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Livestock feed resources, seasonality, utilization practices and nutrient contents of selected feeds in Duna District, Central Ethiopia

[Recursos alimentares para o gado, sazonalidade, práticas de utilização e teores de nutrientes de alimentos selecionados no Distrito de Duna, Etiópia Central]

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Abstract: The study was conducted with aim of assessing feed resources and utilization practices, related constraints and chemical composition of selected feeds. A total of 194 households were randomly selected and interviewed. Most of the interviewed households were males (70.81 %) and attended primary education (54.32 %).The survey results revealed that the dominant feeds in the area were natural pasture, crop residues, improved forages and browse species. Respondent households use chopping (22.7 %), mixing with green feeds (51 %) and urea treatment (20.6 %) to improve nutritional values of crop residues. Zero grazing (58.25 %), continuous grazing (25.77 %) and differed grazing (15.98 %) were the common grazing land utilization practices. The dry matter (DM) content of the major feeds ranged from 89.53 - 92.48 %, ash values 5.42 - 11.7 %, crude protein (CP) 2.63-14.08 %, neutral detergent fiber (NDF) 39.03 - 61.86 %, acid detergent fiber (ADF) 5.99-37.48 % and acid detergent lignin (ADL) ranged from 1.48-7.53 %. The major feed related constraints were shortage of land, over grazing and over population. Reducing cattle herd size, purchasing feed, using the conserved hay and fodder tree were the coping up strategies for feed shortages. Overall, most locally available feeds are of low nutritional quality, underscoring the need for local extension services, research institutions, farmer cooperatives, NGOs, and seed suppliers to encourage the production and adoption of improved forages.

Keywords: assessment; availability; quality; agro ecology.

Resumo: O estudo foi conduzido com o objetivo de avaliar os recursos alimentares para o gado e as práticas de utilização, as restrições relacionadas e a composição química de alimentos selecionados. Um total de 194 domicílios foram selecionados aleatoriamente e entrevistas realizadas. A maioria dos entrevistados eram homens (70,81 %) com ensino fundamental completo (54,32 %). Os alimentos utilizados pelo gado eram pastagens naturais, resíduos de culturas, forragens melhoradas e espécies arbustivas forrageiras. As famílias entrevistadas utilizam o picado (22,7 %), a mistura com forragens verdes (51 %) e o tratamento com ureia (20,6 %) para melhorar o valor nutricional dos resíduos de culturas. O pastejo zero (58,25 %), o pastejo contínuo (25,77 %) e o pastejo diferido (15,98 %) foram as principais práticas de utilização das áreas de pastagem. O teor de matéria seca (MS) dos principais alimentos variou de 89,53 a 92,48 %, o teor de cinzas de 5,42 a 11,7 %, a

proteína bruta (PB) de 2,63 a 14,08 %, a fibra em detergente neutro (FDN) de 39,03 a 61,86 %, a fibra em detergente ácido (FDA) de 5,99 a 37,48 % e a lignina em detergente ácido (LDA) de 1,48 a 7,53 %. As principais restrições relacionadas à alimentação do rebanho foram a escassez de terra, o superpastejo e a superpopulação animal. A redução do tamanho do rebanho, a compra de alimentos, o uso de feno conservado e de árvores forrageiras foram as estratégias adotadas para enfrentar a escassez de alimentos. De modo geral, a maioria dos alimentos disponíveis localmente apresenta baixa qualidade nutricional, o que evidencia a necessidade de atuação dos serviços locais de extensão rural, instituições de pesquisa, cooperativas de agricultores, ONGs e fornecedores de sementes para incentivar a produção e a adoção de forragens melhoradas.

Palavras-chave: avaliação; disponibilidade; qualidade; agroecologia.

1. Introduction

Ethiopia has the largest livestock populations in Africa, with about 70 million cattle, 42.9 million sheep, 52.5 million goats, 8.1 million camels, and 57 million poultry [1]. However, productivity of livestock in the country is very low [2]. This is because animals primarily thrive on high-fibre feeds that are deficient in nutrients [3]. Shortage of feed both quantity and quality results in low milk and meat yields, high mortality of young stock, longer inter calving intervals and low animal weights [4].

