Begait sheep production systems and breeding practices of smallholder farmers in Tigrai, Ethiopia

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Abstract

Reconnaissance tour, focus group discussion and semi-structured interviewwere used to generate the datasetfrom 144 randomly selected small holder Begait sheep ownersin two districts of Tigrairegion, namely Tahtayadyabo and Kaftahumera,Ethiopia to understand Begait sheep production systems and identify breeding practices, breeding objectives, and constraints as a first step towards developing breeding strategies of Begait sheep smallholder farmers in the two districts of Tigrai regional state, northern Ethiopia and analyzed using descriptive statistics of SPSS 2010.The study area was characterized by mixed crop-livestock system where farmers livelihood depends on both crop and livestock production. The overall livestock holding per households (mean ±SE) are 55.69 ±4.88 sheep, 28.36 ±2.43 goats, 9.23 ±1.05 cattle, 9.87 ±1.08 poultry, 1.33±0.11 donkeys, 0.14 ±0.02 camels and 0.39 ±0.19 honey bee; and most farmers in the study area keep sheep primarily as source of income. The main feed sources for sheep in the area were; crop residue (index =0.38), range land (index =0.31), hay (index =0.16), and natural pasture (index =0.14) and majority of the farmers (77.78 %) shelter their sheep in separate housing during the night to prevent from thefts and predators. Breeding was generally uncontrolled. Even though poor practice of controlled breeding in the study area, 99.31% and 87.50 % of the respondents practiced selection for breeding male and females respectively.Color, body size, facial profile, libido and tail size were the most frequently reported traits in selecting breeding Begait rams across the two districts; whereas milk yield, body size, color, tail size and facial profile were mentioned as traits given due emphasis in selecting future Begait breeding ewes. The survey identified several constraints such as disease, feed shortage, water shortage, limitation of grazing land, predator and market demand. It needs special attention on effective management of major constraints to utilize the potential sheep breed and to realize full benefits of a breeding strategy in Begait sheep breed.

Key words: Begait Sheep breed, Breeding objective, Flock, Kaftahumera, Livestock, Tahtayadyabo, Trait.

Introduction

In most developing countries, farmers and pastoralists depend on small ruminants for much of their livelihood, often to a greater extent than on cattle, because of their smaller body size and higher reproductive rate and their adaptation for harsh environment (Helen 2012). Small ruminants are widely distributed and are of great importance as major source of livelihood for smallholder farmers and the landless in rural communities in Ethiopia. However, sheep and goats are kept mainly as secondary investment and require minimal inputs, hence, integration of sheep and goats with crop agriculture usually occur under subsistence conditions on small-scale farmers (Zelealem and Anal 2014). According to Zelealem and Anal (2014), small ruminants are central to the nutrient cycling, and to the efficiency, stability, & sustainability of farming system. At the farm level, small ruminants serve as an investment and insurance due to their high fertility, short generation interval, small feed requirement and adaptability to harsh environment conditions (Dhaba et al 2012).

There has been a positive trend of meat demand in Ethiopia driven by population growth, urbanization and income change. As per Matawork (2016) Sheep and goats are among the major economically important livestock in Ethiopia. It accounts for about 90 % of live animals/meat and 92 % of skin and hide export trade value. They are integral part of livestock keeping in Sub-Saharan Africa that are mainly kept for immediate cash sources, milk, meat, wool, manure, and saving or risk distribution. The amount of small ruminant meat available per person decreased throughout sub Saharan Africa, 0.3% a year suggesting that small ruminant productivity was not keeping up with the Continent's rapid human population growth (ILCA 1990). Therefore, there is an urgend need to improve sheep productivity to meet the protein demand by the ever increasing human population and to improve the livelihoods of poor livestock keepers and alleviate poverty among the rural poor dwellers.

The success of any genetic improvement and conservation programme depends upon the action of livestock keepers who own, utilize and adopt breeds and adapt them to their needs and urgently demanding knowledge and aspiration of local community for better community-based sheep breeding strategy. Further, designing and implementation of community-based breeding programmes require a good understanding of the production system and the alternative importance of the different constraints in the system; clear understanding of selected breeding objectives supported by the farmers and accurate methods of identifying the

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superior genotypes (Baker and Gray 2003). However, there is little or no information on sheep production system, breeding practices and constraints to design community-based breeding strategies for smallholder sheep keepers of Ethiopia in general and for Begaitsheep breeds in particular.

