

Goat Feed Inventory and Feed Balance in Hamer and Bena-Tsemay Woreda of South Omo Zone, South Western Ethiopia

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Abstract

Goat feed inventory and feed balance studies were conducted in Hamer and Bena-Tsemay Woredas with the aim of assessing the current status of major goat feed resources, dry matter availability and goat feed balance. Five kebeles from Bena-Tsemay and three kebeles from Hamer were selected. In each Woreda, between eight and twelve herders were selected to participate in focus group discussions (FGD). Herders were interviewed about major feed resource for goats, their availability, seasonal dynamics and the plant parts utilised by goats. In addition to the FGDs, in each of the study kebeles, subsets of the experienced herders were asked to collect samples of forage species mentioned in the FGDs. These samples were catalogued in code corresponding to local names for each species and botanical names subsequently assigned, following identification by trained botanists. The findings from this study revealed that there were 22 and 20, 51 and 40 herbaceous and browse forage species identified as goat feeds from Hamer and Bena-Tsemay Woredas respectively. The herders also reported that goat feed was generally plentiful from April to August and became scarce during January and February. The estimated total annual maintenance dry matter requirement for goats across districts is likely to be in the order of 470,000 and 170,000 tons which exceeds the estimated dry matter of 370,000 and 40,000 tons produced for Hamer and Bena-Tsemay respectively and equates to estimated deficits of roughly 94,000 and 129,000 tons of dry matter. It was therefore, recommended that the primarily focus on improving the existing feed resources through area enclosure, improving poor quality feeds, forage banking during surplus production, introduction and demonstration of adaptable cultivated fodder species and enhancing the utilisation of native browse species as a local protein supplements.

Keywords: Goat Feed Resources; Feed Resource Availability; Feed Resource Dynamics; Feed Balance

Introduction

Goats play a key role in livelihoods of poor pastoral communities through the provision of milk, meat, skins, manure and cash income [1,2]. However, within the Ethiopian context, shortfalls in both quality and quantity of feed represent major limitations for goat productivity [3]. These constraints are reflected within in the focal regions of the present study, where previous research has demonstrated that goat production is limited by constraints in both nutritional quality as well as supply, with pronounced fluctuations in the seasonal availability of range forage [4-6]. Nutritional stress contributes to slow growth rates, loss of body condition and increased susceptibility to diseases and parasites [6]. Within the study regions it is also apparent that pastoral communities do not always possess a full appreciation and understanding of the quality and availability of major goat feed resources [6]. Issues such as

these validate the need for research activities focused on the appraisal and quantification of goat feed resources and the seasonal fluctuations that influence their supply within the study districts. The information provided by such research has the potential to be immense utility to policy makers, government departments, NGOs and development agencies in the formulation and implementation of programs aimed at sustainably improving goat productivity. The availability of such information would also enable the improved provision of practical recommendations for goat keepers and other stakeholders. Moreover, to date on the assessment of goat feed supply and demand has not been carried out in Hamer or Bena-Tsemay.

Aim of the Study

Therefore, this study aimed to contribute to the existing bank of knowledge regarding goat feed resources in Hamer and Bena-Tsemay by assessing the current status and availability of major

goat feed resources and attempting to calculate the annual goat feed supply-demand balance.

Study Methodologies

Description of the study areas

The study was conducted in pastoral and agro-pastoral areas of the Hamer and Bena-Tsemay districts of South Omo Zone. Bena-Tsemay Woreda is located between 04° 59.00" and 05° 58.40" N and Hamer is 36° 12.45" and 37° 30.25" E. The climate of Bena-Tsemay Woredas is hot to warm semiarid with altitudinal variation of 500m to 1800m. The average daily temperatures range between 15.6°C and 26.5°C in Bena-Tsemay while, in Hamer Woreda the average temperature is 37°C and altitude varies from 450 m to 1765m a.s.l with the average annual rainfall is 400 mm.

Methods of data collection

Focus group discussions (FGDs) and on-farm field observations were the main methods of data collection employed for the completion of the goat feed inventory study. A questionnaire was designed for the purposes of guiding FGDs and capturing all information relevant to the major goat feed resources and their availability.

Focus group discussions

Within Bena-Tsemay, FGDs were conducted in the five kebeles of Shaba Arigemenda, Dize Aman, Bori, Moregolla and Sile. In Hamer, FGDs were conducted in the the three kebeles of Area Umbule, Area Kiyisa and Dimeka Zuria. Each of the eight FGDs engaged between eight and twelve pastoralists and was facilitated with the aid of local kebele development agents, who selected pastoralists for inclusion, taking into consideration of their age and degree of local experience in regard to goat production and feed management practices. The participating herders were asked about the major goat feed resource categories (herbaceous forages, browse forages, and crop residues) that are available within their kebeles. For each of these categories, they were asked to recall and list all of the species that comprise them, before being asked to rank each species in order of preference for goat production. For each species the pastoralists were also asked about seasonal patterns of availability, morphological plant parts utilised by goats and whether they thought each species was increasing or decreasing in prevalence over the longer term.

On-farm rangeland field observations

Following the completion of each FGD, five of the most experienced and knowledgeable herders were nominated by the FGD participants, for the purpose of collecting and identifying rangeland field samples of the major goat feed species nominated during the FGD activities. With the assistance of researchers these pastoralists collected, catalogued and photographed a sample of each

nominated species using a numerical code corresponding to indigenous plant names. Upon return from the field, species were identified and assigned botanical names with the assistance of trained botanists from the Adami Tulu Agricultural Research Centre.

Source of secondary data

Secondary information on goat population numbers and the total areas of land under browsing were sourced from the respective Woreda livestock and fisheries resource development offices. Moreover, the figures for the area of land under each class of crop were collected from the Hamer and Bena-Tsemay Woreda Office of Agriculture and Natural Resource Development.

Estimation of annual dry matter availability

The figures obtained from each of these departments were then utilised to calculate an estimate of the quantity of dry matter produced per year for goats within the study areas for each respective land use category. Estimated annual dry matter production for the browsing land use category was calculated using the methodology recommended by Kearn LC [7] and while estimated annual dry matter yields obtained from crop residues per crop were estimated using conversion factors developed by the FAO [8].

Estimation of dry matter requirements and feed balance for goat

Goat holdings per study Woreda were aggregated into Tropical Livestock Units (TLUs) by considering the annual average goats based on the number of goats by using the species-specific TLU conversion factors of 0.1 for goats [9,10]. The dry matter demand of goats in the study area was estimated based on the expected daily dry matter intake suggested for the standard TLU of 250 kg at 2.5% of the body weight, which is equivalent to 6.25 kg/day. The Goats' feed balance at the entire production year was determined as the difference between the total annual feed dry matter supplies from different major goat feed resources and the total annual dry matter demands for goats.

