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Biodiversity of Wild Fodder Plants of Semi-arid Regions, North East Karnataka, India

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ABSTRACT

Livestock farming in semi-arid regions like north eastern Karnataka, India, relies heavily on wild fodder plants due to limited agricultural opportunities. This study explores the ethnobotanical knowledge of pastoralist communities in Koppal and Bellary districts regarding wild fodder plants. Through interviews and participatory plant collection, 16 herders were surveyed, revealing a diverse range of plant species used as fodder for various livestock. The study identified 16 herbs, 13 shrubs, 9 trees, 4 grasses, and 2 climbers utilized as fodder, with habitats ranging from road edges to rocky hills. Notable species include *Allmania nodiflora*, *Alternanthera sessilis*, and *Aerva lanata*, which are fodder for multiple livestock types. Additionally, species like *Cleome viscosa* and *Vachellia nilotica subsp. indica* are exclusive to goats. The study also uncovered wild hay supplement plants like *Lagascea mollis* and *Barleria prionitis.* The average data matrix rank scores provided insights into the perceived importance of different species as fodder sources. This research highlights the intricate traditional knowledge systems of pastoralists and underscores the importance of conserving biodiversity for sustainable livestock management in semi-arid regions.

Keywords: Biodiversity, Ethnobotany, Farming, Fodder plants, Livestock, Pastoralist

INTRODUCTION

Livestock farming serves as a cornerstone of rural economies worldwide, particularly in semi-arid regions where agricultural opportunities are constrained by water scarcity and arid conditions. In these environments, the availability of nutritious fodder for livestock holds paramount importance for sustaining their health and productivity, thus ensuring the economic well-being of pastoralist

communities. Understanding the ethnobotanical knowledge associated with wild fodder plants is crucial for devising sustainable livestock management practices and conserving biodiversity in such regions.

The semi-arid regions of northeastern Karnataka, India, encompassing districts like Koppal and Bellary, present a unique socio-ecological context characterized by sparse vegetation, erratic rainfall patterns, and rugged terrain (Basavarajappa et al., 2015). Despite these challenges, pastoralist communities in this region have developed indigenous knowledge systems that enable them to identify, collect, and utilize wild plants as fodder for their livestock. This traditional knowledge, passed down through generations, forms an integral part of their cultural heritage and contributes to their resilience in the face of environmental uncertainties (Kolekar et al., 2020).

This research paper aims to explore the diversity, distribution, and utilization of important wild fodder plants among pastoralist communities in the semi-arid regions of northeastern Karnataka, India. Drawing upon a multidisciplinary approach encompassing ethnobotanical interviews, participatory plant collection, and systematic data analysis, the study seeks to document the rich repository of indigenous knowledge regarding wild fodder plants and their ecological significance (Heinrich et al., 1998; Quinlan, 2005).

By documenting the ethnobotanical knowledge of wild fodder plants, this research contributes to our understanding of the intricate relationships between humans, livestock, and the natural environment in semi-arid regions (Balick and Cox, 1996). Furthermore, the findings of this study have practical implications for sustainable land management, livestock husbandry, and biodiversity conservation initiatives in the region (Berkes, 1993).

To achieve these objectives, the research employs established methodologies in ethnobotany, including snowball sampling for participant selection (Jain and Rao, 1997), ethnobotanical interviews for data collection (Cotton, 1996), and direct matrix ranking for data analysis (Phillips and Gentry, 1993). Additionally, field trips were conducted with herders to validate the reported plant species, and authentication was performed at the AYUSH institution in Bengaluru, India, following ethical guidelines outlined in the International Code for Ethnobotany Research (Trotter and Logan, 1986).

Overall, this research endeavours to shed light on the importance of wild fodder plants in supporting the livelihoods of pastoralist communities and fostering ecological resilience in the semi-arid regions of northeastern Karnataka, India.

