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Assessment of Goat Feed Resources and Nutritional Quality of Major Available Feed Stuffs in Dollo Zone, Somali Region, Ethiopia

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About Article

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ABSTRACT

The aim of this study was to assess goat feed resources and evaluate nutritive value of major available feed resources in Warder, Danod, and Daratole districts of Dollo zone, Somali Regional State, Ethiopia. A total of 156 households (52 from each district) who own goats were randomly selected for the study and interviewed using a pre-tested, semi-structured questionnaire. The study revealed that major feed sources for goats during wet season were natural pasture and fodder trees with 63.5% & 36.5%, respectively. On the other side, the major sources of feed in the dry season were natural pasture (42.3%) followed by fodder trees (30.8%) and crop residues (26.9%), respectively. Drought (46.2%), weed dominance (38.5%) and overstocking (15.4%) were reported as the major factors affecting grazing land productivity in the study area. The major factors affecting availability of feed resources were climate variability, lack of input, population growth, lack of awareness about feed conservation mechanisms, & lack of extension of extension services. Regarding to chemical composition of the sampled feeds, a significant difference was observed in CP, NDF, ADF and ash between seasons. The DM content of the sampled feeds ranged from 88.6% to 90.9% in wet season, while during the dry season, it ranged from 91.1% to 92.4%. The CP content ranged from 5.3% to 10.7%, while in the dry season, it ranged from 2.4% to 4.4% and a significant drop was observed in the dry season. The NDF contents ranged from 53.3 to 84.9%. The ADF content also ranged from 10.5% to 27.3% in wet season and from 7.6% to 31.9% in dry season. The ash content also ranged from 8.3% to 21.3% in wet season and from 4.5% to 14.3% in dry season. Therefore, the study suggests that it is essential to promote drought-resistant forage cultivation, implement effective feed conservation practices, strengthen extension services, manage grazing pressure sustainably, adapt to climate variability, and conduct further research on the nutritive value of local feed resources.

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1. INTRODUCTION

Goats are exceptionally suited to a variety of agro-ecological settings and are raised by numerous ethnic groups, thereby playing a crucial role in Ethiopia's livestock industry. They are particularly important for smallholder farmers who rely on them for meat, milk, skin production, and as a source of income (Solomon *et al.*, 2012). Ethiopia boasts one of the largest goat populations in Africa, serving multiple purposes for the communities that depend on them. The estimated total goat population in the country is approximately 52.5 million, with around 16.4 million goats located in the Somali Regional State alone, excluding data from six additional zones (CSA, 2021).

The accessibility, quality, and expense of feed resources represent significant limitations to achieving optimal animal productivity in diverse regions and agro-ecological zones throughout Africa. In Ethiopia, the primary goat production system is traditional, marked by inadequate nutrition, poor management practices, and a high incidence of diseases. During the dry season, goats are allowed to graze freely on communal lands, crop residues, fallow fields, roadways, riparian areas, and bushland. In contrast, during the wet season, their grazing is restricted to both communal and private lands. The availability and quality of feed resources vary considerably with the seasons, influenced by a range of environmental factors such as drought, frost, and flooding (Jimma *et al.*, 2016).

Feed shortages are especially severe in arid and semi-arid livestock production systems, a situation that is evident in the current study area. In these regions, unpredictable rainfall patterns hinder both crop and fodder production, thereby restricting the productivity of pastures and rangelands, which are essential for livestock feed (Chernet, 2012). According to Yisehak and Geert (2014) Dry matter (DM), crude protein (CP), and metabolizable energy (ME) supplied by various feed resources are negatively balancing the annual requirements of the total tropical livestock unit (TLU). To effectively enhance feeding systems, it is essential to align the nutritional properties of feed resources with the specific nutrient needs of the animals, considering their intended use and productivity levels.

