International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
NAAS Rating (2025): 4.61
VET 2025; SP-10(8): 06-12

www.veterinarypaper.com
Received: 11-05-2025
Accepted: 13-06-2025

Kabinesh V
Research Scholar, Department of Forest Products and Wildlife, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Nandha Kumar R
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Moulidharshan R
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Bargavi S
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Sabarish M
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Kalpana R
Assistant Inspector of Sericulture, Department of Sericulture, Govt. of Tamil Nadu, Tamil Nadu, India

Bridha Bharathi SA
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Menaka S
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Durgadevi R
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Anusuya G
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Bhuvaneshwari T
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Corresponding Author:
Moulidharshan R
Research Scholar, Department of Sericulture, Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu, India

Tree fodders for livestock nutrition: A review

Kabinesh V, Nandha Kumar R, Moulidharshan R, Bargavi S, Sabarish M, Kalpana R, Bridha Bharathi SA, Menaka S, Durgadevi R, Anusuya G and Bhuvaneshwari T

Abstract
India's economy heavily depends on the production of livestock, which boosts the nation's GDP and agricultural sector. However, the growing disparity between the supply and demand of fodder, which is made worse by the depletion of natural resources, climate change, and water shortages, poses difficulties to the industry's sustainability. The possibility of tree fodders as a long-term remedy for India's fodder shortage is examined in this review. It looks at the nutritional advantages of different tree species, how they integrate into agroforestry systems, and typical strategies for producing fodder from agroforestry. The paper also addresses the nutritional characteristics of tree fodders as well as their anti-nutritional aspects, highlighting the significance of efficient management techniques to optimize their advantages while reducing hazards to animal health. The study's overall findings emphasize the need for additional investigation and real-world application to support the inclusion of tree fodders in livestock diets and promote environmental and financial sustainability in animal husbandry techniques.

Keywords: Fodder, livestock, agroforestry, GDP and sustainability

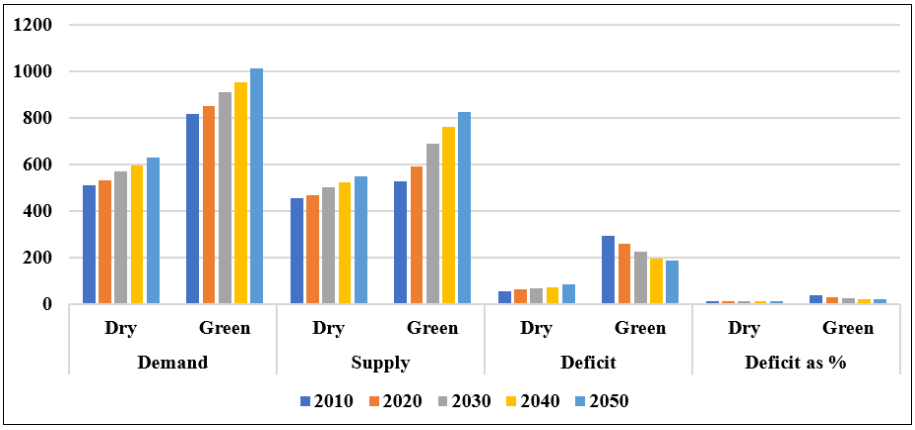
Introduction
India holds the top position globally with a livestock population of 535.78 million (DAHD, 2021) [9] and milk production of 198.4 million tonnes (2019-20) which contributes 4.11% to the country's GDP and 25.6% to the total agriculture GDP. The livestock in India mainly comprises cattle (193.46 million), buffaloes (109.85 million), sheep (74.26 million) and goats (148.88 million).

India and China together contribute more than 70% of the world's livestock population and 25% to the world's farm produce. Livestock production is increasing rapidly globally and in India, it is predicted that meat and milk consumption will grow at a rate of 2.8 and 3.3% per annum respectively. This would require a steady supply of fodder to support the livestock population. Nutrition is a primary limitation of cattle production in tropical regions, particularly due to the scarcity of protein during the dry season (Gebeyew *et al.,* 2015) [16]. India has about 4.9% of the total cropped area under forage cultivation, which has been almost static since the last few decades. Under such circumstances, feeding animals with an adequate quantity of nutrient-rich feedstock throughout the year remains the major technical constraint in meeting future demands for meat and milk production (Sunil Kumar and Mukesh Choudhary, 2021) [45].

Some causes of lower fodder production in India include
- Natural resource degradation
- Climate change
- Water scarcity due to recurring droughts
- Rise in weather uncertainties

There is a huge gap between the demand and supply of fodder supply with a deficit of 35.6% in green fodder, 10.95% in dry fodder, and 44% in concentrate feed materials across the country (Kumar *et al.,* 2022) [22]. By 2050, the demand for green and dry feed is projected to be 1012 and 631 million tonnes respectively.