Natural pasture, crop residues, improved forages, fodder trees and shrubs, roadsides are sources of animal feeds in Ethiopia [5, 6, 7]. Natural pastures in the highland are overcrowded with stocks generally exceeding their optimal carrying capacity, causing overgrazing, erosion and overall soil degradation [8]. Forage production is not sufficient to feed livestock in the highlands for reasons related to limited grazing and poor management [9].

The seasonal variation in rainfall and poor grazing land management practices make the feed shortage worse [10, 11]. For optimum livestock productivity, the feed availability must correspond to the production system practiced and the number of livestock in a given area. Despite this, location specific information on availability of different feed resources, nutritional qualities and feed related problems are lacking in most remote areas of the country. Similarly, in Duna district, there are lack of comprehensive information on feed resources base, seasonality, nutritional values and feed related constraints. Therefore, the objective of this study was to assess livestock feed resources, utilization practices, seasonality, and feed-related constraints in the district, and to evaluate the nutrient composition of major feeds and their implications for improving livestock productivity.

2. Material and methods

2.1 Description of the study area

Duna is a district in Hadiya Zone, Central Ethiopia. It is located between latitudes 7015'N and 7025'N degrees and longitudes between 370 32'E and 37046'E degrees. Administratively, Duna district is divided into 31 rural kebeles and one city Kebeles [12]. The terrain ranges from 1,500 to 2,926 meters above sea level. The district has average minimum and maximum temperatures of 16.5° C and 19.8° C respectively [35].

2.2 Sampling procedures and data collection

Multi-stage purposive and random sampling techniques were used to select the study area and sampled households. In the first step, the kebeles in the study district were stratified into highland and midland agro-ecologies following stratified random sampling technique. The district had 31 rural kebeles of which 25 and 6 were highland and midland kebeles respectively.

In the second stage, study kebeles, proportional to the agro ecologies, were selected purposively based on the available livestock population and road accessibility. Accordingly, two/2/ kebeles (*Dabiyago and Senigiye*) from midland and four/4/ kebeles (*Kufena, Letebo, Somicho and Keshira*) from highland agro ecologies were selected for this study. In the third stage, household heads with at least five years' experience of livestock keeping in the study kebeles were identified and listed. The respondent households were then randomly selected from the list. The total number of respondents (194) was determined based on Cochran (1979) formula at confidence level of 95 %. Structured questionnaire was prepared and used to gather data on the socio-economic characteristics of households, feed resources availability across seasons and agro-ecology and feed utilization practices, associated constraints and coping strategies. The questionnaire and data collection procedures were reviewed and approved by the Department Research Committee. Prior to data collection, all participants were informed about the purpose of the study, and their voluntary consent was obtained.

2.3 Feed sampling and chemical analysis

Respondent households were asked to rank feed resources based on their availability and importance. Based on respondents ranking, top five feed resources in each Agro-ecology were considered for chemical analysis. Samples of fresh feeds were allowed air-dried under the shaded before transporting to Laboratory analysis. These air-dried samples were taken to Animal Nutrition Laboratory of Hawassa University.

The sampled and dried feeds were milled to pass through a 1mm sieve and analyzed for nutrients. The dry matter (DM) content of the sample was determined by drying the sample in a forced oven at 105 °C overnight, and the ash content was determined by completely burning the feed sample in a furnace at 550 °C [13]. The Kjeldhal procedure was used to determine the total nitrogen (N) and crude protein (CP) was calculated as N x 6.25. Neutral detergent fibers (NDF) was analyzed by detergent extraction method as described by Van Soest *et al*. [14] and acid detergent fiber (ADF), and acidic detergent lignin (ADL) was analyzed according to Van Soest and Robertson [15].

2.4 Data analysis

The Statistical Package for the Social Sciences (SPSS, version 20) was used to analyze the collected data. Collected data was described using descriptive statistics (mean, percentage, and frequency). Chi-square tests were employed to see significant associations of qualitative variables at $p<0.05$. For parameters required ranking, indexes were used. Index= Sum (3 x number of household ranked first + 2 x number of household ranked second + 1 x number of household ranked third) given for an individual reason, criteria or preference divided by the sum (3 x number of household ranked first + 2 x number of household ranked second + 1 x number of household ranked third) for overall reasons, criteria or prefer.