MATERIALS AND METHODS

Study area

The study has been taken place in the year 2021 in old northeast Karnataka region which consisted Koppal and Ballari. The Koppal district, spanning 5570 square kilo meters in northern latitude between 15° 7’ to 16° and eastern longitude of 75° 46’ to 76° 48’, boasts a population of 13.9 lakhs. With an average rainfall ranging from 579 mm to 637 mm and temperatures varying from 17°C to 38°C, the region predominantly features plain terrain with sparse vegetation and few hillocks. Notably, the Yemme-Gudda hill chain in Kushtagi taluk stands out, originating from the Badami hills and extending into Gangavathi taluk. While the district's forest area covers 5.3% of its total geographical expanse, these forests are largely concentrated along the Tungabhadra riverbanks in Koppal and Gangavathi taluks. However, the overall forest vegetation remains negligible.

In contrast, the Bellary district spans 8461 square kilometers with a population of 14 lakhs, situated in the eastern sector of the State. With average rainfall ranging from 551 mm to 810 mm and temperatures fluctuating between 16.7°C and 39.2°C, the district features two distinct natural divisions separated by the Sandur hills. The eastern division, characterized by flat, treeless expanses and rocky hills, contrasts with the western division, marked by rugged hills and greater elevation. Despite the presence of mixed red ferruginous soil and scattered patches of black cotton soil, the district faces arid conditions with uneven rainfall distribution, resulting in limited vegetation growth.

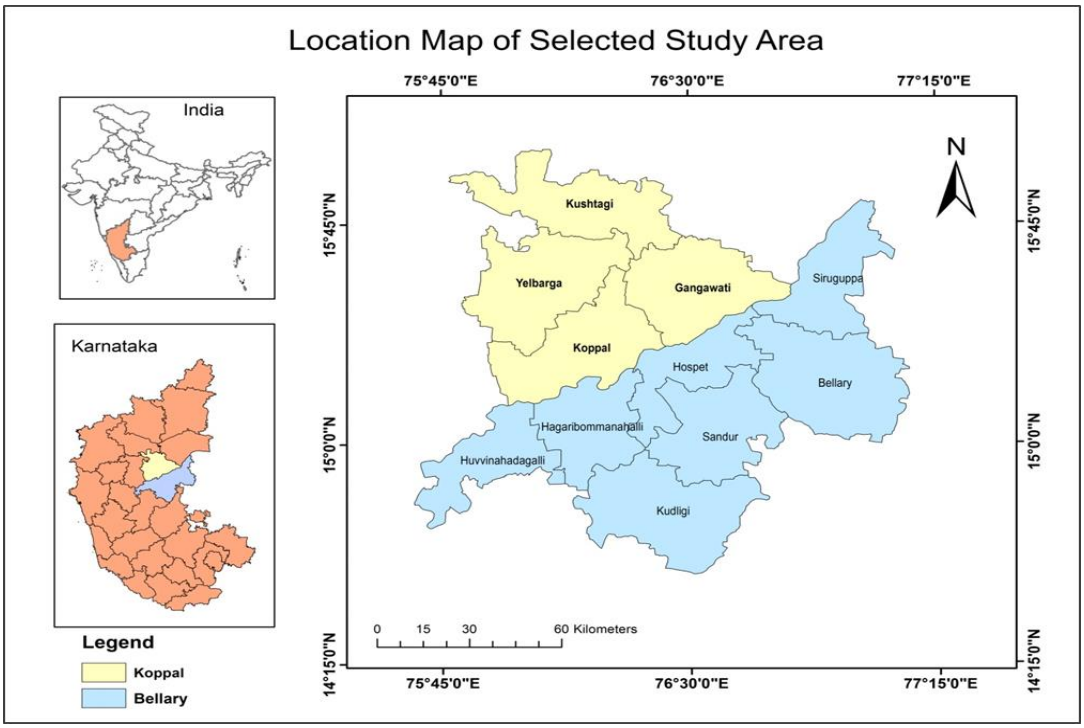

Fig. 1: Study Area of Wild Fodder Plants of Semi-arid Regions, North East Karnataka, India

Research Methods

Our research aimed to explore the ethnobotanical knowledge of pastoralist communities residing in selected villages across Koppal and Bellary districts of Karnataka, India (Heinrich et al., 1998; Voeks and Leony, 2004). To ensure comprehensive coverage, we selected one village from each taluk in both districts as our study sites. The target population comprised pastoralists, individuals whose livelihoods are primarily dependent on animal husbandry. The snowball sampling method was employed to select participants within the pastoralist communities (Quinlan, 2005). This method facilitated the identification of key informants through initial contacts, followed by referrals within the community network. By leveraging this approach, we ensured the inclusion of individuals with rich traditional knowledge of plant uses.