In the year 2050, based on the current rate of expansion in forage supplies, there will be an 18.4% deficit in green fodder and a 13.2% shortfall in dry fodder (Figure 1). To meet this demand, green forage supply needs to be increased at an annual rate of 1.69%.



Source: IGFRI Vision 2050

Fig 1: Estimates of dry and green forages demand and supply (million tonnes)

The leaves of certain tree species serve as a source of additional nitrogen and energy for animals during the dry season, (Elseed *et al.,* 2002) [12]. Tree foliage acts as a readily accessible source of crude protein and essential minerals for ruminants in tropical regions. These plants maintain their green foliage even in the dry season, offering superior nutritive value compared to other annual grasses and herbaceous species (Aregawi *et al.,* 2008) [3]. There is a rising trend in modern silvopastoral systems, where trees originally planted for different purposes increasingly serve as an additional food source for animals. This growing interest revolves around the use of woody plants and shrubs as supplementary feed for ruminants. Nevertheless, there is still a need for further understanding of sustainable methods of introducing and managing woody forage in more intensive and sustainable temperate and tropical production systems.

The determination of a forage's palatability relies on its capacity to stimulate the oropharyngeal senses of the animal, encompassing taste, aroma, and texture. To categorize browsing species by their palatability, criteria such as the ratio of consumed biomass to offered biomass are employed. Palatable species are dwindling, while less nutritious and unpalatable species are becoming more prevalent. In Silvopastoral systems, the digestibility of forages in ruminants is influenced by the specific type and proportion of each forage species consumed (Cuartas Cardona *et al.,* 2014) [8]. Tree biomass is employed in various forms for animal nutrition, including the incorporation of fruits into concentrates or nutritional blocks, which serves to enhance digestibility and digestive products (Briceño *et al.,* 2012) [6].

Green forages have a cooling effect on the animal body, are more palatable contain easily digestible nutrients, provide fresh effectively utilizable nutrients in natural form and are slightly laxative. Therefore, determining the nutritional quality of these fodder sources is an important aspect of ruminant feeding and a step towards making balanced rations. Although the nutritional value of some fodder tree species has been widely studied, there is still a lack of study on such values on many common fodder species around the country. Tree fodder is hay made from the branches and twigs of deciduous trees and shrubs while still in leaf. Fodder trees are tree species that are palatable to animals, including shrubs and bamboo. They provide animal feed through leaves, twigs, and fruits, which are rich in protein, minerals, vitamins, energy, and fibre.

Tree hay is produced by cutting (or breaking) off the limbs and twigs of deciduous trees and shrubs whilst they are in full leaf - as with meadow hay the optimum time is often from the end of June to early August when the tree is in full leaf, and the maximum amount of nutrients and minerals are found in the leaves and twigs. These nutrients will remain present after harvesting and the tree hay can either be stored until winter, or fed fresh to ruminant animals such as sheep, goats and cattle. When it comes to feeding time, you just give it to them as it is, and the tree hay tends to stay lovely and green and remain very appealing after harvesting. Tree fodder can usually be stored for up to 18 months to two years after harvesting before use so it can easily be kept as an emergency alternative to hay.

The total area under cultivation for fodder in Tamil Nadu is 1.72 lakh hectares or 3.28 percent of all the cultivated areas. This means that the districts of Erode, Namakkal, and Salem make up 73.6% of the fodder area. Four hundred and sixty thousand tonnes of green fodder are produced. Only 1.10 lakh hectares of land are used for permanent pastures and other grazing, showing how much more space there is in Tamil Nadu to increase the production of fodder. The available green fodder only amounts to 12.7 million tonnes, leaving a 71.1 million tonnes shortfall compared to the required 83.8 million tonnes.

There is a limited likelihood of having good-quality arable land accessible for the production of fodder because arable land is mostly used for food and cash crops due to the pressure of an ever-increasing human population unless milk production becomes profitable for the farmer relative to other crops. The immediate solution to meet the current level of livestock production and its annual population growth is to cultivate perennial fodder varieties that can yield higher biomass per unit area and use a transformative, environmentally friendly method that turns raw agricultural materials into compact, nutritionally enhanced feed pellets.

Role of Agroforestry in Tree Fodders

Combining trees and shrubs with farming (agroforestry) unlocks a treasure trove of benefits for raising animals responsibly, including providing tree-based food for livestock. These tree 'snacks' are packed with nutrients like protein, energy, minerals, and vitamins, making them especially

helpful when regular feed is hard to come by. By integrating these special trees into farms, animals get healthier, produce more, and even better handle changing weather patterns. This article explores how agroforestry and its tree-based treats contribute to sustainable livestock production.