The constraints of feed availability, quality, and cost have been recognized as significant barriers to achieving satisfactory livestock productivity across various regions and agro-ecological zones within the country (Devendra, 1986). The persistent challenges posed by drought and climatic fluctuations have intensified the pressure on the accessibility and utilization of feed resources (Hibbebo, 2022). During the dry season, feed shortages become particularly pronounced in both the highland and lowland areas of Ethiopia (Alemayehu, 2003). In many regions, the primary feed resources for ruminants consist of crop residues and low-quality hay, which are characterized by reduced digestibility and intake (Negesse *et al.*, 2016). The severity of feed shortages is especially acute in arid and semi-arid livestock production systems. In these regions, the unpredictable nature of rainfall adversely affects crop yields, which in turn limits the availability of byproducts that serve as animal feed, as well as restricting natural pasture and rangeland resources that are vital for livestock nutrition. Furthermore, the essential nutrient crude protein (CP) found in herbaceous plants diminishes during the dry season, resulting in extended periods of under-nutrition for livestock raised in such challenging environmental conditions (Yeyneshet *et al.*, 2016).

In pastoral and agro-pastoral systems like those in the Dollo Zone, goats play a pivotal role in the production system, serving as a source of cash income and milk for smallholder farmers. However, despite their economic and nutritional significance, goat productivity remains suboptimal. Additionally, there is a lack of comprehensive data on feed resource availability and production practices in the region. This underscores the necessity for systematic research to evaluate the available feed resources for goats, identify the constraints limiting their accessibility, and assess their nutritional composition. Such an investigation is essential for informing the planning and implementation of targeted development interventions tailored to the region's production systems. Therefore, this study aims to assess the principal feed resources available for goats, analyze the challenges affecting their availability, and evaluate their nutritional quality in the Dollo Zone, Somali Regional State, Ethiopia.

2. LITERATURE REVIEW

2.1. Husbandry practice of goat in ethiopia

2.1.1. Housing of goats

Effective goat housing must establish an environment that safeguards goats from harsh weather, predators, and theft, while simultaneously enhancing their welfare and productivity (Solomon *et al.*, 2012). Critical climatic elements that necessitate management include extreme temperatures, humidity levels, solar exposure, wind, and precipitation (Amani, 2017). The design of housing must strike a balance between the requirements of the animals and the economic considerations for producers (Solomon & Alemu, 2009).

The design of housing varies according to production systems, management goals, and regional customs. Structures can range from basic shelters with partial walls to more sophisticated facilities equipped with automated systems. Goats and sheep may be accommodated within the family residence or in specialized sheds, often constructed from materials readily available in the local area (Fikru & Gebeyew, 2015). Essential features include adequate ventilation, sloped flooring for effective drainage, and construction that prevents vermin intrusion. Additionally, considerations for fire safety and hygiene are paramount (Fikru & Gebeyew, 2015).

Housing designs should be tailored to the specific agroecological conditions and management strategies employed. For example, it is advisable to house pregnant and nursing does separately to mitigate the risks of unintentional breeding or stress-related miscarriages (ESGPIP, 2009). Seasonal kraals, designed for use during the dry season, must be secure against predators and incorporate sloped, dry floors to facilitate drainage and ensure safety (Fikru & Omar, 2015). Ultimately, thoughtfully designed housing is crucial for promoting goat health, productivity, and safety, while also addressing the practical needs of producers.

2.1.2. Herding practices of goats

Goats are primarily herded throughout the year in Ethiopia. According to a study by Alubel (2015), goat herders in the areas of Tanqua Abergelle and Ziquala engage in year-round herding. Since goats are browsers and sheep are grazers, goats

and sheep are usually herded together during the dry season to maximize the use of forage resources (Silanikove, 2000). Goats, on the other hand, are frequently herded alone or sporadically with sheep during the rainy season. The seasonal cultivation of fallow lands, which limits access to specific grazing regions, is blamed for this split. Goats are kept aside to avoid intruding on cultivated areas, while sheep are typically grazed along field boundaries or along roadsides (Solomon *et al.*, 2012).