Results

Major herbaceous feed resources for goats

The major herbaceous forage species utilized as goat feed resources in Hamer and Bena-Tsemay Woredas are listed in table 1 below. Participating herders identified 22 and 20 different herbaceous forage species for Hamer and Bena-Tsemay Woredas respectively. During the FGDs, the pastoralists were asked to rank each of the nominated forage species based on their importance as goat feed resources and these rankings are also indicated in table 1 below. There was extensive overlap in the species recorded within both Woredas, however *Oresoschimperella verrucosa*, *Sporobolus pyramidalis*, *Commelina benghalensis*, *Cido obata* and *Colotoria en-*

Benagna Language	Scientific Name	Ranking	Hameregna Language	Scientific Name	Ranking
Turna	<i>Indigofera spicata spira</i>	1	Turina	<i>Indigofera spicata spira</i>	1
Kontsala	<i>Cyperus bulbosus</i>	2	Mara	<i>Tetrapogon teneullus</i>	2
Garant	<i>Vernonia natalensis</i>	3	Mugri	<i>Crotalaria incana?</i>	3
Mugr	<i>Crotalaria incana?</i>	4	Garanti	<i>Vernonia natalensis</i>	4
Zaki	<i>Vigna unguiculate</i>	5	Genya	<i>Tribulus terrestris</i>	5
Zersi	<i>Cynodon dactylon</i>	6	Kuntsale	<i>Cyperus bulbosus</i>	6
Erbo	<i>Ormocarpum mimosoides</i>	7	Gojo	<i>Euphorbia tirucalli</i>	7
Mara	<i>Tetrapogon teneullus</i>	8	Eribo	<i>Ormocarpum mimosoides</i>	8
Enku	<i>Lablab purpureus</i>	9	Sefity	<i>Rhoicissus tridentata</i>	9
Gojo	<i>Euphorbia tirucalli</i>	10	Zersi	<i>Cynodon dactylon</i>	10
Gaya Ukuma	<i>Tribulus terrestris</i>	11	Enku	<i>Lablab purpureus</i>	11
Sepety	<i>Rhoicissus tridentata</i>	12	Metsa	<i>Achyranthes aspara</i>	12
Mesta	<i>Achyranthes aspara</i>	13	Zaki	<i>Vigna unguiculate</i>	13
Malo	<i>Capparis tomentosa</i>	14	Genteta	<i>Cido obata</i>	14
Ganaya	<i>Tribulus terrestris</i>	15	Malo	<i>Capparis tomentosa</i>	15
Pelik	<i>Digitaria abyssinica</i>	16	Tiri	<i>Lawsonia inermis</i>	16
Melkela	<i>Dovyalis abyssinica</i>	17	Gera	<i>Hyparrhenia hirta</i>	17
Gali	<i>Tephrosia species</i>	18	Buska	<i>Sporobolus pyramidalis</i>	18
Tire	<i>Lawsonia inermis?</i>	19	Okilibuko	<i>Commelina benghalensis</i>	19
Menzo	<i>Lantana camara</i>	20	Gali	<i>Tephrosia species</i>	20
			Ago	<i>Oresoschimperella verrucosa</i>	21
			Gaya Ukuma	<i>Tribulus terrestris</i>	22

Table 1: List of major herbaceous species and their ranking in order of importance as goats feed in Hamer and Bena-Tsemay woredas. For each plant nominated, local names are listed along with the corresponding scientific name and usefulness ranking assigned by participating herders.

kana were only reported from Hamer Woreda and *Ovyalis abyssinica*, *Lantana camara* and *Digitaria abyssinica* were reported only from the Bena-Tsemay district.

Major browse forages for goats

The major browse forage species used as goats feed resource in Hamer and Bena-Tsemay woredas are listed in table 2 below. Herders identified 51 and 40 browse forage species utilised by goats in Hamer and Bena-Tsemay Woredas respectively. Forage usefulness rankings assigned by herders are also displayed in table 2. As was the case with the herbaceous species, there was extensive overlap in the species recorded within both Woredas, however *Boscia coriacea*, *Dalbergia sissoo*, *Combretum molle*, *Rhoicissus revoliilii*, *Sida ovate*, *Commiphora erlangerana*, *Delonix regia*, *Grewia bicolor* and *Seurinega virosa* were reported within Hamer district only whereas, *Ficus sycomorus*, *Piliostigma thonningii* and *Sclerocarya birrea* were reported only in Bena-Tsemay district.

Major crop residues for goats

The major crop residues used as goats feed resource in Hamer and Bena-Tsemay Woreda during harvesting time is listed in table 3. The findings from this study shows that agro pastoralist in the study areas identified 5 and 4 different crops residues that were being fed to goats as major goats feeds for Hamer and Bena-Tsemay Woredas respectively. Agro pastoralists from these areas had grouped crop type used as goats feed into cereals, legumes and roots and ranked them in order of their importance as goat feed resources. Accordingly, *Phaseolus vulgaris* (L), *Eleusine coracana* (L.), *Ipomoea batatas* (L), *Sorghum bicolor* (L) and *Zea mays* (L) were ranked 1 up to 5th by Hamer agro pastoralists and whereas, *Phaseolus vulgaris* (L), *Sorghum bicolor*, *Ipomoea batatas* (L) and *Zea mays* (L), were ranked 1 up to 4th by Bena-Tsemay agro pastoralists.

Herbaceous goat feed resource availability

As expected, pastoralists and agro-pastoralists in the study areas reported that dry matter from the herbaceous feed resources

Benagna Name	Scientific Names	Ranking	Hameregna Name	Scientific Names	Ranking
Tulungo	<i>Sclerocarya birrea</i>	1	Maga	<i>Annona senegalensis</i>	1
Pulanti	<i>Acacia seyal</i>	2	Zuriguma	<i>Avicennia manna</i>	2
Zurguma	<i>Avicennia manna</i>	3	Kena	<i>Ekebergia capensis</i>	3
Zergo	<i>Acacia brevispica</i>	4	Zergo	<i>Acacia brevispica</i>	4
Ara	<i>Terminalia brownie fresen</i>	5	Kilansa	<i>Acacia polyacantha</i>	5
Mega	<i>Annona senegalensis</i>	6	Dile	<i>Dichro stachys cinerea</i>	6
Banaki	<i>Cenearia diacrostadilia</i>	7	Lola	<i>Acacia nilotica</i>	7
Kelansa	<i>Acacia polyacantha</i>	8	Jamo	<i>Entada abyssinica</i>	8
Arike	<i>Acacia sieberiana</i>	8	Ara	<i>Terminalia brownie fresen</i>	9
Menzo	<i>Brachimia discolor</i>	9	Baraza	<i>Bridelia micrantha</i>	10
Goleli	<i>Acacia toritilis</i>	10	Mudakale	<i>Boscia coriacea</i>	11
Dile	<i>Dichro stachys cinerea</i>	11	Banaki	<i>Cenearia diacrostadilia</i>	12
Jamo	<i>Entada abyssinica</i>	12	Manzo	<i>Brachimia discolor</i>	13
Domoko	<i>Belanites aegyptila</i>	12	Galansa	<i>Acacia albida</i>	14
Galansa	<i>Acacia albida</i>	13	Gedaki	<i>Dalbemergia melanoxyylon</i>	15
Moshiko	<i>Indigofera spicata spira</i>	14	Golali	<i>Acacia nilotica</i>	16
Lelo	<i>Acacia nilotica</i>	15	Tubaki	<i>Rhus vulgaris</i>	17
Kenya	<i>Ekebergia capensis</i>	16	Bitsobitso	<i>Mytenus ovatus</i>	18
Anshali	<i>Crotolaria spinosa</i>	17	Keyi	<i>Rhus natalensis</i>	19
Briza	<i>Bridelia micrantha</i>	18	Gergeta	<i>Vitellaria paradoxa</i>	20
Bitsobitso	<i>Mytenus ovatus</i>	18	Seftiy	<i>Bridelia micrantha</i>	21
Gedake	<i>Dalbemergia melanoxyylon</i>	19	Mekela	<i>Grewia tenax</i>	22
Sefiti	<i>Bridelia micrantha</i>	20	Rubi	<i>Delonix regia</i>	23
Gelife	<i>Combretum molle</i>	21	Tera	<i>Acacia toritils</i>	24
Gergeta	<i>Vitellaria paradoxa</i>	22	Giri	<i>Calpurnia subdecandara</i>	25
Mekela	<i>Grewia tenax</i>	23	Wuchembe	<i>Pithecellobium dulce</i>	26
Kufre	<i>Albizia lophantha</i>	24	Arke	<i>Acacia sieberiana</i>	27
Chakanti	<i>Grewia tenax</i>	25	Anishali	<i>Crotolaria spinosa</i>	28
Akmba	<i>Acokanthera schimper</i>	26	Shafi	<i>Morus alba</i>	29
shaf	<i>Morus alba</i>	27	Pulanti	<i>Acacia seyal</i>	30
Lola	<i>Acacia Oerfota</i>	28	Kufri	<i>Albizia lophantha</i>	31
Dekalo	<i>Acacia lahali</i>	29	Hanshela	<i>Rhoicissus revoilii</i>	32
Kalikala	<i>Hevea brasiliensis</i>	30	Genteta	<i>Sida ovata</i>	33
Key	<i>Rhus natalensis</i>	31	Chakanti	<i>Grewia tenax</i>	34
Tubakey	<i>Rhus vulgaris</i>	32	Sebe	<i>Cordia gharaf</i>	35
Keja	<i>Acacia nubica</i>	32	Dita	<i>Dalbergia sissoo</i>	36
Onoki	<i>Sarcocephalus latifolius</i>	32	Gumeza	<i>Commiphora erlangerana</i>	37
Tseleko	<i>Albizia grandibracteata</i>	34	Akmba	<i>Acokanthera schimper</i>	38
Zinak	<i>Allophylus abyssinicus</i>	35	Kaja	<i>Acacia nubica</i>	39
Gerigecha	<i>Grewia villosa</i>	36	Gilifi	<i>Combretum molle</i>	40
Omoa	<i>Ficus sycomorus</i>	37	-	-	-
Wuchembe	<i>Pithecellobium dulce</i>	38	Rubi	<i>Delonix regia</i>	41
Tera	<i>Acacia toritilis</i>	39	Domoko	<i>Belanites aegyptila</i>	42

