Fodder Trees in India: Enhancing Livestock Nutrition and Land Use Efficiency

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ABSTRACT

India's rapidly growing livestock population places immense pressure on limited fodder resources, resulting in significant deficits in green fodder, dry fodder, and concentrate feeds. Fodder trees offer a sustainable and efficient solution to this challenge by providing nutrient-rich biomass, particularly in semi-arid and marginal environments. These multipurpose species contribute not only to livestock nutrition but also to soil conservation, carbon sequestration, and overall ecosystem stability. This paper reviews the importance, advantages, and major species of fodder trees in India, highlighting their role in enhancing land-use efficiency and supporting agroforestry systems. Additionally, it outlines future prospects, strategies for large-scale adoption, and the development of fodder banks to ensure year-round feed availability. Promoting fodder tree-based systems can significantly improve livestock productivity while fostering environmental sustainability and resilience in Indian agriculture.

INTRODUCTION

In many parts of India, livestock rely heavily on tree and shrub leaves as a vital component of their diet. These leaves are typically rich in protein and serve as an important supplement to low-quality fodder. This underscores the need to promote

multipurpose fodder trees, which are often cultivated primarily for fuelwood and timber. During the 1950s, several indigenous and exotic fodder tree species were introduced into India to address the limited availability, slow growth, and low productivity of native species. Most natural fodder resources are concentrated in semi-arid regions, where vegetation plays a crucial role in sustaining livestock systems. India possesses the world's second-largest livestock population, placing immense pressure on existing fodder resources. Currently, only about 8.4 million hectares are under cultivated fodder crops—a figure that has remained largely stagnant over the past two decades. This has led to a significant deficit in fodder availability, estimated at 35.6% for green fodder, 10.95% for dry fodder, and 44% for concentrate feed (Kumar *et al*., 2022). By 2050, the demand for green and dry fodder is projected to reach 1012 million tonnes and 631 million tonnes, respectively. Fodder trees play a critical role in bridging this gap, particularly in dairy production systems and during adverse climatic conditions such as drought. They are easy to cultivate, require minimal inputs, and can begin yielding biomass within a year of planting (Robinson, 1985). Integrating multipurpose trees into farming systems can significantly enhance pasture productivity and sustainability.

BENEFITS OF FODDER TREES OVER REGULAR FODDERS

Fodder trees offer several advantages over regular fodder crops, providing a sustainable and efficient source of feed for livestock. Here are some benefits of using fodder trees:

1. **Perennial Growth:** Fodder trees are typically perennial, meaning they can provide a continuous and long-term source of feed without the need for replanting every season.
2. **Reduced Water Requirements:** Many fodder trees are adapted to a variety of climates and can thrive with less water compared to traditional annual fodder crops. This is particularly beneficial in arid and semi-arid regions.
3. **Nutrient-Rich Foliage:** Fodder trees often have leaves that are rich in essential nutrients such as proteins, minerals, and vitamins. This can lead to improved animal health and productivity when included in the livestock diet.
4. **Adaptability to Marginal Lands:** Fodder trees can be grown on lands that may be unsuitable for traditional crops. They are often more resilient in harsh conditions, making them suitable for marginal and degraded lands.
5. **Drought Resistance:** Some fodder tree species are well-adapted to withstand drought conditions, making them a valuable resource in areas prone to water scarcity.
6. **Year-Round Availability:** Unlike many annual fodder crops that have specific growing seasons, fodder trees can provide feed throughout the year, ensuring a consistent supply for livestock.
7. **Improved Animal Welfare:** The nutritional quality of fodder tree leaves can positively impact the health and well-being of livestock, leading to improved reproductive performance and overall productivity.
8. **Soil Conservation:** Fodder trees help in preventing soil erosion and improving soil structure. Their deep root systems can stabilize the soil, reducing the risk of nutrient runoff and erosion.
9. **Carbon Sequestration:** Trees play a crucial role in sequestering carbon dioxide from the atmosphere, aiding in the fight

against climate change. By incorporating fodder trees, you contribute to carbon sequestration and offsetting greenhouse gas emissions.

10. **Agroforestry Opportunities:** Integrating fodder trees into agroforestry systems allows for simultaneous cultivation of crops, trees, and livestock. This approach promotes a more sustainable and diversified agricultural model.

Incorporating fodder trees into farming systems can offer a range of benefits, promoting sustainability, resilience and efficiency in livestock management.

