

Salvadora (Jaal): Integrating Nutritional Fodder and Environmental Stewardship in Arid Regions

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Western Rajasthan is home to the Great Indian Thar Desert, a vast sandy and warm desert that extends into southern Haryana and Punjab and northern Gujarat. Covering approximately 200,000 km², the Thar Desert spans the western part of the Indian subcontinent between 24° to 28° N latitude and 68° to 71° E longitude (Arora et al., 2010). It includes 12 districts in Rajasthan: Barmer, Bikaner, Churu, Ganganagar, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, Pali, Sikar, and Sirohi. Around 20 million people live in this desert region, which is about double the population of Haryana. Additionally, the region supports a substantial cattle population of approximately 23 million. The hot arid climate is marked by scarce natural resources and harsh conditions. Rainfall ranges from less than 100 mm to 400 mm and is highly erratic and unpredictable. Temperatures fluctuate drastically from -2°C to 48°C, with long hours of sunshine, high wind speeds (35–40 km/h), and high evaporation rates. Moreover, 41–85% of the groundwater is saline (Bhati, 1997). Despite these challenges, the region hosts various indigenous multipurpose tree species and breeds of sheep and goats that sustain the local population. These trees are crucial for nomadic grazers, providing fuel, fodder, and medicine (Dhyani et al., 2009).

Animal husbandry is the primary subsidiary activity in the Indian desert. Trees and shrubs are vital components of the ruminant diet, especially in areas with limited alternative feed sources (Babayemi and Bamikole, 2006). They are increasingly recognized as important protein suppliers for animal feeding (Azim et al., 2011). The top fodder trees of Rajasthan offer a rich source of nutritionally and phytochemically significant metabolites. *Salvadora*, commonly known as the toothbrush tree or mustard tree, is an indigenous plant species well-adapted to arid and semi-arid regions. It is highly valued for its numerous ecological, medicinal, and agricultural benefits. One of its notable attributes is its potential as a high-quality fodder for animals, particularly in regions where traditional fodder sources are scarce due to harsh climatic conditions. This article explores the characteristics, nutritional value, and benefits of

Salvadora as animal fodder, along with its cultivation and management practices, and its role in sustainable agriculture in arid regions.

Characteristics of *Salvadora*

Salvadora persica Linn. is widely distributed across sandy plains, while *S. oleoides* Decne. typically grows on sandstone, predominantly in arid regions of the Indian desert. Both species exhibit xeromorphic characteristics in their general habit and vegetative parts, with dark green, thick leaves. They differ in habitat, habit, and the morphological characteristics of their vegetative and floral parts. The tree is highly resilient to drought and salinity, making it an ideal candidate for cultivation in arid and semi-arid regions.

Morphology



Fig. 1: *Salvadora* showcasing their resilience as a drought-hardy plant ready to take on the toughest conditions

The leaves are small, succulent, and thick, which helps in minimizing water loss. They are oval to lanceolate in shape and have a distinctive mustard-like smell. The flowers are small, white to yellowish, and occur in dense clusters. They are known to attract various pollinators, which is beneficial for the ecosystem. The fruits are small, fleshy drupes, red to purple when ripe. They are rich in nutrients and are consumed by both humans and animals. The root

system is extensive and deep, allowing the plant to access water from deeper soil layers, which is crucial for its survival in arid conditions.

Nutritional Value of *Salvadora persica* as Fodder

The nutritional composition of *Salvadora persica* makes it an excellent fodder for livestock. Various studies have shown that the leaves, twigs, and fruits of this plant are rich in essential nutrients. The leaves of *Salvadora persica* contain a high level of crude protein, ranging from 12% to 18%, which is comparable to many conventional fodder crops. Protein is essential for the growth and maintenance of body tissues in animals, making this plant a valuable protein source, especially during dry seasons when other sources are scarce. *Salvadora persica* leaves are rich in fiber, with crude fiber content ranging from 15% to 25%. Fiber is crucial for proper digestion and helps in preventing digestive disorders in ruminants. The plant is a good source of essential minerals such as calcium, potassium, magnesium, and phosphorus. These minerals play vital roles in bone development, metabolic processes, and overall health of livestock. Additionally, the presence of vitamins, particularly vitamin C and B-complex vitamins, contributes to the nutritional balance of the diet. The energy content, measured as Total Digestible Nutrients (TDN), is relatively high in *Salvadora*. This makes it an effective energy source, crucial for maintaining the health and productivity of animals in energy-deficient arid environments.

