Seasonal fluctuation of livestock feed resources in dry regions of Benin

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Abstract

In dry regions of Benin, it is very difficult to cover livestock nutritional requirements both qualitatively and quantitatively over the whole year. Therefore, it is necessary to assess the seasonal fluctuation of livestock feed resources in order to define future interventions to improve livestock feeding systems. A survey has been conducted in Sudano-Guinean and Sudanese regions of Benin. A total of 360 dairy farming households were surveyed. The Feed Evaluation Tool (FEAST) developed by the International Livestock Research Institute (ILRI) was used to design data collection forms and for analysis. The results showed that in both Sudano-Guinean and Sudanian regions, seven types of feed were used by dairy farmers (natural grass, legume forage, tree fodder, green crops residues, dry crops residues, concentrated feeds, fodder treated with urea). In Sudano-guinean region, livestock feed availability fluctuated throughout the year depending on rainfall and the type of feed. In this region, natural grass is the most widely available feed, followed by concentrated feed, tree fodder, dry crop residues and fodder treated with urea. The availability of other feeds, such as green crop residues and legume forage, fluctuated considerably over months($p<0.001$). In Sudanian region, the most available feeds are concentrated feed, fodder treated with urea, natural grass and tree fodder, which are available throughout the year. The availability of dry crop residues, green crop residues and fodder legumes varied greatly throughout the year($p<0.001$). In terms of water consumption associated with various types of feed, it was noted that compared with Sudano-Guinean region, water consumption was higher in Sudanian region. In addition, significant water consumption was recorded for some feed resources, mainly fodder treated with urea and dry crop residues. This study will help to guide decisions regarding the current management of feed resources for livestock, including training on the integration of legume fodder into tree and arable crops, the efficient use of available feed resources, and better management of environment, fodder and water resources.

Key words: Feed resources; seasonal fluctuation; dry regions; productivity; sustainability; Benin.

Introduction

Livestock is a key asset for poor communities, fulfilling multiple economic, social and risk management functions. In Benin, the livestock sector accounts for 13% of Benin's agricultural GDP (DSA, 2020). Livestock are socially and economically critical to cattle farming regions of Benin mainly definated as dry regions, thus high priority should be given to the sustainable management of the natural resources base that supports them. However, Climate extremes and seasonal fluctuations in herbage quantity and quality affect the well-being of livestock, and will lead to declines in production and reproduction efficiency (Sejian, 2013). The climate change effect is expected to induce the vulnerability in to livestock production systems through impair feed intake, metabolic activities and defense mechanisms (Lomiso et al, 2020). The changes in seasonal patterns of forage availability could pose additional challenges for grazing management in the rangeland. Similarly, the climates become hotter and drier; pasture composition is likely to shift to species that may be less suitable for grazing. The length of the pasture growing period is expected to decrease in many parts of Benin dry regions and this may be accompanied by greater variability in rainfall patterns with more frequent droughts. Futhermore, longer dry periods may reduce also groundwater recharge, reduce river flow and ultimately affect water availability, agriculture and drinking water supply. The deprivation of water affects animal physiological homeostasis leading to loss of body weight, low reproductive rates and a decreased resistance to diseases (Naqvi et al, 2015). Therefore, to increase the productivity of dairy cattle, it is especially important to improve the availability of local feed resources (Mutimura et al, 2015 ; Mayberry et al, 2021). In Benin, fodder species found on rangelands are essentially composed of herbaceous plants, trees and shrubs that are largely used to feed ruminants (Diogo et al, 2021). Herbaceous plants are found in swampy areas, fallow land, forest reserves and rangelands, especially during the rainy season (Djenontin et al, 2004 ; Matovu et al, 2023). These herbaceous forages are the major source of cattle feed (Lesse, 2016). In addition to herbaceous , tree fodder and crop residues, agro-industrial by-products are also important feedstuffs for ruminants. Unfortunately, in these past year, natural grazing land fodder, which is the main source of feed for ruminants in Benin, is affected both quantitatively and qualitatively by rainfall and seasonal changes (Lesse 2016 ; Montcho et al, 2022). The problem of seasonality of feed resources in Benin is further aggravated by absence of controlled breeding practice, which does not make adjustments with seasonal variation in feed supply and demand. In this context, information about the resources available from rangelands to support pastoral livestock are essential, for herders and also for governments and development partners. Seasonal climate variations, which has been identified as one of the most important environmental issues of the present time and having a widespread destructive impact on ecology, ecosystem and species survival, has been expected to intensify the vulnerability of living beings, including livestock. This study aims to assess the seasonal fluctuation of livestock feed resources in order to define future interventions to improve livestock feeding systems.