2.1.3. Watering of goats

Water is an essential resource for goats, and a lack of adequate supply can significantly impair their physiological functions and overall productivity (Alamer, 2010). Insufficient water intake can hinder digestion and diminish the efficiency of feed utilization. The water requirements of goats are influenced by various factors, including environmental conditions, dietary composition, age, body weight, activity levels, health status, moisture content of feed, milk production, heat stress, and dry matter intake (Mengistu *et al.*, 2007). The presence of contaminated water can lead to disease transmission and parasitic infections, which may result in significant outbreaks (Zewdei & Welday, 2015; Tesfahun *et al.*, 2017). In Ethiopia, common sources of water include boreholes, ponds, rivers, and rainwater; however, the quality of water can vary depending on the location and season (Alefe, 2014; Asefa *et al.*, 2017). Implementing proper hygiene practices, such as ensuring clean and disinfected watering points, is vital, especially when livestock are watered downstream. Furthermore, it is important to isolate sick goats and provide them with separate water sources to prevent contamination (Alubel, 2015).

2.2. Feed resource and feeding of goats

The feed resources available for goats in Ethiopia exhibit considerable diversity, encompassing natural shrubs and bushes, as well as conserved hay and crop residues (Gatew *et al.*, 2017). This diversity is shaped by seasonal variations and the specific production systems employed in goat husbandry (Tsedeke, 2007). The differences in feed resources can be linked to the type and amount of feed accessible in particular regions, which are influenced by environmental conditions and various related factors. In areas dedicated to pastoral and agro-pastoral livestock production, the predominant feed resources consist of natural pastures, with crop residues and improved forages being less prevalent. Natural pasture serves as the main feed source for goats in Ethiopia, especially plentiful during the rainy season. In certain regions, it is collected during the wet season and stored for use in the dry season (Duressa *et al.*, 2014; Feyissa *et al.*, 2014; Geleti *et al.*, 2014). Crop residues rank as the second most significant feed source in the nation (Duressa *et al.*, 2014; Fantahun *et al.*, 2016).

2.3. Feeding Behaviour of goats

Goats exhibit distinct and complementary foraging behaviors, characterized by their browsing nature and high selectivity in feed choices. This adaptive strategy enables them to sustain productivity even under limited feed availability, particularly in environments where only shrubs and bushes persist. Such traits render goats highly suitable for utilization in fragile ecosystems (Desta, 2011). While goats are frequently regarded as detrimental to environmental sustainability, they can play a pivotal role in biodiversity conservation when appropriately managed, contributing to the preservation of diverse plant species (Tsedeke, 2007). However, the environmental challenges attributed to goats are often a consequence of anthropogenic factors, including suboptimal management strategies and the overstocking of livestock in ecologically unsustainable regions (IBC, 2004; Adane & Girma, 2008).

2.4. Constraints of goat production in ethiopia

Goats have a big population and serve a variety of purposes in households and the country, but their overall productivity and economic contributions are low. Ethiopian goat production is limited by a number of biotic and abiotic factors. With the exception of their relative importance, which varies by region, the main obstacles to goat production are generally the same across the nation (Hulunim, 2015). According to studies by Zewdie and Welday (2015), in addition to a lack of improved genotypes and high levels of inbreeding, significant obstacles to goat production include a lack of infrastructure, a high prevalence of diseases and parasites, inadequate records, poor market management, and a shortage of feed. The limitations in the Bale zone are comparable to those in other regions of the nation (Asefa *et al.*, 2017).

2.5. Nutritional quality of goat feed resources

Natural pastures, including grasses, legumes, herbs, shrubs, and tree foliage, serve as primary feed resources for goats (Preston & Leng, 2009). In smallholder goat production systems, communal lands provide essential feed sources, particularly grasses and browse species. However, the availability of natural pastures is diminishing due to factors such as rapid population growth, agricultural land expansion, and prolonged overgrazing. According to Steinfeld *et al.* (2006), browse plant species exhibit various defensive mechanisms against herbivory, including the presence of thorns, spines, and secondary metabolites such as saponins, toxic amino acids, phenolics, cyanogenic glycosides, and alkaloids. These secondary compounds can hinder nutrient absorption and adversely affect goat health; for instance, hydrolysable tannins have been implicated in causing goat mortality (Roberthaert, 2000).

Browse species generally exhibit higher crude protein (CP) content compared to grasses, with some species reported to contain CP levels exceeding 25% (Carew, 1983; Mergersa *et al.*, 2017). This high protein content makes browse plants a valuable resource for developing sustainable feeding systems aimed at enhancing livestock productivity (Johnson *et al.*, 2007).