Thispaper reports results of the study undertaken to understand sheep production systemsand identify breeding practices,breeding objectivesand constraints as a first step towards development of breeding strategies for Begait indigenous sheep breeds of smallholders.

Materials and methods

Study Area Overview~~Description of the Study Area~~

The study was conducted in northwestern and western zones of Tigrairegional State, Northern part of Ethiopia in two closely connected districts, namely Tahtayadyabo and Kaftahumera(Fig.1) which are the known the begait potential habitat areas of the region. The area is located some 1300 km northeast of Addis Ababa to Addis Ababa-Humera highway and at about 450 km northeast of Mekelle, the regional capital city. Its geographical location lies within the co-ordinates of 13^0 59'-14^0 43' north latitude and 36^0 26'-37^0 48' east longitude and altitude the area ranges from 675 to 1262 meter above sea level. It has unimodal rainfall pattern with 80 to 85% of the rain falling during summer season. The study districts are found within the lowland part (kola) of the Zones and share the mean annual rainfall and mean annual temperature 448.8mm and 25^{o}C respectively. The people of the study area practice mixed farming systems as means of livelihood (OARD 2016).

These districts are considered ~~believed~~ to be the home tracts for Begait sheep population,with a mixed crop-livestock production system being the primary farming practice.~~and the farming system practiced in the study area is mixed crop-livestock production system~~. Sesame, sorghum, and cotton are the most common crops produced. Livestock are the valuable components of the farming system contributing enormously towards ensuring food security in the study area and it consists of different livestock composition. According to CSA (2017), the study zones had 187685 Cattle, 238950 Sheep, 216341 Goats, 256530 Donkeys, 2144 Mules, 2059194 Poultry, 23262 Camel for north western zone and the corresponding values for western zone were 885100, 117398, 666913, 70469, 1369, 703748 and 9101 respectively. Tahtayadyabo district has a livestock population of 224283 cattle, 80184 sheep, 316359 goats, 23358 donkeys, 248836 poultry, 7197 camels and 2880 honey bee colonies and the

Comment [AM1]: It is better to include detailed genetic and phenotypic information about this breed for non-Ethiopian readers in this section, as well as information on whether there are other breeds of sheep. Most importantly, why focus on this breed of sheep?

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corresponding values for Kaftahumera district were 237307, 182391, 103616, 23529, 112683, 3674 and 2368 respectively (OARD 2016).

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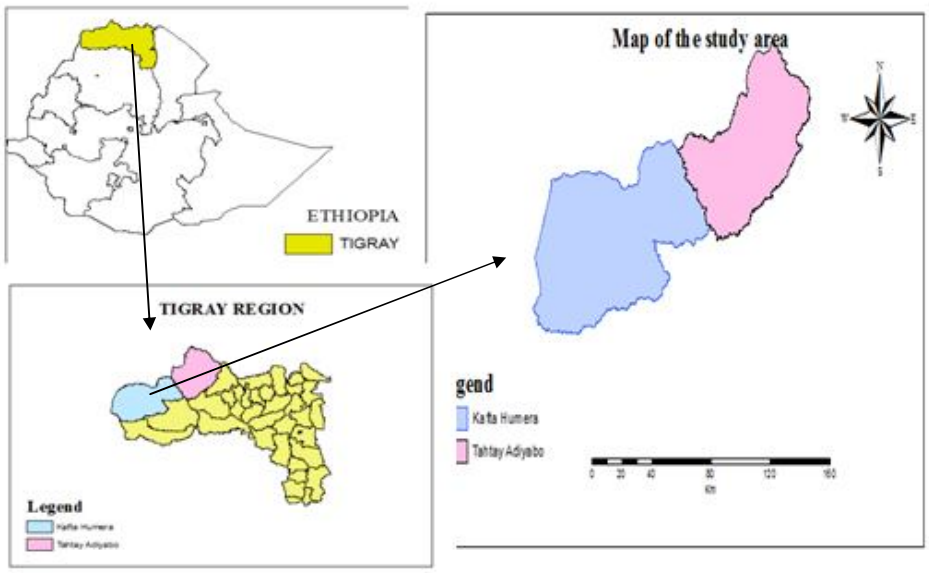

Figure 1. Map of study area

Sampling and Data Collection

~~Sampling Strategy and Data Collection Procedures~~

The study used a multistage purposive sampling technique, focusing on districts with significant sheep production potential. The sample size was determined using the Z-square determination method, considering the total population of households that rear sheep.