Methodology

Description of study areas and sampling techniques

The study was carried out in Benin.Benin is located between the latitudes 6◦20'Nand 12◦30'N and the longitudes 0◦45'E and03◦70'E (figure 1). Data were collected in two climates zones of the country (Sudano-Guinean and Sudanian zones). The Sudano-Guinean zone is characterized by unimodal rainfall varying annually from 900 mm to 1,110 mm. The rainy season is from May to October and dry season from December to March . The annual temperature of this zone ranges from 25°C to29°C and the relative humidity from 31% to 98%. Soils are mainly ferruginous. The Sudanian zone has one rainy season ranging from May to October and one dry season from November to April. Its mean rainfall is 900 mm. The temperature varying from 24°C to 31°Cand the relative humidity from 18% to 99%.The study focused on seasonal availability of livestock feed resources and water consumption related across dry regions of Benin. A single-visit multi subject formal survey method was used for the study. In dry areas of northern Benin, the districts studied were selected on the basis of the importance of ruminant farming, in particular dairy farming, as the main activity of the local population. Prior to selecting respondents, a brainstorming session was prearranged with the district livestock experts, local livestock advisors and development agents on the objective of the study, the permanent benefits of the farming community from the survey and the respondents selection criteria. Purposive sampling technique was used to select respondents.

Data collection methods and tools

Qualitative and quantitative investigation was carried out using FEAST developed by International Livestock Research Institute (ILRI, 2015) , which offers a systematic and rapid methodology to assess feed resources availability and utilization at a site level with a view to developing a site-specific intervention approach to improve and optimize feed supply and utilization through technical or organizational interventions and characterize the livestock production system. FEAST differs from conventional feed assessment approaches that focus on the feeds nutritive value and ways to improve it. FEAST encompasses focused group exercises which provide an indication of the production system with a particular emphasis on livestock feed resources and

water consumption related and a simple and succinct quantitative questionnaire intended to be completed by professionals under the direction of FEAST facilitator.

Statistical analysis

The collected data was managed and organized with MS-Excel and was analyzed using the updated FEAST software version 2.21 (ILRI, 2015), and statistical package for social science (SPSS) version 20 SPSS (2011), for further analysis with the procedure of general linear model. Means were compared using least significant difference (LSD), adopting the probability level of 5%.

Results and Discussion

Seasonal fluctuations of livestock feed resources in Sudano-guinean region of Benin

Figure 2 shows the availability of livestock feed resources in Sudanian region of Benin. It shows that the availability of livestock feed in Sudano-guinean region was a function of both season and type of feed. Availability of concentrated feed is low between January and March, then rises gradually to reach a peak in September. After that, the availability decreased gradually through to December. Similarly, dry crop residues are less available at the beginning of the year. Then availability of dry crops residues increased gradually to reach a peak in August and September. It then declines until December. Concerning fodder treated with urea, its availability is relatively stable throughout the year. However, there is a slight increase in availability in March and April. Green crop residue availability is also low at the start of the year (January to May), then gradually