The stage of harvest and seasonal variations significantly influence the CP content in grass species. While Hassan *et al.* (2016) highlighted fluctuations in CP levels based on these factors, Gworgwor *et al.* (2012) observed consistent CP ranges in grasses, with immature grasses showing 7.2–20.2% CP and mature grasses ranging from 5.6–11.5% CP. Additionally, Ifut (2006) reported dry matter (DM) content of 95.30% for grasses and 93.52% for browse species, findings supported by Limea *et al.* (2009), who documented DM values of 94.86% for grasses and 95.4% for browse plants. Variations in DM content are

attributed to differences in species, collection timing, and harvest stage.

Furthermore, Johnson *et al.* (2007) documented average ash content values of 11.45% for grasses and 9.62% for browse plants, alongside neutral detergent fiber (NDF) content of 75.37% for grasses and 56.37% for browse. They noted that NDF values exceeding the critical threshold of 60% could reduce voluntary feed intake, prolong rumination time, and impair feed conversion efficiency. Limea *et al.* (2009) suggested that elevated NDF levels in some samples may result from the inclusion of dry pods and fine stems during collection, which increases lignin and NDF content.

3. METHODOLOGY

3.1. Description of the study area

This study was carried out across three districts in the Dollo zone, located in the Somali Regional State of Ethiopia. The Dollo zone is one of the eleven administrative zones in the Somali region, bordered to the southwest by Korahe zone, to the northwest by Jarar zone, and to the northeast and southeast by the country of Somalia. The Warder district, which serves as the administrative center of the zone, is positioned at a latitude of 6°58′N and a longitude of 45°21′E, with an elevation of 541 meters above sea level and an average annual temperature of 28°C. It is situated 537 kilometers from Jigjiga and 1131 kilometers from Addis Ababa. The district is bordered to the southwest by Korahe zone, to the north by Danot district, and to the east by Geladi district, which has an average elevation of 943 meters above sea level at coordinates 6°50′N and 45°30′E. Danot district is bordered to the south by Warder, to the west by Korahe zone, to the northwest by Jarar zone, to the north by Somaliland, to the east by Boh district, and to the southeast by Galadi, located at 7°50′N and 45°50′E. Daratole district is bordered to the south by Warder, to the west by Korahe zone, to the northwest by Danot district, to the east by Boh, and to the southeast by Galadi. The communities in this zone rely heavily on livestock species such as goats, sheep, camels, and cattle for their livelihoods.

3.2. Study design and sampling procedure

This research utilized a cross-sectional design to collect relevant data concerning the availability and identification of goat feed resources, as well as the primary challenges associated with these resources in the designated study area. The sampling method employed was purposive sampling, targeting regions characterized by a high incidence of goat rearing and well-maintained road infrastructure, in collaboration with specialists from the zonal and district bureaus of pastoral development and agriculture. To achieve the study's aims, purposive sampling was conducted across three of the seven districts within the zone that exhibit considerable potential for goat production. Nine Kebeles (three from each district) were selected based on the prominence of goats as a significant livestock species. In total, 156 households (52 from each district) that own goats were randomly selected to participate in this investigation.

3.3. Data collection methods

Data for this research were gathered through a semi-structured questionnaire tailored for interviews with selected goat owners, complemented by key informant interviews and focus group discussions. Each Kebele facilitated one focus group discussion, which included a minimum of ten participants from the relevant study areas. Comprehensive information was obtained through in-depth discussions with key informants, such as district livestock specialists. The study employed a pretested questionnaire and checklist to confirm the presence of observed attributes at the household level, thereby enhancing the reliability of the household surveys. Focus group discussions were structured around checklists that covered topics including goat production systems, feed resources, feed availability, and feeding practices pertinent to the study region. Furthermore, the semi-structured questionnaire was designed to gather primary data from households regarding the critical issues of the study. The focus group discussions and key informant interviews played a crucial role in identifying and prioritizing the main feed resource species utilized by goats.