Ethnobotany interview techniques were utilized during data collection to gather insights into the diverse plant uses among pastoralists (Alexiades, 1996). These interviews were structured to collect demographic information, including gender, age, literacy levels, and ethnicity, to provide context to the collected data. Additionally, detailed information was obtained regarding the types of livestock reared by local pastoralists, including cattle, goats, and sheep (Cotton, 1996). Participants were asked to

identify and describe the plants consumed by different types of livestock, as well as their respective plant forms (e.g., leaves, roots, fruits) and habitats.

To validate the reported plant species, field trips were conducted with herders to collect plant specimens (Jain and Rao, 1997). Authentication of these specimens was carried out at AYUSH, a governmental institution located in Bengaluru, India, specialized in traditional medicine and herbal research. Throughout the research process, ethical guidelines outlined in the International Code for Ethnobotany Research were strictly followed (Trotter and Logan, 1986). Informed consent was obtained from all participants, and measures were taken to respect cultural practices and ensure confidentiality. Data analysis involved the calculation of a data matrix, serving as the chief ethnobotanical index to assess the significance of different plant species based on their reported uses (Phillips and Gentry, 1993). Furthermore, the Direct Matrix Ranking (DMR) method, as described by Heinrich et al. (1998), was employed to compare the perceived uses of plant species among participants.

RESULTS

In our study, we interviewed a total of 16 herders, comprising 12 males and 4 females, all belonging to the Kurubha ethnicity. Among them, 3 individuals had completed schooling up to the 6th grade, while the rest had no formal education. We identified a variety of plant families represented in our study, including 6 species from Asteraceae, 15 from Fabaceae, 4 from Poaceae, and 4 from Amaranthaceae. Additionally, we found 2 species each from Lamiaceae, Nyctaginaceae, and Phyllanthaceae, along with one species each from Cleomaceae, Convolvulaceae, Commelinaceae, Cyperaceae, Menispermaceae, Zygophyllaceae, Malvaceae, Rubiaceae, and Acanthaceae (Fig 2 and Table 1).

Our study identified a total of 16 herbs, 13 shrubs, 9 trees, 4 grasses, and 2 climbers. The chief habitats of the identified wild fodder plants include road edges, rocky hills, areas near water bodies, waste lands, dry and uncultivated lands, scrub forests, and grasslands in the Koppal and Bellary districts.