3. Results and discussion

3.1 Socio-economic characteristics of the households

The socio-economic data of the households are presented in Table 1. In line with the present finding, Belay and Geert [16] noted 75.9 % of males in smallholder dairy farmers of Jimma town. The same author reported few (1.9 %) level of illiteracy in Jima town dairy farmers. Higher number of illiterates (36.4 %) was reported by Debire et al. [17] for Farta District, South Gondar Zone, Ethiopia.

Table 1. Socio-economic characteristics of the households

Variables		Agro-ecology		Overall (N=194)	X^2	p-value
		Highland (N=132)	Midland (N=62)			
Sex (%)	Males	73.90	67.74	70.81	11.30	0.01
		26.10	32.26	29.20		
Education (%)		12.13	19.40	15.85	10.12	0.024
	Primary Education	53.8	54.84	54.32		
	Secondary Education	23.5	14.5	19		
	College and above	10.6	11.30	10.93		
Family size (Mean + SE)		7.47 ± 0.359[a]	7.19 ± 0.432[b]	7.38± 0.359	-	0.043

a b means with different superscripts in a row are significantly different; N = number of respondent; SE = standard error; % = percentage

Family size of the households (7.38± 0.359) was higher than 6.06 ± 0.118 report by Fiseha [18] in Kambata Tambaro Town. The average family size of 5.7 and 6.6 per household were reported respectively for highland and mid-altitude agro-ecologies of South Gonder zone, Ethiopia [19].

3.2 Major livestock feed resources and seasonality in the study area

The major feed resources available in the study areas are natural pasture, crop residues, improved forage and pastures and browse species (Table 2). The major crop residues used for livestock feeding included wheat, barley, and bean straw, as well as maize stover. The most common browsing plants in the area were *Croton macrostachyus*, *Vernonia auriculifera*, *Milletia ferruginea*, *Euphorbia abyssinica*, and *Vernonia amygdalina*.

Many authors noted that natural pasture, crop residues, browsing trees and improved forage as the major feed resources in different parts of the country [6, 19]. In Sub-Saharan Africa and South Asia, crop residues have become limited but essential resources for household activities, particularly for livestock feeding [20]. This indicates that crop residues are important feed sources across the tropics.

Regarding the seasonality of feed resources; natural pasture, crop residues, browses and improved forages ranked respectively 1, 2, 3 and 4 during the wet season. During the dry season; crop residues, improved forage and browsing plants ranked 1, 2 and 3 respectively.

Table 2. Feed resource availability by season and agro ecology

Feed resource	Agro-ecology											
	Highland (N=132)				Midland (N=62)				Over all (N=194)			
	Dry season		wet season		Dry season		wet season		Dry season		wet season	
	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index
Natural pasture	4th	0.18	1st	0.37	4th	0.14	1st	0.35	4th	0.18	1st	0.34
Crop residue	1st	0.34	2rd	0.26	1st	0.33	2rd	0.24	1st	0.32	2nd	0.24
Improved Forage	2rd	0.25	4th	0.16	2nd	0.29	3th	0.22	2nd	0.27	4th	0.19
Browse species	3th	0.23	3th	0.21	3th	0.24	4th	0.19	3th	0.23	3th	

N=number of respondents

Crop residues and leaves of fodder trees and shrubs were the major sources of feed in dry season while thinned plants and weeds from crop fields were the primary sources of feed in the wet season of Daro Labu district, Western Hararghe Zone [21]. Native pastures, crop residues, grazing of crop stubbles and browse trees were the major feed resources during the dry seasons in Guji Zone, Southern Oromia [22]. Degefa and Tamirat [23] also noted that crop residue, conserved hay and agro-industrial by-products as dry season feed sources in Soro district of Hadiya zone, Southern Ethiopia.

3.2 Grazing land utilization and management practices

Most farmers owning grazing land, practiced Zero, continuous and differed grazing systems (Table 3). Free-ranging in fallow and natural vegetation, rotational grazing in fenced pasture and cut-and-carry feeding were practiced in an upland village in northern Laos [24].

Approximately 79.6 % of smallholder dairy farmers in Jimma town employed zero-grazing practices [16]. In the study area, over all activities for management of grazing land includes, use of cattle manure, weeding and fertilizer applications. Considerable proportions (23.2 %) of respondent households did not practice managing grazing lands. According to Fekede *et al*. [25] 77.5 % of the respondents in central highlands of Ethiopia did not practice managing their grazing lands. This may be due to lack of awareness on the importance of managing grazing lands.