3.4. Feed sample collection and preparation

A ranking of preferred major feed resources for goats was established through a survey conducted among households engaged in goat rearing. Field samples of the most prevalent feed resources were collected and weighed at various intervals. Specimens of browse plants were gathered, pressed, labeled, dried, and subsequently transported to the Herbarium of Haramaya University for accurate identification and classification. The identification of various browse species was carried out in accordance with the guidelines outlined in the Flora of Ethiopia and the Flora of Tropical East Africa (Hedberg & Edwards, 1995). Among the identified browse species utilized as goat feed in the region, certain types were selected for nutritional analysis based on criteria such as their abundance, livestock preference, ease of browsing, and additional uses beyond livestock feed.

3.5. Determination of chemical composition

The feed samples were dried at 60°C in a forced draft oven for 48 hours. The materials were then individually ground to pass through a 1mm sieve using a Willey mill. The ground samples were kept in airtight plastic bags until they could be analyzed. The dry matter (DM), ash, and nitrogen (N) will be measured using the AOAC (1995) methodology. Nitrogen content was determined using the micro-Kjeldahl technique (AOAC, 1995). Crude protein (CP) was determined by multiplying the nitrogen concentration by 6.25. The ash content will be assessed by incineration of the sample in a muffle furnace at temperatures ranging from 550 to 600°C. Neutral detergent fiber (NDF), acid detergent fiber (ADF), and lignin (ADL) were examined using the techniques.

3.6. Data analysis

All measured and perceived data were analyzed with SPSS version 26. Cross-tabulation was used to analyze categorical data, and significant differences were found at a P-value of less than 0.05. The numerical data was examined using the general linear model (GLM) approach in SPSS, with significance set at $P < 0.05$. The findings on perceptions and measures were presented

using descriptive statistics such as means, percentages, and standard errors of the means. The appropriate statistical model used is indicated below.

$Yij = \mu + \alpha i + \beta j + \epsilon ij$

Where: Yij = total observation due to i, j, and k, μ = is overall mean, αi = the ith effect of location, βj= the jth effect of season (wet and dry season), and ϵij= random error.

4. RESULTS AND DISCUSSION

4.1. Demographic characteristics of the households

The demographic information for the study area respondents, such as sex, age, family size, and educational attainment, are shown in Table 1. Male respondents made up 72.4% of the sample, and female respondents made up 27.6%. The responders were 44.2 years old on average. In line with Ma'alin *et al.* (2022), who also noted high illiteracy rates and a dependence on religious schooling in the Shabele zone of the Somali area, a significant number (76.9%) of the respondents lacked literacy. Household income, the usage of technology, demographics, health, and general socioeconomic standing are all significantly impacted by education (Keralem, 2005). The study districts' average family size was 5.90±0.17, which is less than the Shabele zone's 6.41±1.3, as reported by Ma'alin *et al.* (2022) for the Shabele zone.

Table 1. Age, sex, educational status and family size of the respondents (%) in the study area

Variables	Districts (%)			
	Warder	Danod	Daratole	Overall
Sex				
Male	26.9	25	30.8	27.6
Female	73.1	75	69.2	72.4
Age (Mean±SE)	44.2±1.3	44.4±1.30	44.0±1.3	44.2±0.74
Educational level				
Illiterate	75	78.8	76.9	76.9
Primary school	17.3	15.4	17.3	16.7
Religious school	7.7	5.8	5.8	6.4
Family size (Mean±SE)	6.17±0.33	5.92±0.32	5.62±0.27	5.90±0.17

SE = standard error

4.2. Feed resources and feeding management of goat

4.2.1. Major feed resources and types for goats

The primary feed resources for goats in the examined regions are detailed in Table 2. According to the responses gathered from participants, the predominant feed sources for goats during the wet season are natural pasture and fodder trees, accounting for 63.5% and 36.5%, respectively. Conversely, during the dry season, the main feed sources shift to communal natural pasture (42.3%), followed by fodder trees (30.8%) and crop residues (26.9%). The findings indicate that natural pasture, crop residues, and fodder trees are prevalent feed resources in the study area, with communal grazing lands serving as the primary feed source throughout the year. However, the availability of pasture diminishes during the dry season. This aligns with the findings of Abraham *et al.* (2017), who identified similar feed resources in the Kafta Humera district of western Tigray, including natural pasture, browse species, crop residues, and crop aftermath. Additionally, it was noted that communal grazing remains the most significant feed source for goats in the region, despite a marked reduction during the dry season. Focus group discussions revealed that most goat owners across the study areas provide mineral supplements (such as table salt) during the wet season, particularly when feed is abundant, to enhance the animals' health and efficiency. This observation is consistent with the findings of Gatew *et al.* (2017) regarding the Bati, Borana, and Siti areas.