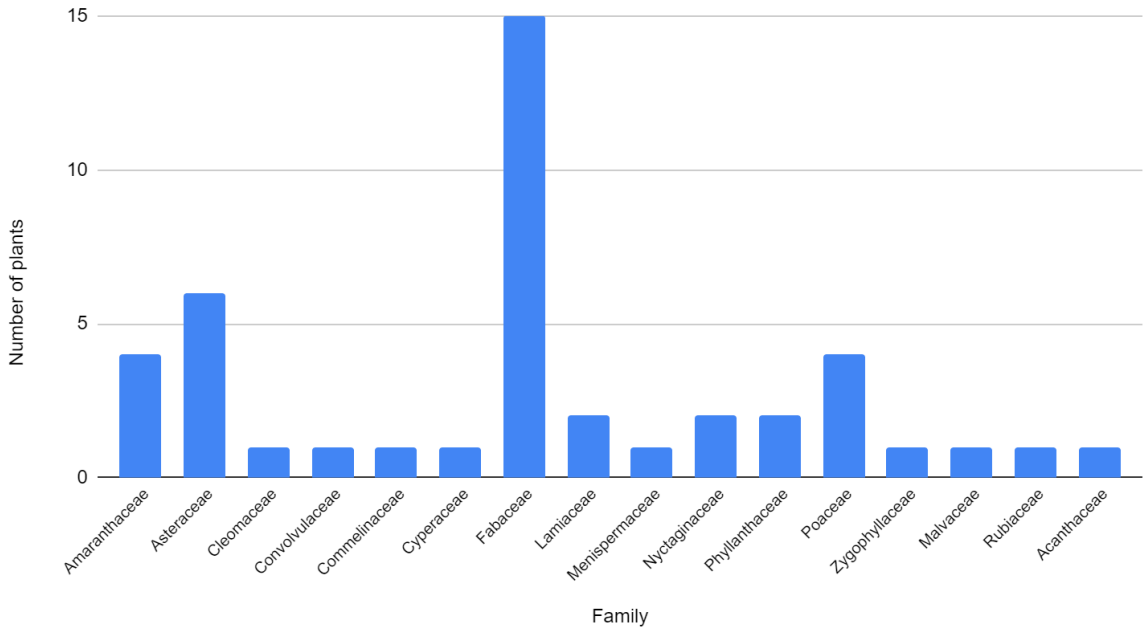

Fig. 2: Number of Wild Fodder Plants Found in each Family

Allmania nodiflora (L.) R. Br. ex Wight, *Alternanthera sessilis* (L.) R.Br. ex DC., *Aerva lanata* (L.) Juss. ex Schult., *Amaranthus viridis* L., *Blumea lacera* (Burm.f.) DC., *Calyptocarpus vialis* Less, *Cyanthillium cinereum* (L.) H.Rob., *Xanthium strumarium* L., *Evolvulus alsinoides* (L.) L., *Cyanotis*

fasciculate (B. Heyne ex.) Roth), *Leucas linifolia* Lin., *Tinospora cordifolia* (Thumb.) Miers, *Boerhavia diffusa* L., *Boerhavia erecta* L., *Flueggea leucopyrus* Willd., *and Flueggea virosa* (Roxb. ex Willd) Royle are utilized as fodder for all the livestock reared by pastoralists, including cows, goats, sheep, and horses.

Cleome viscosa L. *and Vachellia nilotica* subsp. *indica* (L) serve exclusively as fodder plants for goats. Additionally, *Cyperus rotundus* L. is utilized as fodder for both goats and cows. All members of the Poaceae family are exclusively used as fodder for cows and horses. These include *Cenchrus ciliaris* L., *Dactyloctenium aegyptium* (L.) Willd., *Eragrostis minor* Host., and *Heterpogon contortus* (L.) P.Beauv. Among the Fabaceae family, species such as *Senna auriculata* (L.) Roxb, *Abrus precatorius* L., *Dalbergia sissoo* Roxb., *Delonix regia* (Hook.) Raf., *Indigofera linnaei* Ali., *Leucaena leucocephala* (Lam.) de Wit, *Prosopis juliflora* (Sw.) DC., *Senegalia ataxacantha* (DC.) KyaL. *and* Boatwr., *Senna occidentalis* (L.) Link., *Senna siamea* (Lam.) H.S.Irwin and Barneby, *Tephrosia purpurea* (L.) Pers., *Vachellia farnesiana* (L.) Wight and Arn, *Vachellia horrida* (L). KyaL. and Boatwr, and *Vachellia nilotica* (Benth.) are exclusively fed to goats and sheep.

Morinda coreia Buch.-Ham from the Rubiaceae family and *Tribulus terrestris* L. from the Zygophyllaceae family are also exclusively fed to goats and sheep. Additionally, *Hibiscus micranthus* L.f. is not consumed by horses. In our research, we encountered wild hay supplement plants. These supplement plants are not typically consumed by livestock directly but serve as fodder supplements. Pastoralists collect the leaves of these plants and grind them into a fine powder. This powder is then mixed with rice or jowar starch and fed to goats, sheep, cows, and horses. *Lagascea mollis* Cav., *Barleria prionitis* L., and *Dicoma tomentosa Klatt* are the three hay supplements we encountered in this study.