Olopo	<i>Piliostigma thonningii</i>	40	Tsaki	<i>Albizia grandibracteata</i>	43
-	-	-	Kalikali	<i>Hevea brasiliensis</i>	44
-	-	-	Kachikache	<i>Seurinega virosa</i>	45
-	-	-	Dakali	<i>Acacia lahali</i>	46
-	-	-	Gerigisha	<i>Grewia villosa</i>	47
-	-	-	Zinaki	<i>Allophylus abyssinicus</i>	48
-	-	-	Lelo	<i>Acacia Oerfota</i>	49
-	-	-	Moshike	<i>Indigofera spicata spira</i>	50
-	-	-	Onoka	<i>Sarcocephalus latifolius</i>	51

Table 2: The list of major browse species for goats ranked in order of importance in Hamer and Bena-Tsemay Woredas.

S/No	Benagna	Scientific Names	Ranking	Hameregna	Scientific Names	Ranking
1	Bokolo	<i>Zea mays (L)</i>	4	Bokolo	<i>Zea mays (L)</i>	5
2	Alaph	<i>Sorghum bicolor (L)</i>	2	Ensi	<i>Sorghum bicolor (L)</i>	4
3	Fecha	<i>Phaseolus vulgaris (L)</i>	1	Ficha	<i>Phaseolus vulgaris (L)</i>	1
4	Ayishitaro	<i>Phaseolus vulgaris (L)</i>	1	-	-	-
5	Badala	<i>Phaseolus vulgaris (L)</i>	1	-	-	-
6	Dincha	<i>Ipomoea batatas (L)</i>	3	Dinsha	<i>Ipomoea batatas (L.)</i>	3
7	-	-	-	Barga	<i>Eleusine coracana (L.)</i>	2

Table 3: Major sources of crop residues for goats within study regions.

declined during dry seasons, but and it was became readily available after the end of the dry seasons. Interviewees both districts also reported that the availability of important herbaceous forages species such as *Tetrapogon teneullus*, *Tribulus terrestris*, *Eupherbia tirucalli*, *Ormocarpum mimosoides*, *Tephrosia* species and *Lantana camara* had declined over the last five years. During FGDs with pastoralists in Hamer Woreda, one older pastoralist (65 years old) reported that when he was around 14 years of age, herbaceous grass grew up to his shoulder, and fire was regularly used by pastoralists as a land management tool, whereas nowadays much of the rangelands are bear with insufficient grass growth to carry fire.

Browse goat feed resource availability

The availability of browse goat feed resources reported by pastoralists in the study areas are presented in table 5 below. Herders during FGD reported that the dry matter availability was low during dry seasons and surplus during the rainy season. They noted that the availability of browse species: *Avicennia manna*, *Mytenus ovatus*, *Indigofera spicata spira*, *Acacia nilotica*, *Dichro stachys cinerea*, *Pithecellobium dulce*, *Albizia lophantha*, *Acacia albida*, *Seurinega virosa*, *Acacia lahali* and *Grewia villosa* had declined in the last five years and this had negatively affected overall forage availability, forcing herders to graze goats on unusual patches of land, along riverbanks and forcing them to loop browse leaf and pods from trees for the animals during dry seasons. Furthermore,

herders from Bena-Tsemay district reported that *Bridelia micrantha*, *Dichro stachys cinerea*, *Acacia sieberiana*, *Vitellaria paradoxa*, *Belanites aegyptila*, *Vitellaria paradoxa*, *Ficus sycomorus*, *Piliostigma thonningii* and *Sclerocarya birrea* did not provide goat forage during dry seasons. However, Hamer pastoralists classified these species as being moderately available to goats during dry seasons. This variation in seasonal availability is likely to be due to the fact that in Bena-Tsemay Woreda, most of the communities have transitioned from purely pastoralist livelihoods and into agro pastoralism. This has resulted in much of the former browsing rangelands being converted to farmland and this is likely to have led to an increase in stocking pressures on remaining rangeland.

Crop residues availability for goats

Agro-pastoralist in the study areas reported that crop residues for goat feeds were only available during crop harvesting time. However, they also reported that due to the increasing rates of land conversion to cropping, crop residue dry matter supplies increasing significantly.

Seasonal dynamics of herbaceous feeds

The seasonal dynamics of herbaceous forages for goats in the study districts are presented in table 7. Herders from both study districts reported that dry matter from major herbaceous species are completely unavailable to goats from January to February except those herbaceous species such as *Eupherbia tirucalli* and *Cap-*

Benagna	Scientific Name	Availability	Hameregna	Scientific Name	Availability
Mara	<i>Tetrapogon cincroform</i>	*	Mara	<i>Tetrapogon cincroform</i>	**
Kontsala	<i>Cyperus bulbosus</i>	*	Kuntsale	<i>Cyperus bulbosus</i>	***
Turna	<i>Endigophora spinosis</i>	*	Turina	<i>Endigophora spinosis</i>	*
Garant	<i>Vernonia natalensis</i>	*	Garanti	<i>Vernonia natalensis</i>	*
Ganaya	<i>Tribulus terrestris</i>	*	Genya	<i>Tribulus terrestris</i>	**
Gojo	<i>Eupherbia tirucalli</i>	*	Gojo	<i>Eupherbia tirucalli</i>	**
Erbo	<i>Ormocarpum mimosoides</i>	**	Eribo	<i>Ormocarpum mimosoides</i>	***
Zersi	<i>Cynodon dactylon</i>	*	Zersi	<i>Cynodon dactylon</i>	***
Sepety	<i>Rhoicissus tridentata</i>	**	Sefity	<i>Rhoicissus tridentata</i>	***
Mugr	<i>Colotoria enkana</i>	*	Mugri	<i>Colotoria enkana</i>	***
Gali	<i>Tephrosia species</i>	**	Gali	<i>Tephrosia species</i>	***
Mesta	<i>Achentis aspara</i>	*	Metsa	<i>Achentis aspara</i>	***
Gaya Ukuma	<i>Tribulus terrestris</i>	***	Gaya Ukuma	<i>Tribulus terrestris</i>	***
-	-	-	Gera	<i>Hyparrhenia hirta</i>	***
-	-	-	Ago	<i>Oresoschimperella verrucosa</i>	***
-	-	-	Buska	<i>Sporobolus pyramidalis</i>	***
Malo	<i>Capparis tomentosa</i>	*	Melo	<i>Capparis tomentosa</i>	*
-	-	-	Genteta	<i>Cido obata</i>	***
-	-	-	Okilibuko	<i>Commelina benghalensis</i>	***
Enku	<i>Lablab purpureus</i>	*	Enku	<i>Lablab purpureus</i>	*
Tire	<i>Lawsonia inermis</i>	*	Tiri	<i>Lawsonia inermis</i>	***
Melkela	<i>Dovyalis abyssinica</i>	*	-	-	-
Menzo	<i>Lantana camara</i>	**	-	-	-
Pelik	<i>Digitaria abyssinica</i>	*	-	-	-
Zaki	<i>Vaginea unguatum</i>	*	Zaki	<i>Vaginea unguatum</i>	*