Table 2. Primary feed resources accessible for goats across wet and dry seasons in the study area.

Parameter	Districts (%)			
	Warder	Danod	Daratole	Overall
Major feed sources in wet season				
Natural pasture	69.2	59.6	61.5	63.4
Fodder tress	30.8	40.4	38.5	36.6
Major feed sources in dry season				
Natural pasture	44.2	38.5	44.2	42.3

Crop residues	25	28.8	26.9	26.9
Fodder trees	30.8	32.7	28.8	30.8

4.2.2. Major available feeds for goats

Table 3 outlines the primary feed resources for goats in the study area, categorized by local names and scientific classifications, highlighting their importance during both wet and dry seasons. The data indicates that Himir (Gardenia florii) is the most utilized browse, achieving a rank index of 0.21, suggesting it is a preferred feed source due to its availability and nutritional value. In contrast, Hareeri (Terminalia spp.), while significant, ranks lower at 0.16, indicating its secondary importance. Other browse species, such as Gogobe and Qodax-tool, also contribute to the goats' diet but are less favored, reflecting a diverse yet hierarchically structured feeding preference. Grass species, including Dabo-sacle and Gordan, have lower rank indices, indicating they are less preferred compared to browse options, particularly in terms of their availability or nutritional quality. This ranking illustrates the reliance on specific forage types and suggests that enhancing the availability of preferred feed resources could improve goat nutrition and productivity in the region.

Table 3. Major feeds available for goats during the wet and dry seasons in the study area

Local name	Scientific name	Feed type	Rank					Index
			R1	R2	R3	R4	R5	
Himir	Gardenia florii	Browse	84	30	25	12	5	0.21
Hareeri	Terminalia, spp	Grass	19	32	28	17	26	0.16
Gogobe		Browse	10	22	27	25	11	0.13
Qodax-tool	Crotalaria soinosa	Browse	9	11	27	30	15	0.12
Dabo-sacle	Grass, spp	Grass	8	10	9	20	8	0.074
Gordan	Pennisetum thunbergii	Grass	2	3	4	7	30	0.062
Cagaar fuqdhe	Brachiaria ovalis	Grass	2	6	10	10	20	0.065
Ibo-laroor	Crotalaria, spp	Grass	2	13	9	10	17	0.068
Rirmo/ridhmo	Leptothrium senegalensis	Grass	20	19	10	18	10	0.104

4.2.3. Factors affecting the grazing land productivity

Drought conditions (46.2%), the prevalence of weeds (38.5%), and overstocking (15.4%) were identified as the primary factors influencing the productivity of grazing lands in the study region, as illustrated in Figure 1. The recurrent droughts have led to a significant decline in the availability of browse shrubs, grasses, and trees, resulting in prolonged periods without rainfall that render the grazing land dry and less productive, as noted in the focus group discussions. Furthermore, the discussions revealed that overstocking contributes to reduced grazing land productivity, as a high density of animals is concentrated in a limited area. Additionally, the encroachment of weed species, particularly Garanwaa (Prosopis juliflora), has further diminished the availability of grazing trees and shrubs, adversely affecting both the productivity of the grazing land and the overall productivity of livestock.

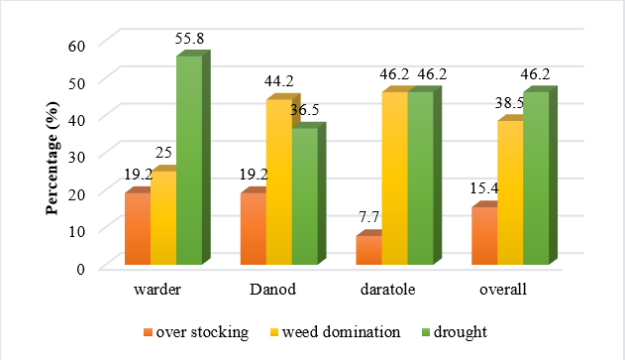

Figure. 1. Factors affecting grazing land productivity in the study area.