~~The sampling method employed for this study was multistage purposive sampling technique, which was based on the potential of sheep production in the districts. Sample size was determined by **Z-square** determination method based on the total population of households that rear sheep~~. Five percent of the total population was used for sample size determination with a total of 144 sample households 72 from each district. As indicated

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in the formula down below the sample determination equation was based on 95% confidence interval and 5% confidence level.

$$n = \left(\frac{z}{m}\right)^2 p(1-p), \qquad n' = \frac{n}{1+n/N}$$

Where:*n* = standard error

z = z value (~~e.g.~~e.g., 1.96 for 95% confidence level)

m = confidence interval, expressed as decimal

p = percentage picking a choice, expressed as decimal (0.05 used for sample size needed)

n' = sample size, and

N = household population (Anon 2016).

From each district, three rural kebeles (total of 6 rural kebeles) were selected based on the sheep ~~population~~ density.Within each kebele, 24 households were chosen through purposive sampling for the semi-structured questionnaire interviews.~~and 24 households per rural kebele were selected through purposive sampling method for the semi structured questionnaire interview~~. A rapid reconnaissance survey was conducted prior to the main survey to identify the distribution of sheep and their production systems~~made prior to the actual survey work to locate the distribution of sheep and their production system~~. Finally, group discussion was made with eight key informants in each rural kebele.

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3.4. Statistical Data Analysis

Descriptive statistics were analyzed using SPSS statistical software (SPSS, 2010), and an index was calculated to rank the breeding purposes according to the following formula:~~The descriptive statistics of SPSS statistical computer software (SPSS, 2010) was used to analyze the survey data and an index was calculated to provide overall ranking of the breeding purpose according to the formula~~:

Rank Index = ∑ (3 X percent of household ranked first + 2 X percent of household ranked second + 1 X percent of household ranked third) given for each purpose divided by∑ (3 X percent of household ranked first + 2 X percent of household ranked second + 1 X percent of

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household ranked third) for all purposes of keeping sheep in the area (Kosgey 2004). Similar indices were calculated for breed selection criteria and production constraints. The effective population size and inbreeding were calculated on the bases of individual household flock size by the formula developed by Wright (1931) as $\Delta F = 1 / (2 N_e)$, Where ΔF = Rate of change in inbreeding $N_e = 4 N_m \times N_f / N_m + N_f$ (N_e = the effective population number) N_m = number of breedable male, N_f = number of breedable female.

Results and discussion

Relative contribution of livestock farming

In both the study districts, livestock and crop production played a vital role in farmers' livelihoods, food security, and income generation ~~both livestock and crop production had vital role in farmer's livelihood, food and income generation~~ (Table 1). ~~Both~~ Livestock and crop production are equally considered major sources of income in the study area. Additionally, off-farm employment, including both self-employment and formal jobs, contributes a portion of the cash earned.

Table 1. Livestock and crop production rank order as food and income source in the study

Description	District								
	Tahtayadyabo (N=72)			Kaftahumera (N=72)			Overall (N=144)		
	R1	R2	I	R1	R2	I	R1	R2	I
HH food source									
Crop production	72	-	0.67	67	5	0.64	139	5	0.66
Livestock	-	67	0.31	5	64	0.34	5	131	0.33
Off farm	-	5	0.02	-	3	0.01		8	0.02
HH cash income source									
Crop production	32	30	0.44	40	25	0.49	72	55	0.46
Livestock production	35	36	0.49	26	38	0.42	61	74	0.45

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Comment [AM4]: How do you divide overall to tow rank???

Comment [AM5]: Explain about the ranking method in the materials and methods section. What was the ranking criteria based on? Was it based on quantity?