Table 4: Herbaceous feed resource availability for goats in Hamer and Bena-Tsemay Woreda.

Marks= *: Not available; **: Low availability; ***: Moderately available.

Benagna Name	Scientific Names	Its dynamics	Hameregna	Scientific Names	Its dynamics
Mega	<i>Annona senegalensis</i>	**	Maga	<i>Annona senegalensis</i>	**
Zurguma	<i>Avicennia manna</i>	**	Zuriguma	<i>Avicennia manna</i>	**
Kenya	<i>Ekebergia capensis</i>	***	Kena	<i>Ekebergia capensis</i>	***
Zergo	<i>Acacia brevispica</i>	***	Zergo	<i>Acacia brevispica</i>	***
Kelansa	<i>Dichro stachys cinerea</i>	*	Kilansa	<i>Dichro stachys cinerea</i>	***
Dile	<i>Dichro stachys cinerea</i>	**	Dile	<i>Dichro stachys cinerea</i>	***
Lelo	<i>Acacia nilotica</i>	**	Lola	<i>Acacia nilotica</i>	**
Jamo	<i>Entada abyssinica</i>	***	Jamo	<i>Entada abyssinica</i>	***
Ara	<i>Terminalia brownie fresen</i>	***	Ara	<i>Terminalia brownie fresen</i>	***
Briza	<i>Bridelia micrantha</i>	*	Baraza	<i>Bridelia micrantha</i>	***
-	-	-	Mudakale	<i>Boscia coriacea</i>	***
Banaki	<i>Acacia sieberiene</i>	*	Banaki	<i>Acacia sieberiene</i>	***
Menzo	<i>Brachimia discolor</i>	*	Manzo	<i>Brachimia discolor</i>	***

Moshiko	<i>Indigofera spicata spira</i>	***	Moshike	<i>Indigofera spicata spira</i>	**
Gedake	<i>Dalbemergia melanoxydon</i>	***	Gedaki	<i>Dalbemergia melanoxydon</i>	***
Goleli	<i>Acacia toritilis</i>	***	Golali	<i>Acacia toritilis</i>	***
Tubakey	<i>Rhus vulgaris</i>	***	Tubaki	<i>Rhus vulgaris</i>	**
-	-	-	Dita	<i>Dalbergia sissoo</i>	**
Sefiti	<i>Bridelia micrantha</i>	***	Seftiy	<i>Bridelia micrantha</i>	***
Bitsobitso	<i>Mytenus ovatus</i>	**	Bitsobitso	<i>Mytenus ovatus</i>	**
Arike	<i>Acacia sieberiana</i>	*	Arke	<i>Acacia sieberiana</i>	***
Anshali	<i>Crotolaria spinosa</i>	**	Anishali	<i>Crotolaria spinosa</i>	***
shaf	<i>Morus alba</i>	*	Shafi	<i>Morus alba</i>	***
Akmba	<i>Acokanthera schimper</i>	***	Akmba	<i>Acokanthera schimper</i>	***
-	-	-	Giri	<i>Calpurnia subdecandara</i>	***
Wuchembe	<i>Pithecellobium dulce</i>	**	Wuchembe	<i>Pithecellobium dulce</i>	**
-	-	-	Sebe	<i>Combretum molle</i>	***
Gelifa	<i>Combretum molle</i>	**	Gilifi	<i>Combretum molle</i>	**
Domoko	<i>Belanites aegyptia</i>	*	Domoko	<i>Belanites aegyptia</i>	**
Pulanti	<i>Acacia seyal</i>	***	Pulanti	<i>Acacia seyal</i>	***
Kufre	<i>Albizia lophantha</i>	**	Kufri	<i>Albizia lophantha</i>	**
-	-	-	Hanshela	<i>Rhoicissus revoilii</i>	*
-	-	-	Genteta	<i>Sida ovata</i>	***
Metete	<i>Acacia brevispica</i>	***	Metete	<i>Acacia brevispica</i>	***
Chakanti	<i>Vitellaria paradoxa</i>	*	Chakanti	<i>Vitellaria paradoxa</i>	**
Gergeta	<i>Rhus natalensis</i>	***	Gergeta	<i>Rhus natalensis</i>	**
Key	-	***	Keyi	<i>Commiphora erlangerana</i>	***
-	<i>Grewia tenax</i>	-	Gumeza	<i>Grewia tenax</i>	***
Mekela	<i>Ekebergia capensis</i>	**	Mekela	<i>Ekebergia capensis</i>	**
Keja	-	***	Kaja	<i>Delonix regia</i>	***
-	-	-	Rubi	<i>Grewia bicolor</i>	***
Tra	<i>Albizia grandibracteata</i>	***	Tera	<i>Albizia grandibracteata</i>	***
Tseleko	<i>Hevea brasiliensis</i>	***	Tsaki	<i>Hevea brasiliensis</i>	***
Kalikala	-	-	Kalikali	<i>Seurinega virosa</i>	**
-	<i>Acacia lahali</i>	-	Kachikache	<i>Acacia lahali</i>	**
Dekalo	<i>Grewia villosa</i>	**	Dakali	<i>Grewia villosa</i>	**
Gerigecha	<i>Allophylus abyssinicus</i>	***	Gerigisha	<i>Allophylus abyssinicus</i>	***
Zinak	<i>Acacia Oerfota</i>	***	Zinaki	<i>Acacia Oerfota</i>	***
Lola	<i>Acacia albida</i>	**	Lelo	<i>Acacia albida</i>	***
Galansa	<i>Sarcocephalus latifolius</i>	***	Galansa	<i>Sarcocephalus latifolius</i>	***
Onoki	<i>Ficus sycomorus</i>	*	Onoka	-	***
Omoa	<i>Piliostigma thonningii</i>	*	-	-	-
Olopo	<i>Sclerocarya birrea</i>	***	-	-	-
Tulungo	<i>Sclerocarya birrea</i>	*	-	-	-

Table 5: Browse feed resource availability for goats in Hamer and Bena-Tsemay Woreda.

Marks = *: No available; **: Low available; ***: Moderately available.

paris tomentosa which were highly available. It was mentioned in the FGDs that during critical dry seasons, all goats were fed on browse species, and leaves and stems shattered from herbaceous feed resource base as mitigation strategies. On the other hand, they reported that availability of dry matter to goats from herbaceous feed resource base is low in December and then moderately available as from September, October, November and March. These were however more readily available from April up to August. Furthermore, they also reported that rains start in moderately and increase from April to August. During these periods, all disappeared herbaceous forage begins to re-emerge and is available in plenty as from July and August.