Table 1: Chemical composition and nutritional value of *Salvadora* (Adapted from Heuzé et al., 2019)

Constituents	Unit	
Dry matter	% as fed	30.8
Crude protein	% DM	14.2
Crude fibre	% DM	10.5
NDF	% DM	23.1
ADF	% DM	14.2
Lignin	% DM	3.3
Ether extract	% DM	1.8
Ash	% DM	34.1
Gross energy	MJ/kg DM	12.6
Minerals	Unit	
Calcium	g/kg DM	69.0
Phosphorus	g/kg DM	1.1
Potassium	g/kg DM	16.9
Sodium	g/kg DM	1.3
Magnesium	g/kg DM	11.4
Manganese	mg/kg DM	74
Zinc	mg/kg DM	11
Copper	mg/kg DM	3

Benefits of Using *Salvadora* as Fodder

Using *Salvadora* as animal fodder offers numerous benefits, particularly in arid regions where traditional fodder sources are limited. Several studies have investigated the impact of *Salvadora persica* as fodder on animal performance, focusing on aspects such as growth rates, milk production, digestibility, and overall health. Goats in the 25% and 50% *Salvadora* groups



Fig. 2: Livestock grazing on *Salvadora* plants in arid regions, benefiting from this hardy and nutritious resource amidst challenging conditions

showed an increase in average daily weight gain by 15% and 22%, respectively, compared to the control group. The study concluded that incorporating *Salvadora persica* leaves into the diet could significantly enhance growth performance in goats (Ali et al., 2012). The highest growth rates were observed in the 40% inclusion group, which showed a 20% increase in weight gain over the control group. Higher inclusion levels (60%) did not further enhance growth, suggesting an optimal inclusion rate around 40% (El-Kady et al., 2014). Cows in the experimental group exhibited a 12% increase in milk yield and improved milk fat content by 1.5%. The study also indicated that *Salvadora* could enhance both the quantity and quality of milk produced (Khan et al., 2016). Ahmed et al., (2017) also explored the influence of *Salvadora* foliage on milk production in buffaloes reported that 18% increase in milk yield compared to the control. Additionally, there was a noticeable improvement in the overall health and body condition of the buffaloes, attributed to the higher nutritional content of the *Salvadora persica* foliage. Rahman et al., (2015) investigated the digestibility of *Salvadora* leaves in goats and found that 20% and 40% *Salvadora* diets showed significantly higher digestibility of dry

matter (DM), crude protein (CP), and crude fibre (CF). The 40% inclusion diet had a dry matter digestibility of 78%, compared to 65% in the control group. Hassan et al., (2019) explored the anthelmintic properties of *Salvadora persica* leaves in sheep and observed a significant reduction in parasite load in sheep fed diets with 30% and 40% *Salvadora* leaves. This indicates potential anthelmintic properties, contributing to better health and productivity.

Several studies have also highlighted the multifaceted benefits of *Salvadora* as a feed component for camels. Al-Zeid et al. (2015) demonstrated that incorporating *Salvadora persica* leaves into camel diets resulted in a 10% increase in average daily weight gain and improved levels of essential nutrients and minerals. Faye and Mulato (2017) found that lactating camels fed with 30% *Salvadora persica* leaves showed a 12% increase in milk yield and higher fat and protein content. Kadi and Ramadan (2018) reported significantly higher digestibility of dry matter, crude protein, and fiber in camels fed diets containing up to 40% *Salvadora persica* leaves, with an 80% dry matter digestibility compared to 68% in the control group. Ali and Ahmed (2019) observed enhanced health and immunity in camels supplemented with 25% *Salvadora persica* leaves, including higher haemoglobin levels and reduced incidence of common ailments. Additionally, El-Shaer and Tawfik (2020) identified the anthelmintic properties of *Salvadora persica*, noting a significant reduction in parasite load and improved health and weight gain in treated camels.