The appendix presents botanical names alongside their corresponding average data matrix rank scores, which reflect the relative importance of each plant species as fodder plants based on the number of respondents who mentioned them. This ranking system offers valuable insight into the significance of these plants within the context of fodder usage. At the top of the list, we find several species with high average rank scores of 11, including *Allmania nodiflora, Alternanthera sessilis, Amaranthus viridis,* and *Aerva lanata*. These species are consistently recognized by a substantial number of respondents as valuable fodder plants, indicating their widespread use and perceived importance in feeding livestock.

In contrast, plants like *Calyptocarpus vialis* and *Cyanthillium cinereum* have significantly lower scores of 2, suggesting they are less frequently mentioned as fodder plants by the respondents. Similarly, species such as *Xanthium strumarium, Cleome viscosa*, and *Eragrostis minor* have average scores ranging from 3 to 4, indicating a moderate level of recognition as fodder sources among the surveyed population. Interestingly, *Lagascea mollis* and *Barleria prionitis* stand out with the highest rank scores of 13. This suggests that these species are consistently cited by respondents as particularly important or preferred fodder plants, potentially due to their nutritional value, palatability, or availability.

Table 1: Appendix of Fodder Plants of Semi-arid Regions, North East Karnataka, India

Sl. No.	Botanical name	Local name	Family	Use category	Average Data

					matrix rank score
1	*Allmania nodiflora* (L.) R. Br. ex Wight	Budde soppu	Amaranthaceae	Fodder for all the Goat, Sheep, cow and horse	11
2	*Alternanthera sessilis* (L.) R.Br. ex DC.	Mokkunna soppu	Amaranthaceae	Fodder plant used for Goat, Sheep, cow and horse	11
3	*Amaranthus viridis* L.	Chilakire soppu	Amaranthaceae	Fodder for all the Goat, Sheep, cow and horse	11
4	*Aerva lanata* (L.) Juss. ex Schult.	Gorakshaganja	Amaranthaceae	The entire plant serves as fodder for goats, cows, horses and sheep.	1
5	*Blumea lacera* (Burm.f.) DC.	Gandhari gida	Asteraceae	Fodder for all the Goat, Sheep, cow and horse	6
6	*Calyptocarpus vialis* Less	Aparanji	Asteraceae	Fodder for all the Goat, Sheep, cow and horse	2
7	*Cyanthillium cinereum (L.) H.Rob.*	*Kaadu hoge soppu*	*Asteraceae*	Fodder for all the Goat, Sheep, cow and horse	2
8	*Xanthium strumarium L.*	*Urulumatti*	*Asteraceae*	Fodder for all the Goat, Sheep, cow and horse	3
9	*Cleome viscosa L.*	Cleomaceae	Kadusasive	Goats forage on its leaves.	4
10	*Evolvulus alsinoides (L.) L.*	*Convolvulaceae*	*Vishnukantha*	Fodder for all the Goat, Sheep, cow and horse	9

11	*Cyanotis fasciculate (B. Heyne ex.) Roth)*	Chingala	Commelinaceae	Fodder for goats, sheep, cow and horse	8
12	*Cyperus rotundus L.*	Geeku	Cyperaceae	Fodder plant for cows and goats	8
13	*Vachellia nilotica subsp. indica (L)*	Babli	Fabaceae	Fodder for goats	7
14	*Leucas linifolia Lin.*	Devva thumbe	Lamiaceae	Fodder for all the Goat, Sheep, cow and horse	7
15	*Tinospora cordifolia (Thumb.) Miers*	Amrutha balli	Menispermaceae	Fodder for all the Goat, Sheep, cow and horse	6
16	*Boerhavia diffusa L.*	Neggilu	Nyctaginaceae	Fodder for all the Goat, Sheep, cow and horse	5
17	*Boerhavia erecta L.*	Bile neggilu	Nyctaginaceae	Fodder for all the Goat, Sheep, cow and horse	11
18	*Flueggea leucopyrus Willd.*	Gudelu gida	Phyllanthaceae	Fodder for all the Goat, Sheep, cow and horse	10
19	*Flueggea virosa (Roxb. ex Willd) Royle*	Belahuli gida	Phyllanthaceae	Fodder for all the Goat, Sheep, cow and horse	10
20	*Cenchrus ciliaris L.*	Kolakatti hullu	Poaceae	Fodder for cows and horses	9
21	*Dactyloctenium aegyptium (L.) Willd.*	Channagudi hullu	Poaceae	Fodder for cows and horses	10
22	*Eragrostis minor Host.*	Dodda parule hullu	Poaceae	Fodder for cows and horses	4