Diverse Tree Fodder Species: Planting different types of trees in farms (agroforestry) helps provide livestock with diverse and valuable food sources. Some great options are *Leucaena, Gliricidia, Calliandra,* and *Sesbania* trees, known for their high protein and appeal to animals (Mekoya *et al.,* 2018; Sthapit *et al.,* 2008) [27, 44]. By mixing these trees with crops or grazing areas, farmers can offer their animals nutritious food all year round.

Nutritional Benefits: Livestock in areas with scarce feed can greatly benefit from tree leaves. Research shows they're packed with protein, key amino acids, minerals like calcium and phosphorus, and vitamins like A and C, making them excellent additions to ruminant diets (Preston & Leng, 1987; Reed *et al.,* 1996) [35, 40]. By integrating trees into farms, we can improve animal diets and boost their performance.

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) [28, 19]. 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.

Climate Resilience: Mixing trees and crops for livestock farming (agroforestry) can make animal production more resilient in a changing climate. Trees act as natural umbrellas and windbreaks, protecting animals from scorching heatwaves (Köngös *et al.,* 2019) [20]. Moreover, tree-based feeds hold up better in droughts compared to yearly plants, offering reliable sustenance during dry periods (Sthapit *et al.,* 2008) [44]. As a result, these combined systems adapt better to shifting environmental conditions and face lower risks of feed shortages.

Socioeconomic Impacts: Planting trees in farmland (agroforestry) can improve the lives of people in rural areas. This is because it gives farmers more ways to make money (diversifies income) and makes them less reliant on buying things from outside the community (reduces dependency on external inputs). This makes them more adaptable to challenges (increases resilience) and helps them live better lives (improves livelihoods) as shown by research (Nair, 1993; Franzel *et al.,* 2001) [28, 14]. Plus, if farmers have extra tree leaves or other tree products they can sell them for more money, which helps reduce poverty and grow the economy in rural areas.

Water Management: In agroforestry, trees act as water superheroes. Their deep roots tap into hidden reserves, soaking up excess water to prevent waterlogging and helping it soak deeper into the ground (Jose *et al.,* 2004) [19]. This superpower duo (reduced waterlogging and increased infiltration) protects the soil from erosion, runoff, and nutrient loss, especially during heavy rain. Not only that, but their leafy crowns act like umbrellas, intercepting rainfall and shielding the soil from erosion. Plus, they breathe out water vapour, creating a cool, moist microclimate for everything below (Nair, 1993) [28]. Altogether, these amazing trees help us use water wisely and make farms more resilient to dry spells and water shortages.

Livelihood Diversification: Growing trees alongside crops in agroforestry isn't just good for the land, it's also great for rural communities. These systems unlock diverse income streams for farmers. Think beyond crops: trees offer timber, firewood, fruits, medicinal plants, and various other products to sell (Franzel *et al.,* 2001) [14]. But that's not all! Special "tree fodders" provide nutritious food for livestock, either on the farm or sold for extra cash (Mekoya *et al.,* 2018) [27]. By having more income sources and making better use of resources, agroforestry helps rural communities thrive and become more resilient to economic challenges.

Carbon Sequestration: Planting trees alongside crops and livestock (agroforestry) helps fight climate change. Trees act like sponges, soaking up carbon dioxide from the air and storing it in their wood and roots (Jose *et al.,* 2004) [19]. Practices like silvopasture, alley cropping, and windbreaks all boost this carbon storage power, both above and below ground (Nair, 1993) [28]. This stored carbon helps lower greenhouse gas levels, slow down climate change, and make farms more adaptable to unpredictable weather.

Fodder trees

The utilization of fodder trees is playing a crucial role in addressing the fodder scarcity issue in India. Following the monsoon season, many regions of the country face a shortage of protein-rich feed for livestock, leading to distress among animals. This situation is exacerbated during the dry season, particularly in rainfed areas where crop cultivation becomes challenging and natural pasturelands become unproductive. Farmers often resort to feeding their animals low-quality hay from stored crop residues or embark on lengthy journeys to gather green grasses or fodder (Dhyani, 2003) [11].

However, in such circumstances, shrubs and fodder trees offer a resilient solution as they can endure drought conditions, maintain their greenery, and provide nutritious feed for livestock. Planting these species, capable of consistently producing palatable forage high in protein and digestible nutrients, can partially alleviate the alarming shortages of forage in the country. Implementing silvi-pastoral systems on degraded lands and integrating fodder trees into various agroforestry systems can boost fodder availability.

