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Tree fodder as an alternate land use option for sustaining forage security in India

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Abstract

Success of animal husbandry and dairy industry is largely depends on quality fodder availability. However, quality fodder availability in India is low due to low or non availability of suitable varietal wealth, more emphasis on food grain and cash crops. The projected fodder scarcity in India reveals a net deficit of 35.6 % green fodder and 10.9 % dry crop residue, which calls for development and adoption of land use based interventions. In this context, tree fodder based land use plans may prove beneficial due to their ability to supply nutritious green fodder round the year at optimally lower cost. Besides, it has wide adaptability and fast growth under marginal areas, and thus, helps in bringing in their fold areas such as non-arable wastelands besides. Thus, it paves the way for forage security besides their role in improving ecosystem services and societal well being.

Keywords: Alternate land use option, forage security, nutritional aspects, fodder trees

1. Introduction

Agriculture including the livestock as an integral component plays an important role in Indian economy^[16]. Since, livestock is considered a major source of income for the poor masses in developing countries^[21] including India, where it contributes, nearly 4.11 percent to total GDP during 2012-13 at prevailing prices of agriculture and allied sector^[16]. India supports worlds 17% human population^[13] and 15% livestock population over an area of 2.4%. The livestock constitutes 37.28% cattle, 21.23% buffaloes, 12.71% sheep and 26.40% goat^[16]. The large population base results into declining per capita land availability of 1.15 ha in 2010-11 and increasing percentage (> 85%) of small and marginal farmers^[29].

Area under cultivated fodder in India is about 8.4 m ha^[27], which is not adequate to meet the fodder demand. Besides, more emphasis on food grains further add to the fury by limiting area under fodder crops and resultant shortage of fodder production^[69] as well as supply of feed^[28, 91 and 80]. Latest estimate on demand-supply gap in fodder availability shows a net deficit of 35.6 % green fodder, 10.95% dry crop residues in India^[41]. This deficit is responsible to some extent for increase in total expenditure on feed stuff by about 60-65%^[49] which equals to about 2/3rd of the total cost in livestock production^[27]. The cost on feed and fodder production is further elevated due to climatic aberrations, edaphic factors and water scarce conditions. These factors limit the fodder production and creates forage scarcity thus, force the animals to feed on wild shrubs and grasses^[88], and this is recognized as one of the primary causes of lower productivity of milch animals in India^[73].

Success of dairy sector is largely depends on the supply quality feed and fodder^[48]. However, it seems little difficult from the existing cultivated fodder area thus, it is important to develop alternatives which constantly supply fodder at low cost. Therefore, effort needs to be made to bring the degraded wastelands under fodder tree plantation. In this regard, India offers great scope because of its vast degraded wasteland areas (146.8 m ha), affected due to various constraints viz., water erosion (94 m ha), acidification (16 m ha), flooding (14 m ha), wind erosion (9 m ha), salinity (6 m ha) and 7 m ha from a combination of factors^[10]. Bringing these areas under the ambit of fodder trees will not only help to sustain the forage supply but also help to improve the ecosystem services in terms of shade, mulch, fuel wood, fertility enhancement and soil stabilization^[25]. Besides, tree fodder will also help in soil and water conservation, water and nutrient extraction^[95]. Research results from several parts of the world including Africa, Ethiopia and India reveals that fodder trees and shrubs are valuable animal feed and play an important role in farming system^[52] due to their better adaptation to local environment^[96] and drought situation^[62]. *Leucaena leucocephala*, *Sesbania sesban*, *Sesbania*

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grandiflora, *Gliricidia maculata* and *Moringa oleifera* can be cultivated on isolated denuded patches of land for supply of nutritious fodder to grazing animals^[17, 37]. Tree fodder can be recommended in area where few or no alternatives are available^[98; 4] to provide cheaper feed supplement including the small landholdings^[64]. Therefore, it is high time to rely upon tree fodder, as an alternate land use option to address the issue of forage scarcity under the changing land use and climatic conditions.