Seasonal dynamic of browse species for goats

The seasonal dynamic of browse species in the study areas have shown similar seasonal dynamic trends to those of herbaceous species shown in table 7. During FGDs herders reported that browse species classified as highly available in table 8, were available all year round as dry matter to goats. However, the seasonal dynamics of dry matter supplies from browse species classified as not available during some months of the year as detailed in table 8, totally declined from January to February. Pastoralists also reported a similar seasonal dynamic trend for feeds from the all browses in the study areas from April to August and a moderate feed availability from September to October except for deciduous browse species.

Benagna Name	Scientific Names	It's dynamics	Hamergna	Scientific Name	It's dynamics
Bokolo	<i>Zea mays (L)</i>	*	Bokolo	<i>Zea mays (L)</i>	*
Alaph	<i>Sorghum bicolor (L)</i>	*	Ensi	<i>Sorghum bicolor (L)</i>	*
Fecha	<i>Phaseolus vulgaris (L)</i>	*	Ficha	<i>Phaseolus vulgaris (L)</i>	*
Ayishitaro	<i>Phaseolus vulgaris (L)</i>	*	-	-	-
Badala	<i>Phaseolus vulgaris (L)</i>	*	-	-	-
Dincha	<i>Ipomoea batatas (L)</i>	*	Dinsha	<i>Ipomoea batatas (L)</i>	*
-	-	-	Barga	<i>Eieusine coracana</i>	*

Table 6: Major sources of crop residues availability for goats.

Marks= *: Increasing; -: Not reported.

Benagna	Hamergna	Scientific	Months in year												
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	
Mara	Mara	<i>Tetrapogon cincroform</i>	*	*	***	***	****	****	****	****	****	***	***	**	**
Kontsala	Kuntsale	<i>Cyperus bulbosus</i>	*	*	*	****	****	****	****	****	****	***	***	***	**
Turna	Turina	<i>Endigophora spinosis</i>	*	*	*	****	****	****	****	****	****	***	***	***	**
Garant	Garanti	<i>Vernonia natalensis</i>	*	*	**	**	***	***	****	****	****	****	****	****	*
Ganaya	Genya	<i>Tribulus terrestris</i>	*	*	**	**	***	***	****	****	****	****	****	****	*
Gojo	Gojo	<i>Eupherbia tirucalli</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Erbo	Eribo	<i>Ormocarpummimosoides</i>	*	*	*	**	**	****	****	****	****	***	***	**	*
Zersi	Zersi	<i>Cynodon dactylon</i>	*	*	*	****	****	****	****	****	****	***	***	***	**
Sepety	Sefity	<i>Rhoicissus tridentata</i>	*	*	***	***	****	****	****	****	****	***	***	**	**
Mugr	Mugri	<i>Colotoria enkana</i>	*	*	*	****	****	****	****	****	**	**	***	***	**
Gali	Gali	<i>Tephrosia species</i>	*	*	*	****	****	****	****	****	**	**	***	***	**
Mesta	Metsa	<i>Achentis aspara</i>	*	*	*	****	****	****	****	****	**	**	***	***	**
Gaya Ukuma	Gaya Ukuma	<i>Tribulus terrestris</i>	*	*	*	****	****	****	****	****	**	**	***	***	**
-	Gera	<i>Hyparrhenia hirta</i>	*	*	***	***	****	****	****	****	****	***	***	**	**
-	Ago	<i>Oresoschimperella verrucosa</i>	*	*	***	***	****	****	****	****	****	***	***	**	**
-	Buska	<i>Sporobolus pyramidalis</i>	*	*	***	***	****	****	****	****	****	****	****	**	**
Malo	Melo	<i>Capparis tomentosa</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
-	Genteta	<i>Cido obata</i>	*	*	***	***	****	****	****	****	****	***	***	**	**

-	Okilibuko	<i>Commelina benghalensis</i>	*	*	*	***	****	****	****	****	****	***	***	**	*
Enku	Enku	<i>Lablab purpureus</i>	*	*	***	***	****	****	****	****	****	***	***	**	**
Tire	Tiri	<i>Lawsonia inermis</i>	*	*	*	***	****	****	****	****	****	***	***	**	**
Melkela	-	<i>Dovyalis abyssinica</i>	*	*	*	***	****	****	****	****	****	***	***	**	**
Menzo	-	<i>Lantana camara</i>	*	*	*	***	****	****	****	****	****	***	***	**	**
Palik	-	<i>Digitaria abyssinica</i>	**	**	**	****	****	****	****	****	****	***	***	***	**
Zaki	Zaki	<i>Vaginea unguatum</i>	**	**	**	****	****	****	****	****	****	***	***	***	**

Table 7: The seasonal dynamic of herbaceous goats feed resources in Hamer and Bena-Tsemay.

Marks: *: Not available; **: Low Available; ***: Moderately Available; ****: Highly Available.

Seasonal dynamic of crop residues for goat

The seasonal dynamic of crop residues is presented in table 9. The herders in the study area reported during FGDs that dry matter supply from crop residues is generally highest from June to July while being completely unavailable from November to May. They also reported that crop residues are highly available in the study

areas from August to October. This is due to the fact that this period coincides with the short rainy season when many of the agro-pastoralists plant crops.

Herbaceous plant parts utilized by goats

Morphological parts of the herbaceous forage species utilized by goats in the study areas are presented in table 10.

Benagna	Hamergna	Scientific Name	Months in year												
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	
Mega	Maga	<i>Annona senegalensis</i>	*	*	***	****	****	****	****	****	****	***	***	**	**
Zurguma	Zuriguma	<i>Avicennia manna</i>	**	**	**	****	****	****	****	****	****	****	****	****	***
Kenya	Kena	<i>Ekebergia capensis</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Zergo	Zergo	<i>Acacia brevispica</i>	*	*	*	****	****	****	****	****	****	****	****	****	*
Kelansa	Kilansa	<i>Dichro stachys cinerea</i>	*	*	*	****	****	****	****	****	****	****	****	**	**
Dile	Dile	<i>Dichro stachys cinerea</i>	*	*	***	****	****	****	****	****	****	****	****	**	**
Lelo	Lola	<i>Acacia nilotica</i>	*	*	*	*	****	****	****	****	****	****	***	***	*
Jamo	Jamo	<i>Entada abyssinica</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Ara	Ara	<i>Terminalia brownie fresen</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Briza	Baraza	<i>Bridelia micrantha</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
-	Mudakale	<i>Boscia coriacea</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Banaki	Banaki	<i>Acacia sieberiene</i>	*	**	**	****	****	****	****	****	****	****	***	***	*
Menzo	Manzo	<i>Brachimia discolor</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Moshiko	Moshike	<i>Indigofera spicata spira</i>	*	*	*	****	****	****	****	****	****	****	*	*	*
Gedake	Gedaki	<i>Dalbemergia melanoxylon</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Goleli	Golali	<i>Acacia toritilis</i>	*	*	****	****	****	****	****	****	****	***	***	**	**
Tubakey	Tubaki	<i>Rhus vulgaris</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
-	Dita	<i>Dalbergia sissoo</i>	*	*	****	****	****	****	****	****	****	****	*	*	*
Sefiti	Seftiy	<i>Bridelia micrantha</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Bitsobitso	Bitsobitso	<i>Mytenus ovatus</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Arike	Arke	<i>Acacia sieberiana</i>	*	*	*	***	****	****	****	****	****	***	***	**	*
Anshali	Anishali	<i>Crotolaria spinosa</i>	*	*	*	****	****	****	****	****	****	**	**	**	*
shaf	Shafi	<i>Morus alba</i>	*	*	****	****	****	****	****	****	****	**	**	**	*
Akmba	Akmba	<i>Acokanthera schimper</i>	****	****	****	****	****	****	****	****	****	****	****	****	****
Wuchembe	Wuchimbe	<i>Calpurnia subdecandara</i>	****	****	****	****	****	****	****	****	****	****	****	****	****