23	*Heterpogon contortus (L.) P.Beauv.*	Dharbe hullu	Poaceae	Fodder for cows and horses	6
24	*Tribulus terrestris L.*	Neggilu	Zygophyllaceae	Fodder for goats and sheep	6
25	*Senna auriculata (L.) Roxb*	Avarike	Fabaceae	Fodder for goats and sheep	5
26	*Abrus precatorius L.*	Galaganji	Fabaceae	Fodder for goats and sheep	8
27	*Dalbergia sissoo Roxb.*	Beete mara	Fabaceae	Fodder for goats and sheep	10
28	*Delonix regia (Hook.) Raf.*	Kempu thorai	Fabaceae	Fodder for goats and sheep	10
29	*Indigofera linnaei Ali.*	Kenneggilu	Fabaceae	Fodder for goats and sheep	4
30	*Leucaena leucocephala (Lam.) de Wit*	Subaabul	Fabaceae	Fodder for goats and sheep	3
31	*Prosopis juliflora (Sw.) DC.*	Belliya jaali	Fabaceae	Fodder for goats and sheep	4
32	*Senegalia ataxacantha (DC.) KyaL. and Boatwr.*	Kale gida	Fabaceae	Fodder for goats and sheep	9
33	*Senna occidentalis (L.) Link.*	Yele muri	Fabaceae	Fodder for goats and sheep	6

34	*Senna siamea (Lam.) H.S.Irwin and Barneby*	Simethangedu	Fabaceae	Fodder for goats and sheep	6
35	*Tephrosia purpurea (L.) Pers.*	Sharapunka	Fabaceae	Fodder for goats and sheep	11
36	*Vachellia farnesiana (L.) Wight and Arn*	Kasthuri jaali	Fabaceae	Fodder for goats and sheep	12
37	*Vachellia horrida (L). KyaL. and Boatwr*	Gubbi jaali	Fabaceae	Fodder for goats and sheep	8
38	*Vachellia nilotica (Benth.)*	Babli jaali	Fabaceae	Fodder for goats and sheep	7
39	*Clerodendrum Phomidis L.f.*	Local name: Husulangi	Lamiaceae	Fodder for Goats and Sheep	6
40	*Hibiscus micranthus L.f.*	Sanna dasavali	Malvaceae	Fodder for Goats, Sheep and cows	3
41	*Morinda coreia Buch.-Ham*	Maddi mara	Rubiaceae	Fodder for Goats and Sheep	10
42	*Lagascea mollis Cav.*	Jaaravadi gida	Asteraceae	Wild hay supplement plant for cows, goats and sheep	13
43	*Barleria prionitis L.*	Mullu goranti	Acanthaceae	Wild hay supplement plant for cows, goats and sheep	13
44	*Dicoma tomentosa Klatt*	Navananji	Asteraceae	Wild hay supplement plant for cows, goats and sheep	12

DISCUSSION

The diversity of plant families and species identified in our study reflects the rich botanical resources available in the semi-arid regions of Koppal and Bellary districts, Karnataka, India. The significant representation of families such as Asteraceae, Fabaceae, and Poaceae, known for their ecological and economic importance, underscores the resilience of wild fodder plants in adapting to harsh environmental conditions (Bhandari et al., 2020). The presence of various plant forms, including herbs, shrubs, trees, grasses, and climbers, highlights the diverse ecological niches occupied by these plants and their importance in providing fodder for livestock in the region (Giridhar et al., 2012; 2014; Patil and Sadashiv, 2018; Sarkodie-Addo et al., 2017).

The chief habitats of these wild fodder plants, ranging from road edges to rocky hills and scrub forests, reflect their adaptability to a variety of ecological conditions. This adaptability is crucial for sustaining pastoralist livelihoods, as it ensures the availability of fodder resources throughout the year, even during periods of environmental stress (Ghosh-Jerath et al., 2013).