4.2.4. Constraints of goat feeds and coping mechanisms for feed shortage

Table 4 presents the identified constraints on goat feed availability and the coping mechanisms employed by pastoralists during feed shortages across the study locations. Among the constraints, climate variability emerged as the most significant issue, particularly in Warder (34.6%), followed by Daratole (30.8%) and Danod (23.1%). The lack of input was particularly pronounced in Danod (42.3%), contributing to an overall average of 26.3%, while other constraints, such as population growth and lack of awareness regarding feed conservation, exhibited uniformity across districts, with population growth consistently at 7.7% across all locations. Additionally, the lack of extension services was highlighted, particularly in Warder (26.9%) and contributing to an overall average of 22.4%.

Regarding coping mechanisms, supplementation of locally

available feeds was reported consistently across the districts, with an overall percentage of 21.2%. The utilization of crop residues and purchasing of livestock feeds were also common, with Daratole showing a higher percentage for purchasing feeds (19.2%). Interestingly, migration as a coping strategy was reported to be the most significant in Daratole (46.8%), highlighting regional variations in responses to feed shortages. Overall, these findings underscore the critical challenges faced by pastoralists and the varied strategies they employ to mitigate the impacts of feed scarcity.

Table 4. Identified constraints of goat feeds and coping mechanisms of pastoralists during feed shortage in the study locations

Parameters	District (%)				
	Warder	Danod	Daratole	Overall	P-value
Constraints of goat feed availability					
Climate variability	34.6	23.1	30.8	29.5	0.01
Lack of input	7.7	42.3	28.8	26.3	
Population growth	7.7	7.7	7.7	7.7	
Lack of awareness of feed conservation	23.1	7.7	11.5	14.1	
Lack of extension service	26.9	19.2	21.2	22.4	
Coping mechanisms of feed shortage					
Supplementation of locally available feeds	21.2	23.1	19.2	21.2	0.9
Utilization of crop residues	15.4	11.5	15.4	14.1	
Purchasing livestock feeds	17.3	17.3	19.2	17.9	
Migrations	15.4	16	15.4	46.8	

4.3. Chemical composition of major feedstuffs

The nutritive value of plants consumed by foraging animals is one of the criteria used to select and prioritize them. During both seasons, nutritional fractions (dry matter, crude protein, neutral detergent fiber, acid detergent fiber, acid detergent lignin, and ash) have an impact on herbivorous animals' acceptance of forage plants. The chemical composition of the sampled feeds for goats' in study area is presented in Table 5. A significant difference was observed in crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and ash between seasons, however there was no significant difference in dry matter in both seasons. In the wet season, the average DM content of the sampled feeds ranged from 88.6% to 90.9%, while during the dry season, it ranged from 91.1% to 92.4% (Table 5). The DM content of identified feeds in this study area agreed with the report of Hassen *et al.* (2022) in Degahbur district.

In the wet season, the crude protein content ranged from 5.3% to 10.7%, while in the dry season, it ranged from 2.4% to 4.4% (Table 5). The study showed a significant drop of CP in the dry season. During the dry season, the high CP content of forage species may be an advantage for feeding livestock as the nutritional value of rangeland grasses declines. This finding is in line with the report of Muhyadin (2010), who stated that, some herbaceous and browsers in Kebribayah district are suitable as protein supplements to low-quality pasture and fibrous crop residues because of their high CP content.

The NDF contents of the major feeds vary between 53.3 to 84.9% (Table 5). The reported NDF contents of this study lie above the critical value of 60% which was reported to result in decreased voluntary feed intake, feed conversion efficiency and longer rumination time (Ahamefule *et al.*, 2006). The mean NDF content found in this study is similar to that found in Metema by Sisay (2006), but higher than that found in Kebribeyah by Muhyadin (2010). If the roughage contains more than 65% NDF, it is considered poor quality feed, according to Singh and Oosting (1992). Furthermore, while Norton (Norton, 1998) claimed that NDF content of 67%-78% was sufficient to limit DM intake and digestibility, Linn *et al.* (2004) found that Neutral detergent fiber is the most important determinant of overall forage quality and digestibility, and has a direct impact on animal performance.