Comment [AM6]: What is its unit?

off-farming	5	6	0.07	6	9	0.10	11	15	0.09

Where, N = number of samples, R1 = rank #1, R2 = rank #2, I = rank index**.**

Livestock Ownership ~~holding~~ and species preference offarmers

The result reveals that, sheep have the highest~~exhibit the higher~~ number per household in ~~compari~~compared of~~son to~~ other livestock species. The a~~A~~verage flock size per household of sheep and goatswas the largest of all livestock categoriesin both districts,with sheep leading in both districts, followed by cattle in Tahtayadyabo and poultry in Kaftahumera.~~was the highest of all livestock holding recorded in their respective order followed by cattle in Tahtayadyabo and poultry in Kaftahumera districts~~(Table 2). This implies sheep and goat were mainly dominant species in the study districts over other livestock and small ruminant production is being given higher emphasis nowadays in the area. The reason might be small ruminants have lower feed and capital requirements compared to the larger species and are therefore more suitable for producers with minimal husbandry conditions. As the farmers, even within the small ruminant they prefer sheep rather than goat due to easy to handle in limited land and their higher fertility rate of Begait sheep compared to Begait goat. This result of livestock holding per household is comparable with the result of Hagos et al (2017), in similar area. The Begait sheep flock size of 55.69 ±4.88 per household was in close agreement with that of Black head Somali sheep breed in Somalia regional state (Solomon et al 2008). Except poultry, there was significant difference between districts in livestock holding in all livestock species. The difference might be due to feed resource availability, since the flock/herd size varied with availability of feed resources due to difference in marginal land holding for livestock. Farmers in Kaftahumera district kept significantly ($P < 0.001$) larger sheep and goat flock per households (85.92 and 37.29 respectively) than the Tahtayadyabo district (25.47 and 19.43) irrespective of variability in the household. The figure of sheep holding per household in Kaftahumera is comparable with the result of large scale farmers in Gumuz and Rutana sheep breeds in north western lowlands of Amhara Region, Ethiopia (Dagnew et al 2017). The reverse is true in case of cattle, donkey and camel species, which is higher ($p<0.01$) in Tahtayadyabo district. As the farmers of the area, this is due to the market demand difference of the two districts; in Tahtayadyabo large animals has higher market demand where as in Kaftahumera small ruminants has higher market demand.

Table 2. Livestock holding (Mean ±SE) and species composition of households across districts in the study area.

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Comment [AM7]: Please discus more about that. What is the difference in keeping index of sheep or other domestic animals?
Culture?
Climate?
Breeding knowledge?

livestock specie	District			Test	
	Tahtayadyabo (N=72)	Kaftahumera (N=72)	Over all (N=144)	~~F value~~	P value
Sheep	25.47 [b] ±1.67	85.92 [a] ±8.22	55.69±4.88	~~51.83~~	<.0001
Goats	19.43[b] ±2.13	37.29 [a] ±4.12	28.36±2.43	~~14.79~~	0.0002
Cattle	12.42[a] ± 1.36	6.04 [b] ±1.52	9.23 ±1.05	~~9.70~~	0.0022
Poultry	8.03[a] ±0.95	11.71[a] ±1.93	9.87±1.08	~~2.92~~	0.0898
Donkeys	1.79[a] ±0.17	0.88 [b] ±0.13	1.33±0.11	~~17.62~~	<.0001
Camels	0.24[a] ±0.05	0.04[b] ±0.02	0.14 ±0.02	~~12.19~~	0.0006
Honey bee	0.78[a] ±0.39	0.00[b] ±0.00	0.39 ±0.19	~~3.93~~	0.0493

N = number of samples, Means within column with different superscripts differ significantly~~vary~~ at α

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The rank of farmers for livestock species commonly reared in the study area was sheep, goat, cattle and poultry in order of their importance with their respective index value of 0.42, 0.32 0.18 and 0.06 respectively (Table 3). The main reason of farmers for the preference of small ruminants than large ruminants is due to feed and water shortage and extended drought period in the area. The study area is known for its moisture scarce and comprehensive drought period. In addition, the higher proportion of sheep and goat as compared to cattle, might be since sheep and goat can thrive well under adverse conditions (feed shortages and drought) while cattle are considered more sensitive to feed shortages and this finding is supported bythe report of Alefe (2016) in Shabelle zone.

Table 3. Ranked livestock species according to their importance of the study area.