Environmental Benefits:

Agroforestry methods incorporating tree fodders provide various environmental advantages such as preserving soil, sequestering carbon, and conserving biodiversity (Nair, 1993; Jose *et al*., 2004). Trees within agroforestry setups enrich the soil with organic matter, enhance its structure, and mitigate erosion, thus bolstering the longevity of agricultural practices. Additionally, the inclusion of trees in agroecosystems fosters biodiversity by offering habitats and sustenance for beneficial insects, birds, and other fauna

MAJOR FODDER TREES

Subabul (*Leucaena leucocephala*):

Leucaena was introduced as a feed for ruminant livestock during 16th century in the Philippines, which subsequently spread to Asia Pacific region and Africa. Distributed widely in the tropical regions of the world, performs better under humid to subhumid climates and can survive in a wide range of conditions including dry season. It can produce up to 60 t ha^{-1} $year^{-1}$ nutrient rich leaf biomass. Leaves contains higher amounts of protein (about 27.5%) compared to common grasses, wherein, it varies from 4% in dry season to about 6% in the rainy season. Beside leaves, pods and seeds are also rich in proteins, minerals and essential fatty acids, which increase growth rate and milk production in animals. Therefore, it should be considered as a potential tree fodder for drier parts of the world where animals, often faces fodder scarcity. Besides, relatively, it is a cheap source of high crude protein when compared with crop fodders and also, most preferred feed for goat and sheep due to its high palatability, selectivity and dry matter intake level.

Sesbania (*Sesbania sesban*):

S. sesban is multipurpose fodder tree, grown for forage as well as green manure purpose in semi-arid to sub-humid tropical climate. It is tolerant to cool temperature (not to frost), and can be grown up to an elevation of 2000 m . Sesbania produces a dry matter yield up to 4-12 t ha-1 year-1 in 3-5 cuttings. Leaves and tender branches are easily digestible, and contain 20-25% crude protein, which varies from 194 g kg-1 dry matter in twigs to 297 g kg-1 dry matter in leaves. Due to its high level foliage nitrogen content it is considered as an ideal supplement to protein poor roughage. Research results reveal that it increases milk production by 13% compare to concentrates supplemented ewes, when ration was supplemented up to 30%, with it. Besides, it is also reported to improve the reproductive performance in sheep.

Agathi (*Sesbania grandiflora L.*):

Agathi is a legume plant of tropical Asia and very popular among the dairy farmers of Asia including India, Indonesia, Malaysia, Myanmar and Philippines. The early research on its use for forage production was conducted in India. In India, it is grown as a valued fodder (leaves and pods) for animals in several states including, Tamil Nadu, Andhra Pradesh,

Kerala, Assam, Gujarat, and Bengal. It is used to supplement rice straw in animal diets, probably due to high levels, about 25-30%, of crude protein content in leaves.

Glyricidia

It is a tiny tree with pale bark that is semi-deciduous. The two species that are known to exist are *Glyricidia maculata* and *Glyricidia sepium*. Green leaf manure made from G. maculata is more beneficial. Additionally, it fixes nitrogen from the atmosphere, increasing soil fertility. A broad variety of climatic and edaphic conditions are tolerated by *G. sepium*. Although it will grow in areas with yearly rainfall as low as 400 mm, growth is fastest in places with annual rainfall over 900 mm. It is intolerant of water logging and thrives on rocky, eroded areas in a variety of soil types, from heavy clays to sands. The plant serves as support plants, fuel wood, green manure, shade, poles, and live fences. Used as a coffee shade tree and as a decorative. Propagated via cuttings or seeds. After each cutting, it can generate a lot of new growth and branching. It can provide enough green leaf manure for two to three hectares of land if grown on a hectare along the border.

Mulberry (*Morus alba*)

Morus alba grown over a wide range of climatic regions of the world ranging from tropical, sub-tropical and temperate areas. It requires annual rainfall in the range of 600-2500 mm for successful cultivation. In the agroforestry systems, for foliage fodder purpose, it can be recommended for plantation on black and low lands as well (kabar soils). It produces about 25-30 t ha-1 year-1 fresh leaves biomass of high protein content (18-25% in DM) and about 75-85%, in vitro DM digestibility. Besides, its leaves are also rich in proteins, minerals, especially in calcium (Ca) and phosphorous (P), and metabolizable energy. Mulberry plant produces more fodder in terms of digestible nutrients compare to most of the traditional forages. It was reported that its foliage is comparable to alfalfa hay mix in terms of digestible energy and crude protein values. Mulberry leaves are protein rich forage supplements and can be used fresh or dried in compound feeds of high yielding animals. When used as supplement feed, it has significant effect on protein as well as fat content, besides improving total quantity of milk in cow and goat. In several parts of the world, it is also used as a substitute to concentrate feed for cattle or goat diets. Moreover, its leaves can be used as main feed for sheep and, goats besides, serving as a maintenance diet for sheep due to their palatability

Shisham (*Dalbergia sisoo*)

Highly nutritive, palatable leaf fodder rich in crude protein and essential minerals. Low crude fibre content in leaves. High dry matter digestibility of 56%. Provides fodder for the longer period as it remains leafless for short duration (November-January). Ensures green nutritious fodder during dry period/summer when other source of green fodder is not available. It can be grown in almost all the agro-climatic zones of the country. It is multipurpose and fast-growing tree that has been proved as suitable tree species under agroforestry, as boundary plantations, block plantations and on wastelands forestry.