Species like Oaks, *Grewia optiva*, and *Celtis australis* in the Western Himalayas, as well as *Ficus spp., Alnus nepalensis,* and *Bauhinia spp*. in the Eastern Himalayas, have been identified as significant fodder trees. Additionally, traditional practices such as lopping Prosopis cineraria (Khejri) in western Rajasthan, and utilizing the leaves of *A. lebbeck, Albizia procera,* and *A. indica* in northern and central India for fodder, along with the use of pods from *A. nilotica* and *P. juliflora*, remain common practices.

These fodder trees offer several advantages, as they can thrive on steep, rocky terrains, in arid or saline soils, and areas with harsh climatic conditions. Moreover, they require minimal inputs such as fertilizers, irrigation, labour, and pesticides compared to conventional fodder crops. Their deep root systems enable them to access moisture resources deep within the soil, making them more resilient to dry periods compared

to pastures. Additionally, trees play a crucial role in nutrient recycling, enhancing forage quality, and contributing to sustainable livestock farming practices.

Common Agroforestry-Fodder Production Models

Various models for agroforestry fodder production have been developed to generate ample foliage for livestock sustenance, particularly in arid periods. These production schemes encompass a range of agroforestry-silvipastoral systems, where trees, livestock, and pastures are intentionally combined to yield multiple benefits and services.

One such model is the Fodder Bank System, where trees are densely planted and regularly pruned to maximize herbage production. This harvested herbage is typically transported to feeding stalls for livestock consumption, although in some cases, animals are brought directly to the plots to graze on the cut branches, serving as a reserve fodder source during dry spells.

An adaptation of this approach is the Protein Bank, which selects trees and shrubs rich in protein for fodder production, such as *Leucaena leucocephala* and *Gliricidia sepium*.

Another strategy, the Three-Strata Forage System, involves planting a combination of forage crops, shrubs, and trees to create three distinct canopy layers on a plot of land. This mixture ensures a consistent supply of fodder throughout the year, with pasture grasses occupying the lower layer, shrubs in the middle, and trees in the upper.

Live Fence or Boundary Systems employ single or double rows of fodder trees along farm perimeters, serving both as a fodder source and as live fence posts. When used to contain livestock, these trees are densely planted to prevent animals from escaping. Thorny species may also be utilized to deter livestock from straying into crop fields and to create barriers against wild animals.

Hedgerow Intercropping Systems entail planting leguminous fodder trees as hedges in single, double, or triple rows, with spaces between hedgerows filled with pasture grasses. As with fodder banks, the harvested herbage can be fed to livestock or animals can be allowed to graze directly on the cut branches and grasses.

Tree Plantation and Animal Grazing Systems involve utilizing the space beneath tree plantations as grazing grounds for livestock, including cattle, sheep, and goats. These plantations may consist of various types of trees, such as forest trees, fruit trees, coconut palms, oil palms, or rubber trees. Livestock is permitted to graze freely on improved pasture grasses that are cultivated beneath the canopy of these trees.

Indigenous Cut-and-Carry Systems, as suggested by the name, entail cutting fodder from the surrounding area and transporting it to animal stalls for feeding. Farmers have employed this traditional practice for an extended period. Preferred fodder tree species for this purpose typically include indigenous legumes like *Ficus, Acacia, Leucaena, Gliricidia,* and *Albizia*.

Fodder quality

Nutritional parameter

The quality of tree food for animals depends heavily on what nutrients it contains. This includes things like protein, energy, fibre, minerals, and specific amino acids. However, some tree foods also have chemicals that make it harder for animals to absorb the good stuff, which can hurt their health and growth.

Protein Content and Quality

Tree leaves are a popular source of protein for animals, with different species offering varying amounts (10% to 30%) (Norton, 1994) [30]. But just having protein isn't enough - the type of protein matters too. Some tree leaves lack certain essential amino acids animals need to grow and thrive, while others provide a more balanced mix. The key takeaway is that while quantity is important, quality deserves equal attention when choosing tree fodder for livestock.

Energy Value

Tree leaves as an energy source for animals:

- The main source of "fuel" in tree fodder comes from digestible fibre and carbohydrates. Compared to grains or concentrated feed, leaves and foliage generally have fewer carbohydrates, but they can still be a good source of energy for ruminant animals (like cows, sheep, and goats). (Devendra & Thomas, 2002) [10].
- Some tree species are like nature's energy bars for animals. For example, *Leucaena leucocephala* and *Gliricidia sepium* pack a higher energy punch, making them popular choices for boosting livestock diets in warm climates. (Lascano *et al.,* 2016) [23].