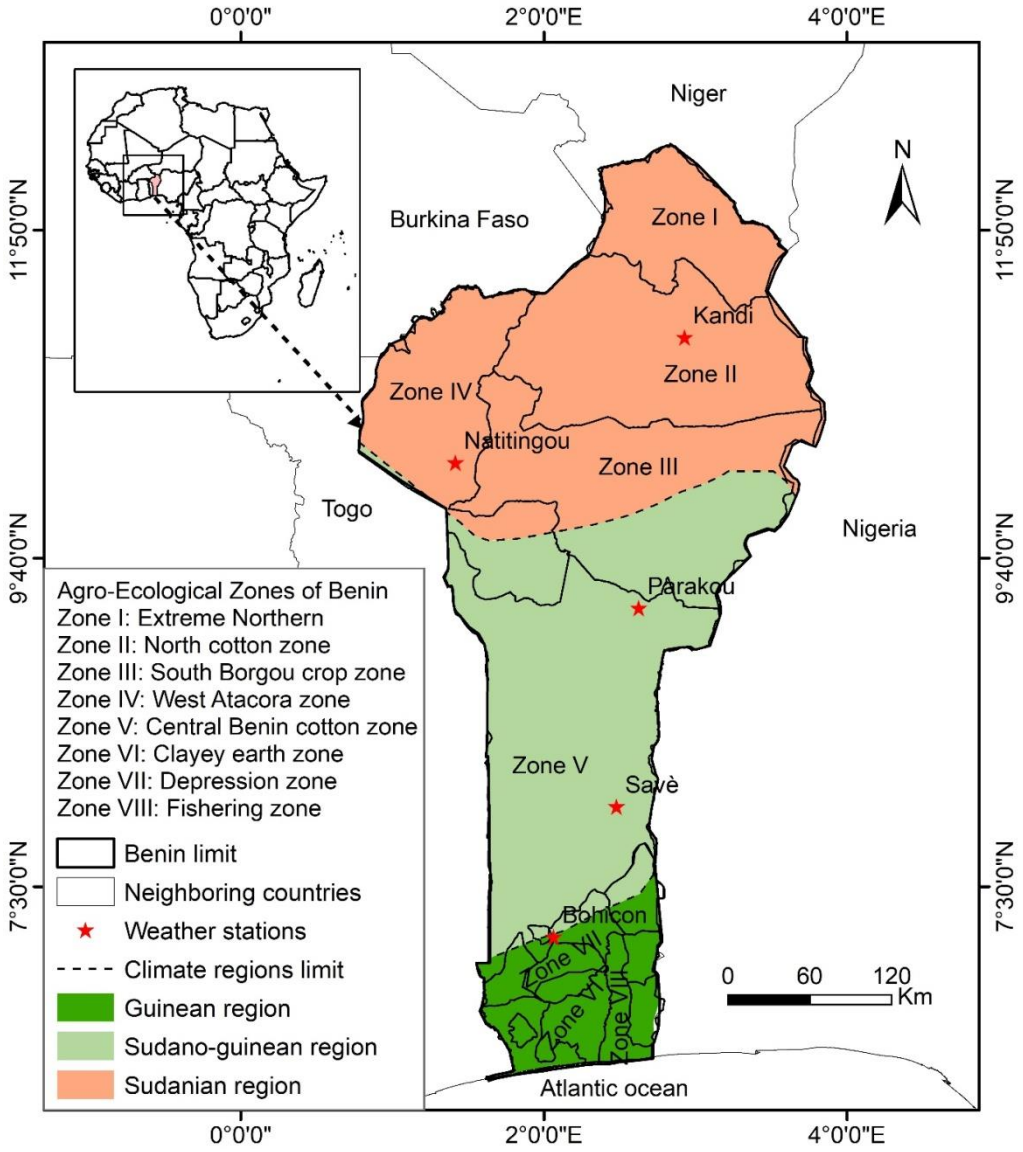
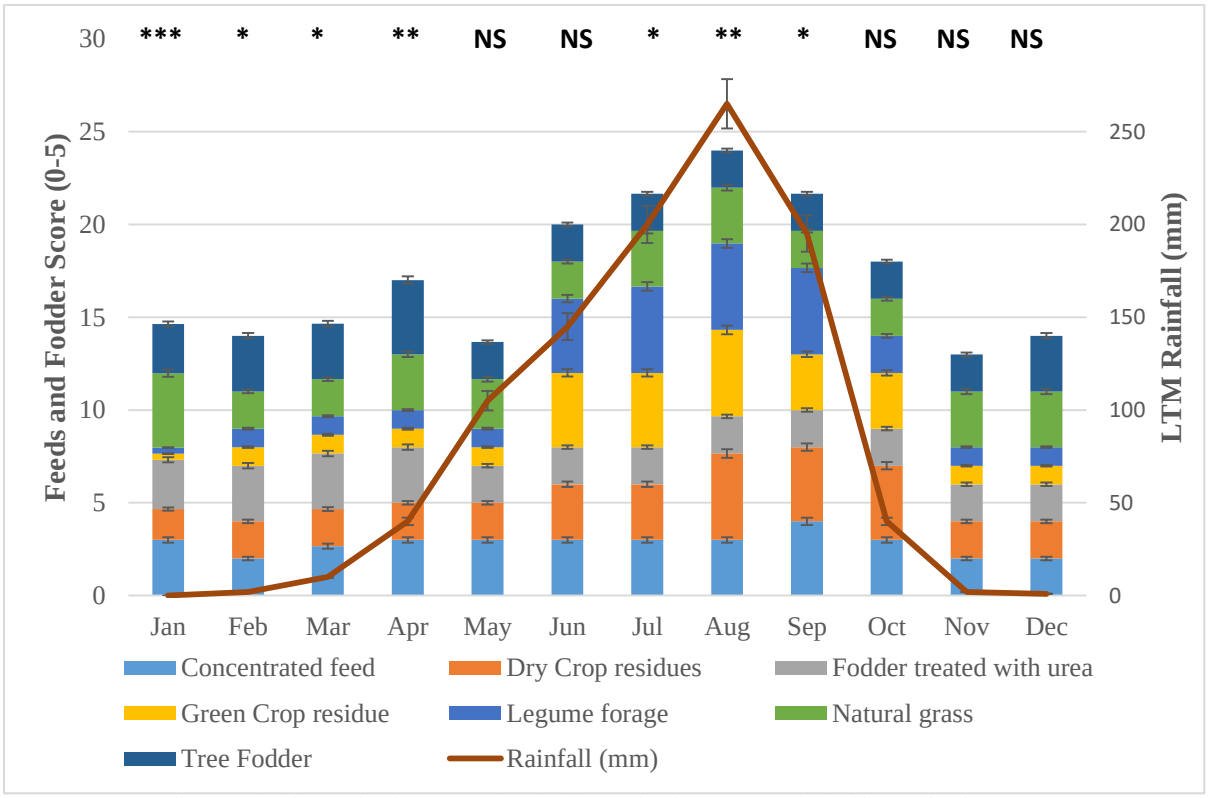