2. Status of tree fodders in India

In large parts of India, animals' feed on tree or shrub leaves, usually rich in protein therefore, used as a supplement for low-protein fodders. The value of trees for feeding animals necessitates the planting of multipurpose fodder trees, which are, otherwise, primarily grown for fuel and timber purpose. In India, several exotic and indigenous trees including fodder trees were introduced during 1950s, to the Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan. Amongst exotic fodder trees and shrubs, most promising one includes *Acacia tortilis*, *Cellophospermum mopane*, *Prosopis juliflora*, *Dichrostachys mutans*, *Brasilettia mollis*, *Pittosporum phillyraesides*, *Schirueus mole*, *Atriplex spp.*, and *Zizyphus spinacristi* while, successful indigenous introductions were *Albizia amara*, *Cardio roti*, *Albizia lebbek*, *Acacia nilotica*, *Hardwickia binata*, *Azadirachta indica*, *A. excelsa*, and *Prosopis cineraria*^[77]. Exotic and indigenous fodder trees were introduced either due to lack of availability of such useful trees or their slow growth and inability to meet feed requirements of the area^[74]. However, most of the areas and vegetations, which could serve as fodder for animals, are mainly found in semi-arid regions of the country^[77].

3. Tree fodders as an alternate land use options for forage and nutritional security

Across the globe concerns have been raised to meet the fodder demand of livestock population especially on account of climate and land use change. These circumstances may pose serious threats to fodder security, affecting most severely the developing nations due to their overdependence on agriculture and allied activities. Since, India supports world's second largest livestock population, may find it difficult to meet the fodder demands from only 8.4 million ha cultivated fodder acreage, which too remained static in the last 2 decades, further exaggerate the situation^[27]. With this area, it's quite difficult to bridge the demand-supply gaps of green and dry forages. However, research results indicates that productivity of the pastures could be enhanced either by substituting low yielding annual grasses with high yielding perennial grasses or through introduction of multipurpose tree species^[68, 67]. Besides, there is a need to explore alternate sources of livestock feeding^[78] such as tree forages^[43]. The leaves of tree fodders considered nutritious feed due to their high proteins, vitamins and minerals^[7] and vital in the nutrition of grazing animals^[59]. Although, every part of tree is useful for feeding^[1, 35], but leaves are considered most valuable due to their high crude protein^[1]. In areas, where herbaceous forages become unavailable during dry season, browse feeding is considered as an essential practice^[6] because most of the browse plants yield high crude protein ranging from 10 to more than 25% on dry matter basis^[60].

Research results from several regions of the world reveal that planting trees for fodder purpose, enhances nutritious fodder availability^[23, 55] and also increases resource as well as land use efficiency^[40, 87, 21, 12]. Thus, tree fodders as an alternate

land use options, offer great scope for forage security under various agro-climatic and ecological conditions.

Prominent tree fodders in India

Khejri (*Prosopis cineraria*): *Prosopis cineraria* is found in some of the most impoverished and harshest arid eco-systems of the world including African Sahel (Senegal to Somalia), Middle Eastern deserts of Yemen, Saudi Arabia and deserts of Rajasthan (India) and Pakistan^[71]. It is one of the chief indigenous tree species of north-western plains of India^[70], and grows mainly in the arid and semiarid parts of Rajasthan, where it occupies highest area among traditional agro-forestry based systems^[14]. Khejri based agro-forestry systems in western Rajasthan recorded 1500 Kg ha⁻¹ forage yield and fodder palatability up to 74.8%^[82]. Its dried pods locally known as *Kho kha*^[81] and contains 11.9% crude protein^[47]. Its leaves, significantly improves the growth rate (46 g/day) of goat kids when supplied at the rate of 672 g/ day^[90], which may be attributed high palatability, protein and other nutrient contents^[9].

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 sub-humid climates and can survive in a wide range of conditions including dry season^[69]. It can produces 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^[63, 42, 102, 14, 32, 33, 79, 22, 34], which increases growth rate and milk production in animals. Therefore, it should be considered as a potential tree fodders 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^[31].

Mulberry (*Morus alba*): *Morus alba* grown over a wide range of climatic regions of the world ranging from tropical, sub-tropical and temperate areas^[44]. It requires annual rainfall in the range of 600-2500 mm for successful cultivation^[94]. In the agro-forestry systems, for foliage fodder purpose, it can be recommended for plantation on black and low lands as well (kabar soils)^[54]. 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^[3]. Besides, its leaves are also rich in proteins, minerals, especially in calcium (Ca) and phosphorous (P), and metabolizable energy^[84, 92].