Fiber Composition

The number of tough fibres (NDF and ADF) in tree leaves tells us how much energy animals can get from them (Barry and McNabb, 1999) [4]. If there's too much tough fibre, animals won't eat as much and won't absorb nutrients well, especially non-ruminants like pigs or chickens. However, some softer fibres, like pectins and gums, actually help ruminants like cows digest their food better (Hristov *et al.,* 2013) [17].

Mineral Content

Tree leaves as mineral powerhouses:

- **Packed with essentials:** Tree leaves can be treasure troves of minerals like calcium, phosphorus, potassium, magnesium, and even trace elements.
- **Variety is key:** The amount of minerals depends on things like soil quality, tree type, and leaf age (García *et al.,* 2019) [15].
- **Boosting animal health:** Animals munching on tree leaves might be healthier, especially in areas with poor soil mineral content. They'll be like mineral superheroes (Norton, 2006) [31].

Anti-nutritional parameters

Plants naturally produce chemicals that can interfere with how animals use their food (Kumar *et al.,* 2017) [21]. These "anti-nutrients" can reduce how much animals eat, digest, and absorb nutrients. They can also harm animal health, causing issues like weakened immune systems, stunted growth, and even death (Ramteke *et al.,* 2019) [36].

Because of these anti-nutrients, using parts of trees like leaves, twigs, and pods as animal feed is limited. The amount of these chemicals varies depending on the plant, its age, where it grows, and the environment (Poutaraud *et al.,* 2017). [34] It's important to measure anti-nutrient levels in fodder trees before using them to feed animals.

Mycotoxins: Moulds like Aspergillus, Penicillium, and

Fusarium can ruin crops and animal feed by producing harmful substances called mycotoxins. These toxins contaminate grains, oilseeds, and forages, making animals sick and reducing their productivity (Bhatti *et al*., 2018; Pierron *et al*., 2016) [5, 33]. Common culprits include aflatoxins, DON, and fumonisins. Studies show that these toxins can even mess up how feed pellets are made, leading to crumbly results. Even worse, animals exposed to mycotoxins can suffer from various health issues like eating less, weakened immune systems, and trouble reproducing.

Phytates

Phytic acid, found in plants like grains and legumes, stores phosphorus but can hinder the absorption of minerals like calcium, zinc, and iron (Cowieson *et al.,* 2018; Ravindran *et al.,* 1995) [7, 37]. This can affect animal health and feed quality. Here's a breakdown of the key points:

- **Phytic acid:** This is the main focus, mentioned as both "phytates" and "phytic acid" for clarity.
- **Found in plants:** Cereals, oilseeds, and legumes are highlighted as the main sources.
- **Stores phosphorus:** This is its main function in plants.
- **Hinders mineral absorption:** This is the key negative aspect, affecting calcium, zinc, and iron.
- **Affects animal health:** Mineral deficiencies can harm animals.
- **Reduces feed quality:** This can cause problems like decreased pellet durability (Selle and Ravindran, 2007) [41].

Tannins

Plant compounds called tannins, found in legumes, leaves, and fruits, can have both upsides and downsides for animal diets. While small amounts can help animals use protein better and cut methane emissions (in ruminants like cows and sheep), too much tannin can be bad. This is because they bind to proteins and carbs, making them hard to digest. This can also hurt the quality of animal feed pellets, making them crumble and dust more easily. Additionally, tannins might block digestive enzymes and nutrient absorption, leading to less efficient growth in animals (Reed *et al*., 2018; Redondo *et al*., 2016) [39, 38].

Lectins

Plants like grains, legumes, and nuts contain proteins called lectins. These proteins can clump red blood cells and attach to gut sugars, causing problems with digestion and nutrient uptake in animals. Additionally, lectins can mess up the process of making animal feed pellets, making them weaker and dustier (Adeola and Cowieson, 2011; Liener, 1994) [1, 25]. Even worse, they can irritate and damage the animal's intestines, making it even harder for them to get nutrients from their food.

Oxalates

Plants like leafy greens, nuts, and seeds contain naturally occurring oxalates. When eaten in large amounts, these oxalates can grab onto calcium, stopping our bodies from using it properly. In animals, high oxalates can even lead to kidney stones. Making animal feed pellets can be tricky with high-oxalate ingredients, as they affect how well the pellets stick together. Studies suggest that extra processing or recipe tweaks might be needed for such ingredients to make strong pellets (Lee *et al.,* 2013; Newkirk, 2009) [17, 29].