-	Sebe	<i>Pithecellobium dulce</i>	****	****	****	****	****	****	****	****	****	****	****	****
Gelifa	Gilifi	<i>Combretum molle</i>	****	****	****	****	****	****	****	****	****	****	****	****
Domoko	Domoko	<i>Combretum molle</i>	****	****	****	****	****	****	****	****	****	****	****	****
Pulanti	Pulanti	<i>Belanites aegyptila</i>	****	****	****	****	****	****	****	****	****	****	****	****
Kufre	Kufri	<i>Acacia seyal</i>	***	*	*	***	****	****	****	****	****	****	****	***
-	Hanshela	<i>Albizia lophantha</i>	***	*	*	***	****	****	****	****	****	****	****	***
-	Genteta	<i>Rhoicissus revouilii</i>	***	**	**	**	****	****	****	****	****	****	***	***
Metele	Metele	<i>Sida ovata</i>	*	*	*	****	****	****	****	****	****	****	***	***
Chakanti	Chakanti	<i>Acacia brevispica</i>	*	*	*	****	****	****	****	****	****	****	***	***
Gergeta	Gergeta	<i>Vitellaria paradoxa</i>	*	*	*	****	****	****	****	****	****	****	***	***
Key	Keyi	<i>Rhus natalensis</i>	*	*	*	****	****	****	****	****	****	****	***	***
-	Gumeza	<i>Commiphora erlangerana</i>	*	*	*	****	****	****	****	****	****	****	***	***
Mekela	Mekela	<i>Grewia tenax</i>	*	*	*	****	****	****	****	****	****	****	***	***
Keja	Kaja	<i>Ekebergia capensis</i>	*	*	*	****	****	****	****	****	****	****	***	***
-	Rumbi	<i>Delonix regia</i>	*	*	****	****	*	**	**	**	**	****	*	*
-	Gera	<i>Grewia bicolor</i>	*	*	*	****	****	****	****	****	****	****	***	***
Tseleko	Tsaki	<i>Albizia grandibracteata</i>	*	*	*	****	****	****	****	****	****	****	***	***
Kalikala	Kalikali	<i>Hevea brasiliensis</i>	***	***	***	****	****	****	****	****	****	****	****	****
-	Ka-chikache	<i>Seurinega virosa</i>	*	*	*	****	****	****	****	****	****	****	***	***
Dekalo	Dakali	<i>Acacia lahali</i>	****	****	****	****	****	****	****	****	****	****	***	***
Gerigecha	Gerigisha	<i>Grewia villosa</i>	*	*	*	****	****	****	****	****	****	****	***	***
Zinak	Zinaki	<i>Allophylus abyssinicus</i>	*	*	****	****	****	****	****	****	****	****	****	****
Lola	Lelo	<i>Acacia Oerfota</i>	*	*	****	****	****	****	****	****	****	****	****	****
-	Galansa	<i>Acacia albida</i>	*	*	****	****	****	****	****	****	****	****	****	****
Onoki	Onoka	<i>Sarcocephalus latifolius</i>	*	*	****	****	****	****	****	****	****	****	****	****
Omoa	-	<i>Ficus sycomorus</i>	*	*	****	****	****	****	****	****	****	****	****	****
Olopo	-	<i>Piliostigma thonningii</i>	****	****	****	****	****	****	****	****	****	****	****	****
Tulungo	-	<i>Sclerocarya birrea</i>	*	*	*	****	****	****	****	****	****	****	***	***

Table 8: The seasonal dynamic of browse goat feed resources in Hamer and Bena-Tsemay Woreda.

Marks= *: Not Available; **: Low Available; ***: Moderately Available; ****: Highly Available.

Benagna	Hamergna	Scientific	Months in year											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Bokolo	Bokolo	<i>Zea mays (L)</i>	*	*	*	*	*	****	****	***	***	***	*	*
Alaph	Ensi	<i>Sofghum bicolor (L)</i>	*	*	*	*	*	****	****	***	***	***	*	*
Fecha	Ficha	<i>Phaseolus vulgaris (L)</i>	*	*	*	*	*	****	****	***	***	***	*	*
Ayishitaro	-	<i>Phaseolus vulgaris (L)</i>	*	*	*	*	*	****	****	***	***	***	*	*
Badala	-	<i>Phaseolus vulgaris (L)</i>	*	*	*	*	*	****	****	***	***	***	*	*
Dincha	Dinsha	<i>Ipomoea batatas (L)</i>	*	*	*	*	*	****	****	***	***	***	*	*
-	Barga	<i>Eleusine coracana (L)</i>	*	*	*	*	*	****	****	***	***	***	*	*

Table 9: The seasonal dynamic of Crop residues as goat feed resources in Hamer and Bena-Tsemay districts.

****: Months with high Crop residues availability; ***: Months with good Crop residues availability; -*: Months with no Crop residues availability.

Benagna Names	Hamergna Names	Scientific Names	Morphological herbaceous forages parts			
			Leaf	Stem	Seed	Pod
Mara	Mara	<i>Tetrapogon cincroform</i>	*	*		
Kontsala	Kuntsale	<i>Cyperus bulbosus</i>	*			
Turna	Turina	<i>Endigophora spinosis</i>	*	*	*	*
Garant	Garanti	<i>Vernonia natalensis</i>	*	*	*	*
Ganaya	Genya	<i>Tribulus terrestris</i>	*	*	*	*
Gojo	Gojo	<i>Eupherbia tirucalli</i>	*	*	*	*
Erbo	Eribo	<i>Ormocarpum mimosoides</i>	*	*	*	*
Zersi	Zersi	<i>Cynodon dactylon</i>	*	*	*	
Sepety	Sefity	<i>Rhoicissus tridentata</i>	*	*	*	*
Mugr	Mugri	<i>Colotoria enkana</i>	*	*	*	*
Gali	Gali	<i>Tephrosia species</i>	*	*	*	*
Mesta	Metsa	<i>Achentis aspara</i>	*	*	*	*
Gaya Ukuma	Gaya Ukuma	<i>Tribulus terrestris</i>	*	*	*	*
-	Gera	<i>Dovyalis abyssinica</i>	*	*	*	*
-	Ago	<i>Lantana camara</i>	*	*	*	*
-	Buska	<i>Digitaria abyssinica</i>	*	*		
Malo	Melo	<i>Capparis tomentosa</i>	*			
-	Genteta	<i>Cido obata</i>	*	*	*	*
-	Okilibuko	<i>Commilina benghalensis</i>	*	*	*	*
Enku	Eniku	<i>Lablab purpureus</i>	*	*	*	*
Tire	Tiri	<i>Lawsonia inermis</i>	*	*	*	*
Mekela	-	<i>Dovyalis abyssinica</i>	*	*	*	*
Menzo	-	<i>Lantana camara</i>	*	*	*	*
Palik	-	<i>Digitaria abyssinica</i>	*			
Zaki	Zaki	<i>Vaginea unguatum</i>	*	*	*	*

Table 10: List of Morphological parts of herbaceous forages utilized by goats in Hamer and Bena-Tsema Woreda.