Table 3. Grazing system and grazing land management and improved forage producers

Variables	**Agro-ecology**				
	Highland (N=132)	Midland (N=62)	Overall (N=194)	X^2	**p-value**
Grazing system (%)					
Continuous grazing	26.50	24.20	25.77	4.16	0.490
Differed grazing	18.50	11.29	15.98		
Zero grazing	55	64.50	58.25		
Grazing land management (%)					
Use fertilizer	30.30	12.90	19.70	6.61	0.070
Weeding	23.50	9.70	22.68		
Use manure	28.80	45.20	35.05		
None	17.42	32.25	23.20		
Improved forage production (%)					
Yes	69.70	75.80	71.65	11.92	0.022
No	30.30	24.20	28.35		
Feeding forage and pasture (%)					
Cut and carry fresh	46.97	19.35	38.14	10.35	0.030
Conserved hay	40.15	51.60	43.30		
Grazing	12.88	29.03	18.04		

% = percentage, n =number of respondents

3.4 Crop-residues, Storage and Feeding Practices

The common practices of crop-residues utilization and feeding in the study area are presented in Table 4. Endale [26] noted that 91 % of the farmers stored the crop-residues by stacking under shade near farms in Yerer area. This form of storage affects the nutritional quality

of crop residues as investigated in barley and wheat straws [27]. Fekede *et al.* [28] also showed that nutritional quality of crop residues were highly affected by storage method and storage duration as investigated in teff and wheat straws. The major sources of crop-residues in the study area were wheat and barley straw, maize stover and barley straw. On the other hand, crop aftermath is also other sources of feeds and most (51 %) of respondents use aftermath for a month.

The respondents in the study area use chopping (22.7 %), water soaking (1.03 %), mixing with green feed and agro-industrial by product (51 %) and urea treatment (20.6 %) for improvement of nutritional and feeding values of crop residues. Contrary to this, Fikru [29] indicated that smallholder farmers in Ethiopia did not practice low quality feed improvement techniques due to lack of awareness, skill gap and availability of improved agricultural inputs.

Table 4. Crop residues storage and treatment techniques

Variables	Agro-ecology		Overall (N=194)	X^2	p-value
	Highland (N=132)	Midland (N=62)			
Crop residues storage techniques (%)					
Stacked outside	11.40	9.60	10.80	12.11	0.010
Stacked under shed	57.56	40	52		
Baled outside	0.00	1.61	0.50		
Baled under shed	31	48	36.60		
Crop residues treatment (%)					
Chopping	22	24.20	22.70	10.86	0.032
Water soaking	1.50	0.00	1.03		
Mix with other feeds	52.30	48.40	51		
Urea treatment	20.50	20.90	20.60		
No treatment	3.80	6.45	4.63		
Duration of aftermath grazing (%)					
One month	53	46.77	51	11.40	0.040
Two months	40	27.40	36.08		
Over two months	6.90	25.74	12.88		

% = percentage, N = number of respondents

3.5 Chemical compositions of selected feed in the study area

Chemical composition values of major selected feed resources in the study area are shown in Table 5. The dry matter content of all selected feed was 89.5 % and above. Among the analyzed feeds, bamboo leaf (*Dendrocalamus* spp.), elephant grass (*Pennisetum purpureum*), and Desho grass (*Pennisetum pedicellatum*) exhibited the highest crude protein (CP) contents, ranging from 9.42 to 14.92 %, followed by Enset leaf (*Ensete ventricosum*) (6.04 CP) and bean straw (5.417 %CP) in the area. The CP content of E*nset* leaf is lower than 11.39 % reported by Dirsha *et al.* [30] in southern Ethiopia. The CP content (12.08 %) of bamboo leaf was higher than reported value of 10.69 % [31]. The wheat straw and barely straw own lower protein content and high fiber contents. The nutritive value of crop residues is variable depending upon the species and variety of the crops, time of harvest, handling and storage conditions and other factors [32].