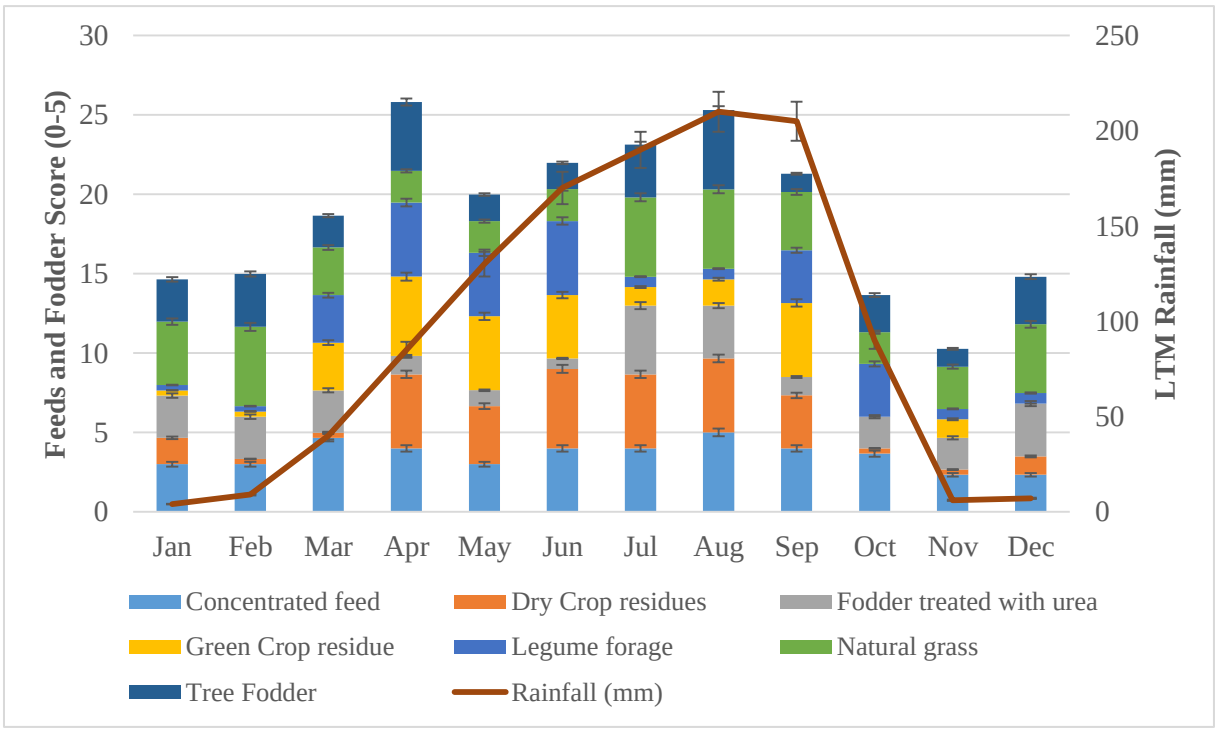