The ADF content also ranged from 10.5% to 27.3% in wet season and from 7.6% to 31.9% in dry season (Table 5). According to McDonald *et al.* (2002), forage species with high ADF content may have lower digestibility because feed digestibility and ADF content are negatively correlated. The ash content also ranged from 8.3% to 21.3% in wet season and from 4.5% to 14.3% in dry season (Table 5). In general, as forages mature in the dry season, their ash content decreases. This was in agreement with Hassen *et al.* (2022) and Derero and Kitaw (2018), who found that different plants increased or decreased ash content in all pasture lands. This could be due to differences in soil and other habitat features, which need to be investigated further. Moreover, Sisay (2006) observed that ash contents of rangeland pasture in Metema district were influenced by seasonal changes.

Table 5. Chemical composition of the sampled feeds

Sampled feeds		Feed type	Season	Chemical composition (%DM)					
Local name	Scientific name			DM%	Ash	ADF	NDF	ADL	CP
Himir	*Gardenia florii*	Browse	Wet	89.2	8.3[a]	49.5[b]	83.6	23.3[b]	5.4[a]
			Dry	91.8	5.2b	56.7[a]	84.9	31.9[a]	2.4[b]
Hareeri	*Terminaliaspp*	Grass	Wet	90.8	11.1[a]	46.7[b]	82.9	26.4[b]	5.3[a]
			Dry	91.5	6.5b	58.7[a]	84.7	28.1[a]	4.4[b]
Rirmo/ridhmo	*Leptothrium senegalensis*	Grass	Wet	90.9	12.1[a]	46.6	81.1	27.3[a]	5.9[a]
			Dry	91.1	10.5[b]	45.2	84.1	19.7[b]	2.8[b]
Qodax-tool	*Crotalaria soinosa*	Browse	Wet	90.9	21.3[a]	43.1[b]	68.1	16.3	6.1[a]
			Dry	91.6	14.3[b]	55.5[a]	71.8	16.9	3.1[b]
Ibo-laroor	*Crotalaria, spp*	Grass	Wet	88.6	10.9[a]	36.8[b]	53.3	22.6[a]	14.3[a]
			Dry	91.4	4.5[b]	86.7[a]	53.9	12.4[b]	2.5[b]
		Browse	Wet	90.3	14.9[a]	47.2[b]	65.2[b]	10.5[a]	10.7[a]
			Dry	92.4	11.5[b]	51.2[a]	75.5[a]	7.6b	3.9[b]

Means followed by different superscripts within a column are significantly different at P< 0.05, DM= dry matter; CP = crude protein; ADF = acid detergent fiber; ADL = acid detergent lignin, NDF = neutral detergent fiber

5. CONCLUSIONS

The research underscores the significant challenges and intricacies associated with goat feeding management in the examined regions, emphasizing the reliance on natural pastures, fodder trees, and crop residues as the main sources of feed. The results demonstrate considerable fluctuations in feed availability between the wet and dry seasons, with natural pastures dominating in both periods; however, their productivity experiences a substantial decline during the dry season due to adverse climatic conditions and overstocking. Furthermore, an analysis of the chemical composition of feed resources indicates a decline in nutritional quality during the dry season, particularly in terms of crude protein content, which could adversely affect livestock performance. Pastoralists employ a range of adaptive strategies, such as supplementing with locally available feeds and migrating, reflecting their resilience in the face of environmental and resource limitations. Nevertheless, the challenges arising from climate variability, inadequate inputs, and insufficient extension services call for targeted interventions aimed at improving feed resource management and supporting pastoralists in enhancing livestock productivity. In summary, the study emphasizes the need for integrated approaches to optimize grazing land productivity and promote sustainable goat husbandry practices, which align with broader goals of food security and resilience within pastoral communities. A comprehensive program focused on improving rangeland productivity should be established to avert or alleviate feed shortages. Additionally, efforts should be made to develop feed conservation strategies and enhance forage production, particularly given the plentiful pastures available during the wet season. Lastly, further investigation is warranted to evaluate the nutritional value of alternative feed resources utilized by goats.

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