Mulberry plant produces more fodder in terms of digestible nutrients compare to most of the traditional forages^[85]. It was reported that its foliage is comparable to alfalfa hay mix in terms of digestible energy and crude protein values^[24]. Mulberry leaves are protein rich forage supplements^[8] and can be used fresh or dried in compound feeds of high yielding animals^[11]. 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^[99]. In several parts of the world it is also used as a substitute to concentrate feed for cattle^[85, 56] or goat diets^[2]. Moreover, its leaves can be used as main feed for sheep^[75, 51] and, goats^[65; 85; 86; 5] besides, serving as a maintenance diet for sheep due to their palatability^[26].

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^[89]. *Sesbania* produces a dry matter yield up to 4-12 t ha⁻¹ year⁻¹ in 3-5 cuttings^[36]. Leaves and tender branches are easily digestible, and contain 20-25% crude protein^[76], which varies from 194 g kg⁻¹ dry matter in twigs to 297 g kg⁻¹ dry matter in leaves^[19]. Due to its high level foliage nitrogen content it is considered as an ideal supplement to protein poor roughage^[83, 53, 66]. Research results reveal that it increases milk production by 13% compare to concentrates supplemented ewes, when ration was supplemented up to 30%, with it^[58]. Besides, it is also reported to improve the reproductive performance in sheep^[83; 57].

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^[72, 45]. 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^[46]. It is used to supplement rice straw in animal diets^[61, 39], probably due to high levels, about 25-30%, of crude protein content in leaves^[46].

Hedge Lucerne or Dasharath (*Desmanthes virgatus* L.): It is native to tropical and sub-tropical regions of the new world. It is grown as a forage legume and produces green fodder containing high amount of crude protein as well as good palatability^[20]. It produces high quality green forage containing, about 22.4% crude protein and yield up to 15-25 t ha⁻¹ under optimum soil and climate conditions^[50]. Besides, its use as a fodder, also found ideal for wasteland development in India^[69].

Future prospects of tree fodder as an alternate land use option

- In the years ahead, tree fodder may be a leading forage option to supply quality fodder for the livestock.
- Tree fodder will act as life line for dry region of the world, often victims of vagaries of the climate and weather. Tree fodder, in these areas may supply round the year green fodder, due to their fast growing habit and adaptation into local environment.
- Due to high palatability and nutrition, it may act as future feed supplement and maintenance diet, even in non-traditional areas, where traditional forage crops are the only option to feed animals.
- Due to their role in reclamation of wastelands and denuded areas, these may be treated as future engine for ecological restoration and balance and thereby offsetting the ill-effects of climate and land use change.
- Tree fodder may act as direct positive support for marginal communities and areas by rendering ecological services as well as serving other commercial interests besides sustaining forage security.

Thrust areas for tree fodder option

- Rising population, shrinking land resources and more diversion of cultivated lands into developmental as well as commercial activities, commercial uses of trees, poses serious challenge for adoption of tree fodder option.

- Development of improved cultivars in fodder trees is a herculean task due to difficulty in breeding. Besides, seed propagated material faces, germination problem because of recalcitrant and orthodox nature while, vegetative propagation requires sophisticated techniques, usually not available in developing countries.
- Nutritional profiles of tree fodder should be prepared and anti-quality substances need to be removed, so as to ensure the safe feeding for livestock.
- Some tree fodder possesses anti-quality substances (tannic acid and mimosine) which make them unfit for consumption. Thus, it is a big challenge to develop suitable cultivars free from anti-quality substances, using improved breeding approaches.
- In tree fodder, disease and pests management is also difficult as compare to traditional forage crops. Thus, it requires great knowledge and understanding on part of both researchers as well as cultivators of tree fodder.
- During initial years, tree fodders require special attention due to germination and establishment issues.
- Development of suitable propagation materials for marginal and degraded wasteland areas is a big thrust.

Conclusion

Changing land use conditions calls for reliance on alternate land use option to bridge the demand-supply gap in fodder, and in achieving higher land use efficiency. Tree fodder may supply the quality green fodder round the year due to their wide adaptation in a range of soils and climates. Besides, these are ideal for growing on wastelands, problem soils, undulating lands, farm boundaries, field bunds, waysides and swampy areas, and dry areas. From the foregoing discussion, it can be concluded that tree fodder based alternate land use options may be a boon for achieving forage security and land sustainability.

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