Role of *Salvadora* in ecological balance

One of the most significant advantages of *Salvadora* is its ability to thrive in drought conditions. Its deep-rooted system and succulent leaves allow it to survive prolonged dry periods, ensuring a continuous supply of fodder even during droughts. The extensive root system of *Salvadora* helps in preventing soil erosion, a common problem in arid regions. By stabilizing the soil, it contributes to the maintenance of soil structure and fertility, which is essential for sustainable agriculture. Cultivating *Salvadora* can enhance biodiversity in arid regions. The tree provides habitat and food for various wildlife species, including birds and insects, thus supporting the local ecosystem. For farmers in arid regions, *Salvadora persica* can be a source of income. The plant's parts, including leaves, twigs, and fruits, can be harvested and sold as fodder. Additionally, the fruits have medicinal properties and can be marketed for traditional medicine uses.

Role in Sustainable Agriculture

Salvadora plays a crucial role in promoting sustainable agriculture in arid regions. Incorporating *Salvadora* into agroforestry systems can enhance the sustainability of agricultural practices. It provides shade and shelter for crops and livestock, improves soil fertility through leaf litter, and reduces wind erosion. Integrating *Salvadora* into livestock systems ensures a reliable fodder source throughout the year. It reduces the dependency on conventional fodder crops, which may fail under drought conditions, thus ensuring food security for livestock. *Salvadora* contributes to climate change mitigation through carbon sequestration. The plant's extensive root system and above-ground biomass store significant amounts of carbon, helping to reduce greenhouse gas concentrations in the atmosphere.

Cultivation and Management Practices

Cultivating *Salvadora* requires understanding its ecological requirements and adopting appropriate management practices to ensure optimal growth and productivity.

Site Selection

Salvadora prefers well-drained sandy or loamy soils. It can tolerate saline and alkaline conditions, making it suitable for marginal lands. Selecting sites with minimal competition from other vegetation is essential for its establishment.

Propagation, planting and irrigation

The plant can be propagated through seeds, cuttings, or root suckers. Seed propagation is the most common method. Seeds should be collected from ripe fruits and sown in nurseries before transplanting. Vegetative propagation through cuttings or root suckers ensures faster establishment and growth. Transplanting should be done at the onset of the rainy season to ensure adequate water availability for the young plants. Spacing should be maintained at 2-3 meters between plants to allow sufficient growth and development. Although *Salvadora* is drought-resistant, supplemental irrigation during the initial establishment phase can enhance survival rates and growth. Drip irrigation is recommended to ensure efficient water use.

Pruning and Harvesting

Regular pruning helps in maintaining the desired shape and encourages the growth of new shoots. Harvesting of leaves and twigs can be done multiple times a year, depending on the growth rate. It is essential to avoid over-harvesting to prevent stress and decline in plant health.

Conclusion

Salvadora with its remarkable drought resistance and high nutritional value, stands out as an excellent fodder option for animals in arid regions. Studies consistently show improvements in growth performance, milk production, digestibility, nutrient utilization, and overall health in animals fed with *Salvadora persica* leaves. These findings highlight the plant's utility in enhancing livestock productivity and sustainability in challenging environments. Its cultivation and use can significantly enhance the resilience of agricultural systems in these challenging environments. By providing a reliable source of fodder, conserving soil, enhancing biodiversity, and contributing to economic well-being, *Salvadora persica* plays a pivotal role in sustainable agriculture. Promoting its use and addressing the associated challenges can lead to improved livelihoods for farmers and better food security for livestock in arid and semi-arid regions.

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