Fig 1 : Study areas



NB: NS=Not Significant; *Significance level (P≤0.05); ** Significance level (P≤0.001); ** Significance level (P≤0.01); LTM, Long term mean rainfall (mm); Score, 0-5, where: 0=none, 1=moderately low, 2=low, 3=moderately high, 4=high and 5=very high availability).

Fig 2. Seasonal fluctuations of livestock feed resources in Sudano-guinean region of Benin



NB: ***Significance level (P≤0.001); ** Significance level (P≤0.01); LTM, Long term mean rainfall (mm); Score, 0-5, where: 0=none, 1=moderately low, 2=low, 3=moderately high, 4=high and 5=very high availability).

Fig 3. Seasonal fluctuations of livestock feed resources in Sudanian region of Benin

Table 1: Availability of livestock feed resources across seasons in Sudano-guinean regions

Seasons	**Average score for available livestock feed resources**	**P-value**
Dry season	2	0,001
Rainy season	2,77	

Table 2 : Availability of livestock feed resources across seasons in Sudanian regions

Seasons	**Average score for available livestock feed resources**	**P-value**
Dry season	2	0,001
Rainy season	3,08	

Table 3. Season variation of water consumption associated with feed resources across climate regions

Parameters	Feeds sources	Dry season			Rain season		
		Sudanian Region	Sudano-Guinean Region	P-value	Sudanian Region	Sudano-Guinean Region	P-value
Water Consumption (L/day)	concentrated feed	4,8 ± 1,09	3,75 ± 0,5	0,001	5,30 ± 0,95	4,20 ± 1,05	0,001
	Dry Crop residues	7,2 ± 1,64	5,93 ± 0,5	0,001	6,41 ± 0,97	6,01 ± 1,06	0,001
	Fodder treated with urea	8,0± 0,52	6,22 ± 0,57	0,001	7,07 ± 0,65	5,12 ± 0,35	0,001
	Green Crop residue	3,8 ± 1,0	4,15± 0,3	0,001	4,00 ± 0,48	3,50 ± 0,50	0,001
	Legume forage	2,8 ± 0,4	2,55 ± 0,9	0,001	4,30 ± 0,40	3,00 ± 0,86	0,001
	Natural grass	4,1 ± 1,09	3,25 ± 0,9	0,001	3,00 ± 0,51	2,85 ± 1,02	0,001
	Tree Fodder	5,9 ± 0,54	4,01± 0,8	0,001	5,31 ± 1,47	3,50 ± 0,51	0,001

increases until it peaks in July and August. Availability then falls rapidly into December (Figure 2 and Table 1). The availability of leguminous forage was also low at the beginning of the year. It then increases gradually until it peaks in July and August. Thereafter, availability declines rapidly until December. About natual grass, the availability was relatively stable over the year, with a peak in August. The same trend was observed for the availability of trees fodder, except that availability peaked in April. Overall, the most feedstuff availability increases during the rainy season (May to October), when rainfall is most abundant. This is particularly relevant for green crop residues, fodder legumes and natural fodder. The availability of concentrated feed, dry crop residues and fodder treated with urea were less affected by rainfall, as these feeds can be stored and used during periods of drought according to farmers (Figure 2).

Furthermore, the availability of feed during each month varies significantly ($p<0.001$) only in January, and is not significant in May, June, October, November and December. From all of the above, feed availability for livestock in sudano-guinean region varies across the year according to rainfall and feed type. Natural grass was the most widely available feed, followed by concentrated feed, tree fodder, dry crop residues and fodder treated with urea. The availability of other feeds, such as green crop residues and fodder legumes, fluctuated considerably (Table 1). This low availability of green crop residues for livestock feeding in the Sudano-Guinea region might be due to crops farming practices in this region, in particular the use of green crop residues as a source of nutrients for crops production in small-scale farms. This is in line with the findings of Baudron et al (2014), who recommend reducing crop residues for livestock feed and using them to fertilise the soil for sustainable agriculture in Africa, so that more crop residues should be retained in the fields for green manuring and soil restauration (Castellanos-Navarrete et al., 2015).

