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Teff: A climate smart fodder for sustainable livestock production in India

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Abstract

India's livestock sector is a crucial part of its agricultural landscape, providing sustenance and livelihoods to millions of farmers and contributing significantly to the economy. However, the country faces challenges in meeting the increasing demand for animal feed due to insufficient fodder production and poor-quality forages. Teff (*Eragrostis tef*), an innovative warm-season annual grass native to Ethiopia, offers a promising solution. Its exceptional drought tolerance and adaptability to diverse agro-climatic conditions make it an attractive alternative fodder crop. Teff's palatability, nutritive richness, and rapid growth have been shown to increase milk production in dairy cows compared to native grass hay in the USA, indicating its potential as an alternative forage source for lactating dairy cows. With growing interest worldwide, teff can help bridge seasonal forage gaps and improve feed availability in India's livestock sector.

Introduction

India's vibrant livestock sector serves as the backbone of its agricultural landscape, providing sustenance and livelihood to millions of farmers across the nation and plays an important role in the Indian economy. The Livestock sector in India contributes 5.73% GDP and 30.19% of total Agriculture GDP as per the latest reports. About 20.5 million people depend upon livestock for their livelihood. Livestock contributed 16% to the income of small farm households as against an average of 14% for all rural households. Livestock provides livelihood to two-third of the rural communities. It also provides employment to about 8.8 % of the population in India as per the 20th Livestock Census of India. With a rapidly growing population and an increasing demand for meat, milk and other livestock products, the need for a stable and nutritious supply of animal feed has become paramount. However, the fodder production in the country is not sufficient to meet the requirements and moreover the forages

offered are mostly of poor quality. There is a huge gap in regional and seasonal fodder availability and requirement in India. Currently, the availability of green fodder stands at 462 million metric tons, while dry fodder amounts to 394 million metric tons. Regrettably, India confronts a net deficit of green and dry fodder by 35.6 and 10.95%, respectively with a significant shortage of concentrate feed ingredients by 44 % as per the IGFRI reports. The allocation of land for the cultivation of green fodder is restricted to a mere 5% of the gross cropped area. In India, the summer season poses numerous climatic challenges that restrict fodder production, including droughts, floods and extreme temperatures. Traditional grasses often suffer during this period, primarily due to water deficits, impacting their growth and development ultimately causing their unavailability as livestock feed. Thus, incorporating water use efficient warm season annual grasses are generally considered to fill the gap of summer season forage reduction that would offer considerable flexibility and adaptability to respond to increasing forage demand.

Teff as a fodder

In this context, Teff (*Eragrostis tef*), a warm-season annual grass native to Ethiopia, emerges as an innovative and promising alternative fodder crop with the potential to revolutionize India's livestock sector. Traditionally renowned as a cereal grain and a dietary staple in Ethiopia, teff's versatility extends to its potential as a forage crop, drawing attention for its exceptional drought tolerance and adaptability to diverse agro-climatic conditions. As water resources continue to deplete and climate change poses uncertainties on agricultural productivity, teff's resilience and capacity to withstand challenging environmental conditions have garnered substantial interest as a solution to the ever-growing concerns of feed availability. Teff has been proven to exhibit rapid growth, producing high-quality forage yields within a relatively short growing season. The forage value of teff lies in its palatability, nutritive richness, rapid growth and drought tolerance. Studies have shown increased milk production in dairy cows fed with teff hay as their sole diet compared to native grass hay in the USA, suggesting teff's potential as an alternative forage source for lactating dairy cows. The growing interest in teff forage worldwide is evident and its summer production can be conserved as stored feed for winter or utilized to bridge the growth slump observed in cool-season grass species.

Qualities of teff making it as a potential feed option for Indian livestock

1. High palatability - Teff crops are characterized by fine stems and possess a softer and leafier profile compared to other types of hay grasses which boost easy chewing and digestion by animals. Teff hay exhibits high palatability when harvested during the boot stage or early maturity by passably gratifying the digestible energy requirements of most mature horses. However, if harvested at a later stage of maturity, the palatability diminishes as it may not provide sufficient digestible energy. Dairy cows in Idaho, USA display a preference for teff hay over alfalfa due to its high palatability.

2. Short life cycle - Teff plant is renowned for its fast growth rate. Within a relatively short growing season, it can achieve substantial height and biomass making it an attractive option for livestock feed production. Depending on the agro-climatic conditions and management

practices, it is ready for first harvest in as little as 45 to 50 days after sowing (Miller, 2010).This rapid growth allows for multiple harvests within a single growing season, ensuring a continuous and abundant supply of fresh feed for livestock.



Fig. Teff crop

3. High yield and quality – Teff yields around 1.5 to 2.5 t ha^{-1} in a single cut. In multiple cut areas, summer production of 4 to 7 t ha^{-1}fresh fodder can be harvested. Under better crop management it is even possible to attain fodder yield of 12 to 25 t ha^{-1}based on soil fertility and agro-climatic conditions. Notably, teff's high yield does not compromise its forage quality compared to other high-quality forages (Table 1). It is rich in protein, fiber, vitamins (A, B-complex and C) and essential minerals (calcium, phosphorus, potassium, magnesium, iron and zinc) nourishing the feeding animal towards superior health and growth. The combination of high yield and excellent forage quality in teff makes it a compelling option for livestock feed production and ensuring that animals receive a balanced and nutritious diet for optimal performance and productivity.