Browse plant parts utilized by goats

The browse plant parts that are eaten by the goats in the study areas are presented in table 11. Herders reported that during wet seasons (April to August), goats show a preference for eating leaves over other plant parts, as the leaves are readily accessible, highly palatable and rich in more nutrients. The pastoralists also, reported that the pods and seeds are readily consumed by goats in the study areas at the beginning of dry seasons. During this time most of herbaceous and browse plants disappear from the grazing areas and the goats begin to experience nutrient deficiencies, therefore they feed on pods and seeds. Plant stems are generally only consumed by goats in the study areas towards the end of harsh dry seasons that usually intensify in February, and sometimes extend into mid-March. During this period, the useful parts of most plants (leaves, seed and pods) have disappeared and

pastoralists are often forced to rely only on stem and bark to keep goats alive until rains arrive.

Annual dry matter production for goats

Total estimated annual dry matter production from different land use systems in Hamer and Bena-Tsema are presented in table 12. In Hamer Woreda, the highest contributor to overall dry matter production was estimated to be communal browsing land, whereas in Bena-Tsema Woreda, private browsing areas account for the highest proportion of dry matter. For both districts, it is estimated that the lowest contributor to overall dry matter production for goats is forest/woody land.

Annual dry matter production from crops

The total estimated annual dry matter productions from different major food crops for Hamer and Bena-Tsema are presented

Benagna Names	Hamergna Names	Scientific Names	Morphological herbaceous plant parts			
			Leaf	Stem	Seed	Pod
Mega	Maga	<i>Annona senegalensis</i>	*			
Zurguma	Zuriguma	<i>Avicennia manna</i>	*			
Kenya	Kena	<i>Ekebergia capensis</i>	*			
Zergo	Zergo	<i>Acacia brevispica</i>	*		*	*
Kelansa	Kilansa	<i>Dichro stachys cinerea</i>	*		*	
Dile	Dile	<i>Dichro stachys cinerea</i>	*		*	
Lelo	Lola	<i>Acacia nilotica</i>	*		*	
Jamo	Jamo	<i>Entada abyssinica</i>	*		*	
Ara	Ara	<i>Terminalia brownie fresen</i>	*			
Briza	Baraza	<i>Bridelia micrantha</i>	*			
-	Mudakale	<i>Boscia coriacea</i>	*		*	
Banaki	Banaki	<i>Acacia sieberiene</i>	*	*	*	*
Menzo	Manzo	<i>Brachimia discolor</i>	*			
Moshiko	Moshike	<i>Indigofera spicata spira</i>			*	
Gedake	Gedaki	<i>Dalbemergia melanoxylon</i>	*			
Goleli	Golali	<i>Acacia toritilis</i>	*			*
Tubakey	Tubaki	<i>Rhus vulgaris</i>	*			
-	Dita	<i>Dalbergia sissoo</i>	*			
Sefiti	Seftiy	<i>Bridelia micrantha</i>	*			
Bitsobitso	Bitsobitso	<i>Mytenus ovatus</i>	*			*
Arike	Arke	<i>Acacia sieberiana</i>	*			
Anshali	Anishali	<i>Crotolaria spinosa</i>	*			
shaf	Shafi	<i>Morus alba</i>	*			
Akmba	Akmba	<i>Acokanthera schimper</i>	*			
-	Giri	<i>Calpurnia subdecandara</i>	*			
Wuchembe	Wuchimbe	<i>Pithecellobium dulce</i>	*	*	*	*
-	Sebe	<i>Combretum molle</i>	*		*	
Gelife	Gilifi	<i>Combretum molle</i>	*			
Domoko	Domoko	<i>Belanites aegyptila</i>	*		*	
Pulanti	Pulanti	<i>Acacia seyal</i>	*			
Kufre	Kufri	<i>Albizia lophantha</i>	*	*	*	*
-	Hanshela	<i>Rhoicissus revoilii</i>	*			
-	Genteta	<i>Sida ovata</i>	*			
Chakanti	Chakanti	<i>Acacia brevispica</i>	*	*	*	*
Gergeta	Gergeta	<i>Vitellaria paradoxa</i>	*			
Key	Keyi	<i>Rhus natalensis</i>	*			
-	Gumeza	<i>Commiphora erlangerana</i>	*			
Mekela	Mekela	<i>Grewia tenax</i>	*			
Keja	Kaja	<i>Ekebergia capensis</i>	*	*	*	*
-	Rumb	<i>Delonix regia</i>	*			
-	Gera	<i>Grewia bicolor</i>	*			
Tseleko	Tsaki	<i>Albizia grandibracteata</i>	*	*	*	*

Kalikala	Kalikali	<i>Hevea brasiliensis</i>	*	*	*	*
-	Kachikache	<i>Seurinega virosa</i>	*	*	*	*
Dekalo	Dakali	<i>Acacia lahali</i>	*			
Gerigecha	Gerigisha	<i>Grewia villosa</i>				
Zinak	Zinaki	<i>Allophylus abyssinicus</i>	*	*	*	*
Lola	Lelo	<i>Acacia Oerfota</i>	*	*	*	*
-	Galansa	<i>Acacia albida</i>	*	*	*	*
Onoki	Onoka	<i>Sarcocephalus latifolius</i>	*		*	*
Omoa	-	<i>Ficus sycomorus</i>			*	
Olopo	-	<i>Piliostigma thonningii</i>	*			
Tulungo	-	<i>Sclerocarya birrea</i>	*	*	*	*

Table 11: List of Morphological herbaceous plant parts utilized by goats in Hamer and Bena-Tsemay Woreda.

Land use type	Amount(ha)		Productivity (t/ha)	Total dry matter(t)			
	Hamer	Bena-Tsemay		Hamer	Total DM as %	Bena-Tsemay	Total DM as %
Private browsing	10,759.5	1,182	3	32,278.5	8.9	3,546	54.38
Communal browsing	150,400.2	1,288	2	300,800.40	82.95	2,576	39.51
Road side browsing	7,951.8	77.25	1.8	14,313.24	3.95	139.05	2.13
Fallow land browsing	6,648.7	152	1.5	9,972	2.75	228	3.50
Forest/woody land	7,500	44.75	0.7	5,250	1.45	31.33	0.50
Total	548,673.75	2,744	-	362,614.14	100	6,520.34	100

Table 12: The total estimated annual dry matter productions from different land use system in Hamer and Bena-Tsemay.

table 13. The estimated highest amount of dry matter production for goats in Hamer and Bena-Tsemay Woredas comes from sorghum and the lowest dry matter comes from Finger millet and Banana leaf for Hamer and Bena-Tsemay respectively. Generally, from this study it is observed that higher amount of crop residues is produced from Bena-Tsemay than Hamer. This is because most of communities in Bena-Tsemay Woreda have gradually shifted into crop farming from pastoralism in order to secure self-food and hence higher crop residues have produced than that of Hamer.

Dry matter requirements by goats

According to Livestock offices of Hamer and Bena-Tsemay report, Hamer and Bena-Tsemay Woreda have 2,053,006 and 755,732 live goats population respectively which is equivalent to 205,3000 and 75,573.20 tropical livestock units and need 468,085.37 and 172,306.89 total dry matter per year.

Feed balance for goats in Hamer and Bena-Tsemay

By assuming that dry matter requirement for maintenance of one TLU is 6.25 kg/day, the total annual the maintenance dry matter requirement of goats in Hamer and Bena-Tsemay is about 468,085.37 and 172,306.89 tons respectively. It is estimated that the

dry matter produced in the study Woredas were 373,473.38 and 42,987.24 for Hamer and Bena-Tsemay respectively. Calculation of feed balances for both study areas it reveals deficits of 94,611.99 and 129,373.65 tons of dry matter for Hamer and Bena-Tsemay Woreda respectively. Accordingly, the estimated feed balance sheet for goats in Bena-Tsemay shows higher minimum dry matter deficit than goats reared by Hamer pastoralist which indicated that goats that reared by Bena-Tsemay have been more nutritional severed than goats reared by Hamer pastoralists and this is clearly shows the higher gap between dry matter supply and goats dry matter requirements.