Saponins

Certain sugary molecules called saponins, found in plants like legumes, grains, and animal feed, act like soap and can damage gut cells. This damage can make it harder for animals to absorb nutrients, leading to lower food intake, slower growth, and less efficient use of nutrients. When making animal feed pellets, these saponins can also weaken the pellets themselves. Special processing methods or additives might be needed for feeds high in saponins to ensure good pellet quality and animal health (Agriculture and Agri-Food Canada, 2016; Woyengo *et al.,* 2017) [2, 47].

Nitrates

The role of nitrates in the anti-nutritional properties of tree fodders is primarily associated with their potential toxicity to animals, particularly ruminants. Nitrates are naturally present in many plants, including tree fodders, and can accumulate to harmful levels under certain conditions. When animals consume fodders high in nitrates, such as those contaminated by fertilizers or exposed to environmental stressors like drought, the nitrates can be converted into nitrites in the rumen through microbial action (Osuji *et al*., 1995) [32]. Nitrites can then bind to haemoglobin in the blood, forming methemoglobin, which is unable to transport oxygen effectively, leading to a condition called methemoglobinemia or "nitrate poisoning". Additionally, high levels of nitrates in tree fodders can disrupt rumen function, reduce feed intake, and impair nutrient utilization, ultimately affecting animal performance and health. Therefore, while tree fodders may offer valuable nutritional benefits, the presence of nitrates poses a risk and necessitates careful management to mitigate their adverse effects.

Alkaloids

Plants like nightshades, tobacco, and some grains naturally contain nitrogen-based compounds called alkaloids. These substances can have various effects on animals, including both beneficial (stimulating, pain-relieving) and harmful (toxic, health problems). If animals eat too much food high in alkaloids, it can disrupt their nutrient absorption and growth. Additionally, when making animal feed pellets, alkaloids can weaken the pellets and affect their quality. Experts suggest detoxifying feed materials with high alkaloid levels or adjusting the pellet recipe to ensure both good pellet quality and healthy animal growth (Francis *et al.,* 2002; Stegelmeier *et al.,* 2016) [13, 43].

Glycosinolates

Cruciferous vegetables like broccoli and kale contain sulfur-based compounds called glucosinolates. While beneficial in some ways, they can cause issues in animals:

- **Thyroid health:** Glycosinolates can mess with thyroid function and iodine uptake, potentially leading to enlarged thyroids (goitre).
- **Feed quality:** During feed processing, they can affect how pellets bind together, making them less durable.

Research suggests that processing techniques or additives might be needed for feed high in these compounds to minimize negative impacts on pellet quality and animal health (Jeffery *et al.,* 2003; Verkerk *et al.,* 2009) [18, 46].

Conclusion

In short, integrating agroforestry, especially fodder trees, tackles diverse issues in livestock farming. It not only

provides nutritious food for animals but also benefits the environment, society, and climate. Planting trees like Leucaena, Gliricidia, and Sesbania improves animal diets, health, and resilience to environmental changes. These systems also help conserve soil, store carbon, and protect biodiversity, making agriculture more sustainable. For farmers, agroforestry boosts income, reduces reliance on external inputs, and fights poverty in rural areas. It also helps manage water by storing it naturally and preventing soil erosion and nutrient loss.

However, choosing the right fodder trees is crucial. Consider their protein, energy, fiber, and minerals while checking for potential harm from anti-nutritional factors. Careful management and selection ensure optimal animal health and feed quality. Overall, agroforestry-fodder production offers a sustainable solution for livestock farming. By using trees effectively, we can boost food security, fight climate change, and build thriving rural communities.

Conflict of Interest

Not available.

Financial Support

Not available.

