. Mesocarp nourishing, sugar rich, palatable, bitter-sweet. *B. aegyptiaca* is a valuable reserve in times of scarcity. Ripe fruits eaten raw or sun-dried and stored like dates, made into sweet-meats or fruits juice (when macerated with water) and mixed with cereals, or fermented to alcoholic beverages. Kernel and seed meal are protein rich (26 to 30% in kernels) and only slightly inferior to peanuts with respect to amino acid content.

Capparis decidua holds exceptional importance in several north Indian communities: the tree offers shade and solace from the scorching desert sun, prevents soil erosion, feeds the locals (and their livestock), provides building materials and medicinal remedies, offers employment through harvesting, and is even considered holy by certain tribes. *Ker* grows wild and unattended throughout India's arid north-west regions. In Rajasthan and Gujarat, the little berry is a staple within the rural economies. Over 7,000 tonne of fruit are produced in the Rajasthan districts of Jodhpur and Bikaner. A prime reason for the fruits' significance is the trees' ability to survive in regions where no other vegetation can. Indeed, its only growing requirements are low rainfall, shallow soils, and dry, hot temperatures. *Ker* shrubs bear fruit twice a year, from March to April, and again from May to July. If the shrub bears for a third time, it will occur during in winter (from

Table 3. Nutritive content of some important forest fruits from arid zone

Species	Protein (%)	Carbo-hydrate (%)	Fat (%)	Fibre (%)	Ca (mg/100g)	P (mg/100g)	Fe (mg/100g)	Energy (Kcal/g)
<i>Balanites aegyptiaca</i>	4.9	69.9	0.1	3.5	147	58	4	300.1
<i>Capparis decidua</i>	8.6	1.8	-	12.3	55	57	-	41.6
<i>Cordia dichotoma</i>	2.0	92	2.0	2.0	55	275	6.0	394.0
<i>Prosopis cineraria</i>	23.2	56	2.0	20	414	400	19	334.8
<i>Salvadora oleoides</i>	6.0	76	2.0	2.0	6.0	76	8.0	346
<i>Ziziphus mauritiana</i>	0.8	17	0.3		4.0	9.0	1.8	73.9
<i>Aegle marmelos</i>	1.8	31.8	0.3	2.9	85	31.8	0.6	137
<i>Feronia limonia</i>	7.3	15.5	0.6	5.2	0.13	0.11	0.6	96.6



Fig. 2 *Ziziphus mauritiana*



Fig. 3: *Prosopis juliflora* with edible pods

October to November). Heaviest fruiting occurs right before the monsoon arrives. As a survival mechanism, highest fruiting happens during the driest times of the year.

Cordia dichotoma also known as Indian cherry, sebesten, goonda and lasora. Medium-sized deciduous tree having dense foliage distributed in rangelands of arid and semi-arid ecosystem. The leaves yield good fodder and are lopped for this purpose. A tree starts fruit production after 4 to 5 years of planting. Flowering varies place to place. Immature green fruits are available in April-May. The yield of fruits is 30 to 50 kg of fruits. They contain 42 to 53 % nitrogen-free extract, 2 to 3 % ether extract, 13 to 17 % total ash, 2 to 4 % calcium and about 0.3 % phosphorus. The seed kernel of *C. dichotoma* contains a high proportion of fatty oils and proteins (46 and 31%, respectively) which has potential as cattle feed.

Ziziphus mauritiana is a small, evergreen much branched tree or a large shrub. For good tree growth and bumper crop in ber, deep sandy loam soil with neutral to slightly alkaline reaction is desirable. However, *ber* trees can tolerate moderate salinity and bear with low fertility of the soil. It prefers hot and dry climate. Many of its varieties were developed which are cultivated extensively. Flowering and fruiting occurs from September to March. Fruits should be picked up at right stage of maturity. The yield of *ber* varieties varies from 1 to 2 q/tree. The fresh fruit comes in market during February-April at a time when there is a slack season for other kind of fruits. It therefore, sells readily at remunerative price. Fruit is a drupe, 12 to 15 mm in dia, globose, fleshy-smooth, yellow or orange when ripe.

The composition of *ber* fruits has been quite widely reported and much of the information is cultivar specific. Fresh mature *ber* fruits contain substances. *Ber* is richer than apple in protein, phosphorous, calcium, carotene and vitamin C and excels oranges in phosphorous, iron, vitamin C and carbohydrates. Fruits of *ber* are commonly used in Indian households as fresh fruit and dehydrated for later use. The mature green fruits are also occasionally used in India to prepare *chutney*, pickle and jelly. Powder is made from ripe fruits. A number of products such as *murabba*, candy and dehydrated *ber* are prepared from the fruits. Pulp made from ripe fruits is used to prepare products such as ready to serve beverage, squash etc.

Aegle marmelos is considered as a sacred tree by the Hindus. The essence of its fruits and leaves possess an evaporating oil which is very good for human system. The leaves absorb foul gases from the atmosphere and keep it clean and salubrious while the raw *bael* fruit produces heat and has purgative effect. The ripe fruit has cooling effect and is constipative. Raw *bael* fruit is consumed for treatment of ailments such as arthritis and gout. Ripe fruit is taken during summer to keep the body and mind cool. *Bael* also helps to sharpen intellect and concentration of mind. Except *Bael* seeds everything is useful for consuming. Taking 5 to 6 leaves regularly keeps the body and mind healthy. Because of its medicinal qualities it cures a lot of ailments. That is why *Bael* is also known as *Mahaphala* or Great fruit.

Feronia limonia (wood-apple) is native and common in dry plains. It prefers a monsoon climate with a distinct dry season. The scooped-out sticky pulp, is eaten raw with or

without sugar, or is blended with coconut milk and palm-sugar syrup and drunk as a beverage, or frozen as an ice cream. It is also used in chutneys and for making jelly and jam. The pulp represents 36% of the whole fruit. The pectin content of the pulp is 3 to 5% (16% yield on dry-weight basis) and has potential for multiple uses. Seeds contain bland, non-bitter, oil high in unsaturated fatty acids. The fruit is used in India as a liver and cardiac tonic, and when unripe, as an astringent means of halting diarrhoea and dysentery and effective treatment for cough, sore throat and diseases of the gums. The tree is lopped for fodder. Juice of young leaves is mixed with milk and sugar candy and given as a remedy for biliousness and intestinal troubles of children. The powdered gum, mixed with honey, is given to overcome dysentery and diarrhoea in children.

SUMMARY

India is highest milk producing country in world but fodder shortages may knock India off its position as the world's top milk producer. The milk productivity of India's livestock is less than half (48%) of the global average: 987 litre per lactation compared to the global average of 2,038 kg/lactation. The availability and quality of fodder has a direct bearing on the quantity and quality of milk productivity. All the three states that topped milk productivity in g/day in Rajasthan, Haryana and Punjab had earmarked more than 10% of their cultivable land for pastures, according to 2015 *State of India's Livelihoods* Report. Currently all three types of fodder (green, dry and concentrates) are in short supply. Considering the demand of milk, land under fodder production needs to be increased. Shortages are forcing to locate new source of fodder. In this situation forest resources may play an important role to complete the fodder requirement.

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