Seasonal fluctuations of livestock feed resources in Sudanian region of Benin

Figure 3 shows the availability of livestock feed resources in Sudanian region of Benin. The availability of livestock feed is highly varied according to the season and months. Concentrated feed is relatively available throughout the year. However, its availability is generally most abundant during the rainy season (from June to September). The same observation was made for dry crop residues, with the difference that a decrease in availability was observed during the dry season (from October to March). In this region, fodder treated with urea is an important feed for livestock during the dry season. Its availability is highest during the dry season. Meanwhile, green crop residues are seasonal feeds, with a peak in availability during the rainy season (July and August). Leguminous fodder was most available in May and June. About natural grass, its availability was relatively stable throughout the year, with a decline during the dry season. The same trend was observed for the availability of tree fodder, with a peak in April and August. There is also a positive relationship between rainfall and food availability (Figure 3). The significant use of fodder treated with urea for livestock feeding in Sudanian region of Benin can be explained by the fact that the use of improved fodder can help alleviate feed shortages and reduce pressure on natural pastures and can reflect also the scarcy of natural pastures. According to Duguma

et al (2021), improved fodder also helps reduce pressure on natural pastures. In addition, improved forages help to maintain a continuous supply of feed during periods of shortage and also provide protein-rich feed of more efficient quality than low-quality crop residues (Mengistu et al, 2016 ; Shiferaw et al, 2018).

Feed availability also varied significantly ($p<0.001$) in all months of the year except October, where the variation was insignificant ($p<0.01$). The availability of livestock feed resources in Sudano-guinean varied according to the season and rainfall. The most widely available feeds were concentrated feed, fodder treated with urea, natural grass and trees fodder, which were available throughout the year. The availability of dry crop residues, green crop residues and fodder legumes is the most variable (Table 2). It has been similarly noted that when there is climate variability, farmers in sub-Saharan Africa tend to use different locally available feed resources as the coping mechanisms to sustain livestock production (Juana et al, 2013).

Season variation of water consumption associated with feed resources across dry regions of Benin

Table 3 shows that average water consumption for each type of feed in the dry season is significantly ($p<0.001$) higher in the Sudan region than in the Sudano-Guinean region. The same trend was observed during the rainy season. When considering each region, it was found that in the Sudanian region the average water consumption was higher in the dry season than in the rainy season for all types of feed.Compared with Sudano-Guinean region, water consumption was higher in Sudanian region . In addition, significant water consumption was recorded for some feed resources, mainly fodder treated with urea and dry crop residues, and this was observed regardless of the season. Furthermore, low water consumption was recorded in dry season for leguminous fodder (2.8 ± 0.4 L/day and 2.55 ± 0.75 L/day respectively for Sudanian and Sudano-Guinean regions). In rainy season, low water consumption was recorded for natural grass fodder (3.00 ± 0.51 L/day and 2.85 ± 1.02 L/day respectively for the Sudanian and Sudano-Guinean regions) (Table 3).

Conclusion

This study has contributed to a clear assessment on the availability periods of various livestock feed resources in Benin. Feed availability for livestock in sudano-guinean region varies across the year according to rainfall and feed type. Natural grass was the most widely available feed, followed by concentrated feed, tree fodder, dry crop residues and fodder treated with urea. The availability of other feeds, such as green crop residues and fodder legumes, fluctuated considerably. In Sudanian region, The availability of livestock feed is highly varied according to the season and months. Concentrated feed is relatively available throughout the year. However, its availability is generally most abundant during the rainy season (from June to September). The same observation was made for dry crop residues, with the difference that a decrease in availability was observed during the dry season (from October to March). In this region, fodder treated with urea is an important feed for livestock during the dry season. Its availability is highest during the dry season. Meanwhile, green crop residues are seasonal feeds, with a peak in availability during the rainy season (July and August). This study will help to guide decisions regarding the current management of feed resources for livestock, including training on the integration of legume fodder into tree and arable crops, the efficient use of available feed resources.

Authors' contributions

MM and ABA coordinated the data collection, ASA and ENB analysed the data, PAO and BS supervised the data collection and analysis. MM and ASA wrote this article, to which all authors contributed.

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Conflict of interest

The authors have no conflicts of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest.

Data availability statement

Data are available upon request from co-authors.

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