References

1. Adeola O, Cowieson AJ. Opportunities and challenges in using exogenous enzymes to improve nonruminant animal production. J Anim Sci. 2011;89(10):3189-3218.
2. Agriculture and Agri-Food Canada. The Canadian forage and livestock industry: Saponins in forages and implications for ruminant nutrition. 2016.
3. Aregawi T, Melaku S, Nigatu L. Management and utilization of browse species as livestock feed in semi-arid district of North Ethiopia. Livest Res Rural Dev. 2008;20(6):86.
4. Barry TN, McNabb WC. The implications of condensed tannins on the nutritive value of temperate forages fed to ruminants. Br J Nutr. 1999;81(4):263-272.
5. Bhatti SA, Anjum MA, Khan MZ, Ijaz M, Saleem MH. Occurrence of aflatoxins in compound feed and feed ingredients. Pak Vet J. 2018;38(2):137-140.
6. Briceño-Poot EG, Ruiz-González A, Chay-Canul AJ, Ayala-Burgos AJ, Aguilar-Pérez CF, Solorio-Sánchez FJ, *et al*. Voluntary intake, apparent digestibility and prediction of methane production by rumen stoichiometry in sheep fed pods of tropical legumes. Anim Feed Sci Technol. 2012;176(1-4):117-122.
7. Cowieson AJ, Acamovic T, Bedford MR, The European Federation of Animal Science. Exploiting gut health to improve efficiency of poultry production. Wageningen: Wageningen Academic Publishers; 2018.
8. Cuartas Cardona CA, Naranjo Ramírez JF, Tarazona Morales AM, Murgueitio Restrepo E, Chará Orozco JD, Ku Vera J, *et al*. Contribution of intensive silvopastoral systems to animal performance and to adaptation and mitigation of climate change. Rev Colomb Cienc Pecu. 2014;27(2):76-94.
9. Department of Animal Husbandry and Dairying (DAHD). Annual Report 2021-2022. New Delhi: Ministry of Fisheries, Animal Husbandry and Dairying, Government of India; 2021.
10. Devendra C, Thomas D. Crop-animal interactions in mixed farming systems in Asia. Agric Syst. 2002;71(1-2):27-40.
11. Dhyani SK. Role of watershed management in improving forage production. In: Jakhmola RC, Jain RK, editors. Sustainable Animal Production. Jaipur: Pointer Publication; 2003. p. 173-207.
12. Fadel Elseed AMA, Amin AE, Abdel Ati A, Sekine J, Hishinuma M, Hamana K. Nutritive evaluation of some fodder tree species during the dry season in Central Sudan. Asian-Australas J Anim Sci. 2002;15(6):844-850.
13. Francis G, Kerem Z, Makkar HPS, Becker K. The biological action of saponins in animal systems: A review. Br J Nutr. 2002;88(6):587-605.
14. Franzel S, Coe R, Cooper PJM. Assessing the adoption potential of agroforestry practices in sub-Saharan Africa. Agric Syst. 2001;69(1-2):37-62.
15. García GW, Acosta YM, Quiñones AM, Rodríguez IG. Mineral composition of fodder trees and shrubs leaves in four Venezuelan agroecosystems. Rev Fac Cienc Vet. 2019;60(2):123-130.
16. Gebeyew K, Animut G, Urge M, Feyera T. The effect of feeding dried tomato pomace and concentrate feed on body weight change, carcass parameter and economic feasibility on hararghe highland sheep, Eastern Ethiopia. Vet Sci Technol. 2015;6(2):1.
17. Hristov AN, Lee C, Cassidy T, Long M, Heyler K, Corl B, *et al*. Effects of increasing concentrations of corn-dried distillers grains with solubles in dairy cow diets on methane production, ruminal fermentation, digestion, N balance, and milk production. J Dairy Sci. 2013;96(4):2413-2427.
18. Jeffery EH, Araya M, Jeffery LE. An estimation of the glucosinolate content of cruciferous vegetables available in the United States. In: ACS Symposium Series. Vol. 859. American Chemical Society; 2003. p. 223-237.
19. Jose S, Gillespie AR, Pallardy SG. Interspecific interactions in temperate agroforestry. Agrofor Syst. 2004;61-62(1-3):237-255.
20. Köngös J, Hüttmann A, Fischer F, Grünewald H, Köngösberger E. Influence of different shade levels on thermal comfort of dairy cows in a silvopastoral system in the tropics. Agric Forest Meteorol. 2019;279:107698.
21. Kumar A, Harikrishna V, Reddy AK, Chadha NK, Babitha AM. Salinity tolerance of *Pangasianodon hypophthalmus* in inland saline water: effect on growth, survival and haematological parameters. Ecol Environ Conserv. 2017;23:475-482.
22. Kumar H, Singh M, Kumar S, Kumar B, Meena VK. Fodder Quality Assessment Through Remote Sensing: A Review. Indian J Ecol. 2022;49(6):2431-2435.
23. Lascano CE, Umanzor S, Avilés L, Williams S, López F. Nutritive evaluation of tropical forages as a ruminant feed. Rev Fac Cienc Agrar Univ Nac Cuyo. 2016;48(2):205-228.
24. Lee KW, Kim HY, Lee YB, Kim YJ, Oh HK, Kang CW, *et al*. Effects of calcium and phosphorus supplementation on growth, nutrient digestibility, and bone mineralization in weaned pigs. J Anim Sci. 2013;91(12):5661-5669.
25. Liener IE. Implications of antinutritional components in soybean foods. Crit Rev Food Sci Nutr. 1994;34(1):31-67.
26. Mathukia RK, Sagarka BK, Panara Dm. Fodder Production Through Agroforestry: A Boon for Profitable Dairy Farming. Innovare J Agric Sci. 2016;4(2).
27. Mekoya A, Oosting SJ, Fernandez-Rivera S, van der Zijpp AJ, Nutting WB. Constraints to the utilization of crop residues and agro-industrial by-products in urban