4. Steady and stable fodder supply during summer - Teff fodder production during the summer months offers several advantages for livestock farmers. As a warm-season grass, teff thrives in high temperatures and is well-suited for cultivation in hot and arid regions. Its ability to tolerate heat and limited water availability makes it a resilient option during the summer season when water scarcity can be a challenge for other forage crops. Teff's rapid growth and short growing cycle allow for quick establishment and multiple harvests within the

Table 1: Quality composition of Teff straw and cereal crop residues (percentage of dry matter) (Mosi & Butterworth 1985)

Quality parameter	Teff straw	*Trifolium* hay	Maize stover	Oat straw	Wheat straw
Dry matter %	91.1	90.1	91.0	91.9	92,4
Organic matter	90.8	89.5	88.2	91.9	89.5
Crude protein	3.6	20.1	5.1	6.2	2.3
Neutral detergent fibre	77.5	44.4	75.5	71,2	76.1
Acid detergent fibre	44.3	36.6	51.3	46.6	51.7
Lignin	5.1	4.8	4.8	6.6	6.4
Hemicellulose	33.3	7.8	24.2	24.6	24.3
Cellulose	39.2	31.8	46.5	40.0	45.3
ADF-ash	3.4	-	5.2	3.6	6.9
Phosphorus	0.25	0.30	0.17	0.15	0.22
Gross energy (MJ kg^{-1})	17.6	19.0	16.7	17.9	18.8

summer season. Furthermore, the quality of teff forage remains high even during the summer, providing animals with a nutritious and palatable feed option. The capacity to produce teff fodder in summer also contributes to diversifying the available feed resources, reducing the pressure on other forage crops and promoting sustainable agricultural practices. In regions, where summer growth of traditional forage crops may be limited, teff serves as a valuable alternative to bridge the feed gap and ensure a stable feed supply throughout the year.

5. Potential forage for drought prone areas - Teff is drought tolerant and can grow in areas with as little as 250 mm of rainfall per year. In numerous regions of India, water scarcity poses formidable challenges, particularly for conventional forage crops reliant on substantial irrigation. Teff presents an appealing alternative due to its remarkable drought tolerance and capacity to flourish under water-limited conditions (Roseberg *et al*., 2018). By choosing teff as a fodder crop, the pressure on water resources can be alleviated, offering much-needed support to livestock farmers operating in areas with restricted water availability.

6. Wider adaptability - Teff has the ability to thrive in moisture-stressed and waterlogged soils. It exhibits wide adaptation to diverse agro-climatic zones, making it a versatile and resilient fodder crop. It has shown successful cultivation in states with varying climatic conditions, such as Rajasthan, Gujarat, Tamil Nadu and Karnataka. This adaptability provides farmers with the flexibility to grow teff in different states, optimizing land use efficiency and ensuring a stable supply of nutritious feed for livestock across the country.

7. Absence of anti-quality compounds - Teff possess no anti-quality compounds (*viz.*, nitrate toxicity and prussic acid) that sometimes occur in sorghum-related annuals. The absence of significant anti-quality compounds in teff ensures better nutrient utilization and feed efficiency in livestock. This attribute enhances its value as a nutritious and readily consumed feed choice, promoting optimal growth and performance in animals.

8. Versatility of Harvest - Although in most instances teff forage is baled as dry hay, it can in some operations be grazed or ensiled (Creech *et al*., 2012). The versatility of teff harvest is one of its key advantages as a fodder crop. Teff can be harvested at different growth stages, providing flexibility in feed availability and management as follows,

a. Early harvest*:* Teff can be harvested at an early growth stage, typically within 45 to 50 days after sowing. This allows quick access to fresh and tender forage, which is highly palatable and nutritious. Early harvest is suitable for feeding young and growing animals or for providing supplementary feed during periods of forage scarcity without any harm to animals as HCN toxicity in young sorghum plants.

b. Mid-stage harvest: If allowed to grow further, teff can be harvested at a mid-stage, offering a balance between yield and forage quality. This stage is often chosen for regular harvesting during the growing season to ensure a continuous and abundant supply of feed for livestock.

c. Late-stage harvest: Teff can also be left to mature for a longer duration, producing mature seed heads for grain production. In this stage, the forage becomes less palatable but can still serve

as a roughage source for ruminant animals providing farmer a double income from both grain and fodder.

d. Multiple harvests: Due to teff's rapid regrowth, harvests produce potential fodder yield up to 3 cuts are possible within a single growing season. After the initial harvest, the regrowth period allows for additional cuttings, providing farmers with a consistent and sustainable supply of forage for their livestock. Thus, versatility in teff harvest allows farmers to adapt their feeding strategies based on the nutritional requirements of their livestock and the prevailing weather and forage conditions. It also offers the possibility of integrating teff into diverse farming systems, making it a valuable and flexible fodder crop option for livestock farmers.

Challenges and Future Prospects

Despite teff's promising potential as a fodder crop, certain challenges must be addressed to fully exploit its benefits. Limited awareness about teff, inadequate seed availability and unscientific cultivation practices pose hurdles to its widespread adoption. To overcome these barriers, research and extension services play a pivotal role in disseminating information about teff's advantages and providing guidance on its cultivation. Thus, encouraging farmers to embrace this alternative fodder crop and harness its advantages in livestock feed production.

Conclusion

Teff presents a compelling alternative fodder crop for Indian livestock sector. Its potential to address challenges related to water scarcity, climate change and sustainable agriculture, positions it as a transformative option in livestock feed production. By embracing teff as an alternative fodder crop, India can foster a resilient, efficient and environmentally-friendly livestock sector, ensuring a stable and nutritious feed supply to meet the demands of a growing population. Through concerted efforts from farmers, policymakers and the agricultural community, teff can pave the way towards a more sustainable and prosperous future for India's livestock production.

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