Ailanthus excelsa

The fodder from Ailanthus excelsa has shown to contain a higher percentage of protein than of the natural grazing, as well as low crude fiber while nitrogen-free extract high lower than that found in groundnut haulms as well as a high percentage of minerals (total ash) was more than that of the natural grazing. In vitro digestibility for fodder taken from Ailanthus excelsa was higher. Ailanthus excelsa fodder

can be considered as good quality roughage for feeding during the dry season.

Drumstick (*Moringa oleifera*)

Moringa oleifera is a rapidly growing soft wood plant that is mainly distributed in tropical and subtropical zones. In recent years, *M. oleifera* has increasingly attracted the attention of researchers in animal husbandry because of its comprehensive nutritional, antioxidative, and medicative attributes. *M. oleifera* leaf contains high amounts of crude protein, vitamin, mineral, and fatty acid. *M. oleifera* can provide 9 times more protein than yogurt, 17 times more calcium than milk, 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 25 times more iron than spinach, and 15 times more potassium than bananas. Moreover, the consumption of *M. oleifera* leaf strengthens neural response, enhances immune functions, and improves health because of the large amounts of microelements and polyphenol antioxidants. Aside from animal productivity and favorably influencing lipid composition, the potent antioxidant in *M. oleifera* leaf prevents meat products from deterioration. Studies have been carried out to evaluate the feeding effects of *M. oleifera* leaf meal on various animal species, including cattle, goats, chickens, and fish. *M. oleifera* leaf can be used as an alternative protein source for animal husbandry.

FUTURE PROSPECTS OF TREE FODDER

- Tree fodder will become a major source of quality forage.
- Essential for drought-prone and climate-vulnerable regions.
- Can serve as both supplement and primary feed resource.
- Plays a key role in ecological restoration and climate mitigation.
- Supports livelihoods of marginal farmers through multiple benefits.

STRATEGIES AND THE WAY FORWARD

The livestock production can successfully be sustained if we can produce sufficient nutritive fodder. Despite of conventional means of fodder and feed production we may generate qualitative fodder production through agroforestry components, particularly silvopastoral systems. Agroforestry research now has provided powerful technological and policy innovations that are rapidly spreading. Agroforestry systems are not only for sustainable production but are also problem-solving mechanism. For example, for rehabilitation of degraded lands, fodder production, mitigating climate change through carbon sequestration, employment generation and food and nutrient security. Profitable agriculture is possible if appropriate technologies and know how are used judiciously. To be sufficient in fodder production, we need attention on the following points:

- Establishment of accredited nurseries to develop improved quality fodder germ plasm and multiply the same for distribution among stakeholders
- Improvement of fodder trees for their nutritive foliage production
- Earmarking the degraded lands for fodder production
- Identification of suitable fodder species for specific degraded areas and developing suitable cultivation practices on those sites
- Strategy should cover selection and breeding of high yielding and multi-stress tolerant

fodder crops and varieties. Selection of new genotypes and varieties of food crops having high forage value (tall varieties) without reduction in foodgrain yield

DEVELOPMENT OF FODDER BANKS

- Promote mechanization for fodder harvesting and storage
- Improve pastures through legumes and fertilization
- Develop community grazing lands under Panchayats
- Encourage controlled grazing and cut-and-carry systems
- Improve livestock breeds and feeding practices
- Prevent crop residue burning and promote efficient utilization
- Integrate fodder trees in watershed and boundary plantations
- Establish fodder markets for surplus produce
- Enhance farmer awareness and capacity building

CONCLUSION

Bridging the fodder deficit in India requires a shift toward sustainable land-use systems. Fodder trees provide a reliable, nutritious, and year-round source of feed while improving land productivity and ecological balance. Their adaptability to diverse environments makes them ideal for integration into agricultural landscapes, including marginal and degraded lands. Promoting tree-based fodder systems is essential for ensuring long-term livestock productivity and environmental sustainability.

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