and peri-urban dairy production systems in Ethiopia. Renew Agric Food Syst. 2018;33(4):372-384.
28. Nair PKR. An Introduction to Agroforestry. Springer Science & Business Media; 1993.
29. Newkirk RW. Calcium oxalate in feeds and the effect of calcium and magnesium concentration on its excretion by sheep. Can J Anim Sci. 2009;89(1):107-111.
30. Norton BW. The nutritive value of tree legumes. In: Forage Tree Legumes in Tropical Agriculture. CAB International; 1994. p. 177-191.
31. Norton BW. Animal production from the use of *Leucaena leucocephala*. In: Leucaena Adaptation, Quality and Farming Systems. ACIAR; 2006. p. 91-112.
32. Osuji PO, Akinlade JA, Khan AA. Nitrate and condensed tannin levels in tree fodders: their relationship with live weight change and carcass traits in Ethiopian Menz sheep. Small Rumin Res. 1995;17(3):239-247.
33. Pierron A, Alassane-Kpembi I, Oswald IP, Pinton P. Impact of two mycotoxins deoxynivalenol and fumonisin on pig intestinal health. Porcine Health Manag. 2016;2(1):21.
34. Poutaraud A, Michelot-Antalik A, Plantureux S. Grasslands: a source of secondary metabolites for livestock health. J Agric Food Chem. 2017;65(31):6535-6553.
35. Preston TR, Leng RA. Matching Ruminant Production Systems with Available Resources in the Tropics and Subtropics. Penambul Books; 1987.
36. Ramteke R, Doneria R, Gendley MK. Antinutritional factors in feed and fodder used for livestock and poultry feeding. Acta Sci Nutr Health. 2019;3(5):39-48.
37. Ravindran V, Hew LI, Ravindran G. Influence of microbial phytase on apparent ileal amino acid digestibility of feedstuffs for broilers. Poult Sci. 1995;74(11):2231-2239.
38. Redondo LM, Chacana AP, Dominguez JE, Fernandez Miyakawa ME. Perspectives in the use of tannins as alternative to antimicrobial growth promoter factors in poultry. Front Microbiol. 2016;7:1-7.
39. Reed JD, Krueger CG, Vestergaard M. Tannins: Major players in regulating soil organic matter. In: Soil organic matter. Elsevier; 2018. p. 221-256.
40. Reed JD, Soller H, Woodward A. Fodder tree and straw diets for sheep: Intake, growth, digestibility and the effects of phenolics on nitrogen utilization. Anim Feed Sci Technol. 1996;60(1-2):27-37.
41. Selle PH, Ravindran V. Microbial phytase in poultry nutrition. Anim Feed Sci Technol. 2007;135(1-2):1-41.
42. Smith TK, McMillan EG, Castillo JB, Rasmussen RR, Filho ACA, Cabrera RA. Current strategies for mitigating mycotoxin risk in the feed industry. Anim Feed Sci Technol. 2016;219:1-10.
43. Stegelmeier BL, Gardner DR, James LF, Panter KE. The toxicology of alkaloids in livestock. Vet Clin North Am Food Anim Pract. 2016;32(2):369-382.
44. Sthapit BR, Rijal D, Rao MR. Biodiversity conservation and use of traditional agroforestry systems in Nepal: Proceedings of an international workshop. Bioversity International; 2008.
45. Kumar S, Choudhary M. Fodder Production Technologies for Irrigated and Dry Lands. In: Agripreneurship Development On Value Added Fodder Products. Hyderabad, India: National Institute of Agricultural Extension Management; Jhansi (U.P.): ICAR-Indian Grassland and Fodder Research Institute; 2021.
46. Verkerk R, Schreiner M, Krumbein A, Ciska E, Holst B, Rowland I, *et al*. Glucosinolates in Brassica vegetables: The influence of the food supply chain on intake, bioavailability and human health. Mol Nutr Food Res. 2009;53(Suppl 2):S219-S265.
47. Woyengo TA, Beltranena E, Zijlstra RT, Newkirk RW. Effect of soybean variety and processing on growth performance of piglets. Anim Feed Sci Technol. 2017;227:1-12.

How to Cite This Article
Kabinesh V, Kumar NR, Moulidharshan R, Bargavi S, Sabarish M, Kalpana R, *et al*. Tree fodders for livestock nutrition: A review. International Journal of Veterinary Sciences and Animal Husbandry. 2025; SP-10(8): 06-12.