Furthermore, the identification of specific plant species utilized as fodder highlights the intricate knowledge systems developed by herders to sustainably manage their natural resources. Integrating this traditional knowledge with scientific research can inform conservation strategies aimed at preserving these valuable plant resources for future generations (Bharucha and Pretty, 2010).

The utilization of a diverse range of plant species for fodder by pastoralists in the semi-arid regions of Karnataka, India, reflects their intricate knowledge of local flora and its suitability for different livestock species. The inclusion of plants like *Allmania nodiflora, Alternanthera sessilis,* and *Aerva lanata* in the diet of multiple livestock species underscores their nutritional value and availability throughout the year. Furthermore, the exclusive use of certain species like *Cleome viscosa* and *Vachellia nilotica* subsp. indica for specific livestock, such as goats, highlights the targeted feeding practices employed by pastoralists to meet the dietary requirements of different animals.

The reliance on members of the Poaceae and Fabaceae families for fodder underscores the importance of these plant families in providing essential nutrients to cows, horses, goats, and sheep. Additionally, the utilization of wild plants like *Cyperus rotundus* highlights the resourcefulness of pastoralists in making use of available vegetation for livestock feed. This study contributes to our understanding of traditional knowledge systems and their role in sustainable livestock management practices in arid and semi-arid regions (Nisha et al., 2015). By documenting the fodder preferences of pastoral communities, this research provides valuable insights for biodiversity conservation and livestock husbandry strategies in similar ecological contexts (Gebrekidan et al., 2019).

The exclusive feeding of certain plant species to specific livestock, such as *Morinda coreia* and *Tribulus terrestris* for goats and sheep, reflects the nuanced understanding of local flora among pastoral communities. Additionally, the identification of plants like *Hibiscus micranthus*, which are not consumed by horses, highlights the tailored feeding practices employed by pastoralists to meet the dietary needs of different animal species. Moreover, the discovery of wild hay supplement plants, including *Lagascea mollis*, *Barleria prionitis,* and *Dicoma tomentosa*, underscores the resourcefulness of pastoralists in optimizing available vegetation for livestock feed. By grinding these supplement plants into powder and mixing them with starch, pastoralists enhance the nutritional value of feed for their animals, demonstrating innovative feeding strategies adapted to local conditions.

The use of an average data matrix rank scoring system provides valuable insights into the perceived

importance of different plant species as fodder sources among respondents. High average rank scores for species like *Allmania nodiflora, Alternanthera sessilis, Amaranthus viridis, Lagascea mollis*, and *Barleria prionitis* indicate their widespread recognition and potential significance in sustaining livestock health and productivity. This research contributes to our understanding of traditional knowledge systems and their role in livestock management practices in semi-arid regions. Furthermore, it underscores the importance of conserving local biodiversity to support sustainable livelihoods and food security in rural communities (Krishnamurthy et al., 2020; Simelane et al., 2021).

CONCLUSION

Our study provides valuable insights into the utilization of wild fodder plants by pastoralists in the semi-arid regions of North East Karnataka, India. Through interviews and ethnobotanical observations, we documented the diverse range of plant species used as fodder for various livestock, highlighting the intricate knowledge systems of local communities. The exclusive feeding of certain plants to specific animals, along with the innovative use of wild hay supplement plants, underscores the resourcefulness and adaptability of pastoralists in managing their livestock's nutritional needs in challenging environments.

The application of an average data matrix rank scoring system allowed us to assess the perceived importance of different plant species as fodder sources, revealing key species recognized by respondents for their nutritional value and availability. These findings contribute to our understanding of traditional feeding practices and emphasize the importance of conserving local biodiversity to support sustainable livelihoods in rural communities.

Moving forward, further research is needed to explore the ecological implications of wild fodder utilization and its potential impact on biodiversity conservation. Additionally, initiatives aimed at promoting the sustainable management of wild fodder resources can enhance the resilience of pastoralist communities and contribute to broader efforts in environmental stewardship and rural development.

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