Discussion

Major herbaceous species

Herbaceous forage is the non-woody component of the vegetation, which includes all grass and forbs [11]. In confirmation with our study, Admasu Teferi, *et al.* [4] had reported about 32 species of grasses, three species of legumes, two species of sedges and seven species of other herbaceous plants into study areas that is used as livestock feeds. Moreover, Worku Bedeke and Nigatu L [12] identified that a total of 19 grasses, 1 legume, 2 sedge and 7 other herbaceous plant species which used as livestock feed were identified for Dassench Communities in South Omo Zone.

Crops	Amount(ha)		Productivity/ha	Total dry matter (tons /ha)			
	Hamer	Bena-Tsemay		Hamer	Total DM as %	Bena-Tsemay	Total DM as %
<i>Zea mays (L)</i>	1565	7539	2	3,130	28.82	15,078	41.35
<i>Sorghum bicolor (L)</i>	2769.65	6493	2.5	6,924	63.76	16,232.5	44.52
<i>Teff</i>	-	752	1.5	-	-	1,128	3.09
<i>Eleusine coracana</i>	23.49	-	0.7	16.44	0.15	-	-
<i>Phaseolus vulgaris</i>	657.33	3182	1.2	788.79	7.26	3,818.40	10.47
<i>Cajanus cajan</i>	-	152	0.7	-	-	-	-
Banana Leaf and Stem	-	13	8	-	-	104	0.28
Total	5,015.5	18,131	-	10,859	100	36,466.90	100

Table 13: Estimated dry matter produced from different major crop types grown in Hamer and Bena-Tsemay Woredas.

Major browse forages for goats

Browse plants, which may be trees and shrubs, are the main important component of the forage for goats [13]. Admasu Teferi, *et al.* [4] reported that there were 19 and 29 woody (browse) species used as livestock feeds in Hamer and Bena-Tsemay districts respectively which is lower than the findings from our study. Meanwhile, Worku Bedeke and Nigatu L [12] reported 21 woody (browns) species which have used as livestock feeds for Dassench communities which are lower than identified values from our study.

Major crop residues for goats

Crop residues represent a large part of feed resources, most of which are underutilized in Ethiopia [14]. Crop residues described as roughages become available for livestock feed after crops have been harvested [15]. Goats are able to subsist and make appreciable gains in long dry season with crop residue based diets that compare favourably with conventional concentrate rations [16]. Some of the crop residues and by-products available are potentially good feed resources which degrade readily in the rumen and some however, have shown poor degradability and hence require some treatments before they can contribute to animal nutrition. Berhanu Tekleyohannes, *et al.* [5] report had demonstrated that some agro-pastoral households in Bena-Tsemay and Hamer districts listed crop residues mainly from *Zea mays* (L) and *Sorghum bicolor* harvests as livestock feed resources next to natural pasture from rangeland which is in line with our findings. Similar to findings from our study, Admasu Teferi, *et al.* [4] also reported that the Bena-Tsemay and some of the Hamer pastoralists who live in higher altitude areas where cropping is more prevalent listed maize, sorghum, wheat, teff and barley as supplementary sources of livestock feed for a number of weeks per year during harvesting season.

Herbaceous feed availability to goats

The availability and quality of dry matter from herbaceous feed resources for goats in Ethiopia are not favourable year round. In

most years, any productivity gains made in the wet seasons are totally or partially lost in the dry seasons [17]. Inadequate feed supply is a major cause of dry season productivity declines in goats within study regions [5]. The feed availability within the study areas is also strongly affected by variations in rainfall amount, distribution, and climate change [5,6,18]. The availability of major herbaceous forages for goats has declined from the last five years. Pastoralist and agro pastoralists mentioned that overgrazing, the conversion of browsing land into cropping land and climate change were major shocks that induced declines in the availability of herbaceous goat forage species. The Berhanu Tekleyohannes, *et al.* [5] and Admasu Teferi [4] also reported that frequent droughts, overgrazing and the expansion of cultivation are important determinants in the decrease of herbaceous forage availability within the rangelands in South Omo. Other research reports have indicated that availability and quality of grazing resources in the pastoral areas of Ethiopia vary with altitude, rainfall, soil type, cropping intensity, inappropriate grazing management, rangeland fires and droughts [19-21].

Browse feed resource availability for goat

Along with herbaceous plants, browse species are among the cheapest goat feed resources available to goat producers in Southern Ethiopia as they which are evergreen, high in nutritional value with abundant nutritional and available all year round [21]. Most browse species have the advantage of maintaining their greenness and nutritive value throughout the dry season when herbaceous vegetation has dried out and deteriorated both in quality and quantity. In alignment with previous research reported by Denbela Hidoso, *et al.* [6], the pastoralists reported that dry matter availability of browse species declines during dry seasons and are available in surplus during the rainy seasons. The low dry matter available to goats from browse species in the study areas has been attributed to climate change, the cutting down of browse trees for charcoal, firewood, house construction, fencing and the expansion of cropping

activities. In support to findings from this study, the study reported by Denbela Hidosa, *et al.* [6] shows that during wet seasons, there is surplus biomass production from the open grazing land while during dry seasons, there are frequent reductions in biomass production from the open grazing land due to fluctuation in rainfall which aggravated by the climate variability. Other studies have reported that poor management of rangelands; inappropriate grazing practices, rangeland fires and droughts limit the availability of browse species dry matter for goats [21].

Browse plant parts utilized by goats

Morphological browse parts (leaves, stem, pods and seeds) can provide valuable nutrients to goats [22]. Due to the lengthy dry seasons and highly irregular rainfall patterns within the study areas, very few nutritious grasses persist into the dry seasons and hence trees and shrubs provide an alternative source of energy, protein and nutrients for goats [6]. The study by Samson Hailemariam, *et al.* [22] and Hodgson RJ [23] demonstrated that Acacia pods and leaves are a common feed supplement in many pastoral areas of Africa during dry seasons and this was reflected in the responses provided by pastoralists during the present study. Moreover, Buza-yehu Ayele and Denbela Hidosa [18] reported that Hamer pastoralists supplement new born kids, calves and sick animal with acacia pods and leaves from a range of locally available trees during the dry seasons which supports ideas reported by the pastoralist from this study. Similarly, the Borana pastoralists in Southern Ethiopia have used pods and leave of native leguminous browse trees such as *Acacia tortilis* and *Acacia nilotica* as dry feed resource supplements [24].

Conclusion and Recommendation

The overwhelming majority of goat feed resources within the two study Woredas are derived from browsing lands. These areas are likely to be declining in productivity as a result of climate change, the cutting down of browse trees for charcoal, firewood, house construction, fencing and the expansion of cropping activities. With pastoralist households having such a heavy reliance on this resource it is imperative that policy makers, researchers and development agencies work to address the issue of rangeland degradation. Strategies could include establishing enclosure for optimum durations. Presently, communities within the study areas are only using crop residues as goat feeds during immediately following harvest, with no storage or feed treatment being undertaken. In this regard, it is important to train and advise communities to conserve crop residues during periods of surplus production in the form of silage and hay. In the study areas, dry season feed shortages are critical problem for goat production and hence forage banking should be developed through harvesting the herbage from rangeland at the optimum stage of maturity. Furthermore, results

from this study also indicated that communities have no trends of growing cultivated fodder species for goats. Therefore, it is recommended that the emphasis should be put in planting adaptable cultivated fodder. Similarly, from the forage inventory, it is obvious that herders are not in a position to properly supplement their goat with protein and energy rich feeds sources that might be required the use of nutritious browse trees. Such supplementation could aid in offsetting could production losses associated with dry season declines in the nutritive value of the native grass and browse species.

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