Table 5. The chemical composition of selected feed resources in the study area

Agro-ecology	Feed samples	% DM					
		DM	Ash	CP	NDF	ADF	ADL
Highland	Wheat straw	91.42	9.92	2.63	58.69	48.82	6.46
	Barely straw	92.03	8.53	3.38	61.85	46.76	5.56
	Bamboo leaf	92.47	9.07	12.08	58.53	36.45	7.52
	Elephant grass	91.64	10.12	14.92	57.51	45.09	4.61
	Enset leaf	91.40	5.41	6.04	59.49	47.91	1.47
	Natural pasture	92.10	7.12	7.43	65.34	44.19	10.41
Midland	Wheat straw	91.02	10.06	2.03	61.22	37.48	6.38
	Barely straw	90.49	11.28	3.11	58.24	37.29	6.14
	Desho grass	91.01	11.70	9.42	59.51	32.17	7.52
	Bean straw	89.52	7.186	5.41	69.03	31.03	5.99
	Natural pasture	91.6	8.20	8.05	67.44	42.98	9.83

ADF: acid detergent fiber; ADL: acid detergent lignin; CP: crude protein; DM: dry matter; NDF: neutral detergent fiber

Crop residues, such as wheat, barley, and bean straw, as well as maize stover, are widely used as livestock feed; however, they have low crude protein content, high fiber and lignin levels, and are often deficient in essential minerals and vitamins. These nutritional limitations result in poor digestibility, low voluntary feed intake, and inadequate nutrient supply, which can lead to reduced growth, lower milk production, poor reproductive performance, and overall decreased productivity in livestock. The reliance on low-nutrient crop residues reflects gaps in SDG 12 (Responsible Consumption and Production).

3.6 Feed related constraints and coping strategies

Feed related constraints and coping strategies are presented in Table 6. In the study area, respondents experience feed shortages mostly during dry seasons. Over all 79.9 % respondents said it occurred in dry season and 20.1 % said both in dry and rainy seasons**.**

Shortages of land, overgrazing, and over population are the major causes of feed shortage according to respondents in the area. To overcome feed shortages, farmers conserve feed by making hay and also purchase and store hay when it is available. Gebrekidan [33] reported that hay is purchased immediately after the end of rainy season and stored for feeding throughout the year in the urban areas of Aksum and Adwa. Reducing herd size as a last option of coping strategy to feed shortage is also a practice employed by Jimma Town dairy cattle owners [16 34]. The recurrent feed shortages, overgrazing of communal lands and poor-quality crop residues hinder progress toward SDG 2 (Zero Hunger)**,** which emphasizes sustainable food production and improved nutrition. These constraints reduce animal productivity and directly affect household food security and income.

Table 6. Feed related constraints and coping strategies in the study area

Variables	Agro ecology					
	Highland (N=132)		midland (N=62)		Overall N=194)	
	Index	Rank	Index	Rank	Index	Rank
Constraints						
Shortage of land	0.410	1	0.35	2	0.40	1
Over grazing	0.35	2	0.26	3	0.31	2
Over population	0.24	3	0.39	1	0.29	3
Coping strategies						
Reduce herd size	0.18	4	0.20	4	0.19	4
Purchasing feed	0.26	2	0.30	1	0.23	2
Uses of fodder trees	0.24	3	0.27	2	0.21	3
Feed conservation	0.32	1	0.23	3	0.28	1

N = Number of sample, % = percentage, n = number of respondents

4. Conclusion

The study has shown that the most important feed resources availability in the areas were crop residues, natural pasture, improved forages and browse species. Maize stover, wheat, barely, bean straws are the most common crop residues used as animal feed resources that are consistently present across agro-ecologies. The major causes of feed shortage were shortage of land, over grazing and over population. The nutritive qualities of feeds in the area were characterized with low crude protein contents and higher fiber contents.

Conflict of interest statement

The authors declare no conflict of interest.

Data availability statement

The complete dataset supporting the results of this study is published within the article itself.

Author contributions

Conceptualization: C. Tefera. Methodology: Y. Tadele; Y. Kechero. Investigation: C. Tefera. Data curation: C. Tefera; Y. Tadele. Formal analysis: Y. Tadele. Supervision: Y. Kechero. Writing (original draft): C. Tefera; Y. Tadele. Writing (review and editing): Y. Tadele; Y. Kechero.

Generative AI use statement

No generative AI tools were used in this research.

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