Species	District											
	Tahtayadyabo (N=72)				Kaftahumera (N=72)				Overall (N=144)			
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
Sheep	43	20	9	0.41	51	16	1	0.43	94	36	10	0.42
Goat	25	33	4	0.34	12	42	13	0.31	37	75	17	0.32
Cattle	2	12	41	0.16	7	10	43	0.19	9	22	84	0.18
Poultry	2	5	12	0.06	2	4	8	0.05	4	9	20	0.06
Donkey	-	-	-	0.00	-	-	-	0.00	-	-	-	0.00
Camel	-	-	-	0.00	-	-	2	0.00	-	-	2	0.00
Honey bee	-	-	-	0.00	-	-	-	0.00	-	-	-	0.00

Non-selective	-	2	6	0.02	-	-	5	0.01	-	2	11	0.02

Where, N = number of samples, R1 = rank #1, R2 = rank #2, R3 = rank #3, I = rank index**.**

Begait Sheep Flock Structure and Strains~~Begait sheep breed flock structure and strains composition~~

~~The study reveals that~~results showed that, there were hitherto unknown strains (Barka sheep, Gerej sheep and Hassan sheep) within the Begait sheep population in the area but Gerej and Barka were found in large number. Farmers differentiate the three different sheep strains by their morphology and color. Thus, Barka sheep have long leg and ear, and mostly plain white in color; Gerej are known by their unique color of white with black spotted in their terminal parts, especially leg, mouth and ears, whereas Hassan ~~are~~is known by their very short ear, red color and compacted body conformation. ~~Overall~~Overall, about 65.28%, of the sampled households kept Barka sheep only, 29.17% both Barka and Gerej and 5.55% all the breeds (Barka, Gerej and Hassan) together. But there was significant ($\chi 2 = 0.64$, $P<0.001$) difference among districts in the sheep population proportion.

In Tahtayadyabo district the proportion of farmer's ownership was Barka 91.66%, Gerej 5.56% and Hassan 2.78%, whereas in Kaftahumera district the corresponding proportion was 38.89%, 52.78% and 8.33%, this might be due to source of entry route of these different strains getting access. As the farmer's response about the origin of these Begait strains, the entry rout of Barka sheep is from Eritrea Gash barka, whereas the Gerej from Sudan but the Hassan breed has no clear-cut origin identified, it might be the cross breed of the two strains.

According to shabait (2012) the Barka type of the western lowlands zone is the most commonly known type of sheep in Eritrea. It is long thin tailed and the body weight ranges from 42 to 47 Kg. From observation and interviewed farmers Gerej sheep has a unique characteristic of white color with black patchy and this sheep appears like Sudanese sheep breed. Farmers preferred to rear Gerej sheep than the other two sheep strains because of its drought resistance, faster growth and better twining rate but they are not accessible in Tahtayadyabo district.

The sheep flocks were composed of all age and sex group but breeding ewes took the largest portion (29.26 ±3.08) with highly significantly ($P<0.001$) larger in Kaftahumera district (45.72 ±5.46) than Tahtayadyabo district (12.79 ±0.97) because, there is a direct relationship to the flock size of farmers which was higher in Kaftahumera than that of

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Tahtayadyabodistrict. The average flock size identified by age and sex group in this study was consistent with sheep flock structure reported for north Wollo sheep (Mohammed et al 2014a) and Gumz and Rutana sheep (Dagnewet al 2017) in north Gondar zone, but it is higher than other sheep breeds in the Tigray region (Zelealem and Anal 2014). Except castrates, in all age and sex groups of sheep the higher number was in Kaftahumera district. The very small number of castrates, 0.03 ±0.02 in Tahtayadyabo district and 0.01 ±0.01 in Kaftahumera district indicates that, castration practice for sheep was not common in the areas and has no significant difference between districts (P> 0.05). Small number is recorded in ram age between 6 months and one year old next to breeding rams with an overall mean of 2.35±0.35. The main reason of this small might be farmers' sale to market when they reach in the age between 6 months and one year because this age is the market age of Begait sheep in the study area. Thus, in Begait sheep the market weight of about 30 kg could attain when they are in the age of six months and above and farmers in the area sale their sheep at this age. This also uses farmers as culling method when they are not selected for breeding because this age is the age at first mating of Begait sheep.

Table 4. Sheep flock size and structures in the study area

Animal age and sex group	**District**			**Test**	
	Tahtayadyabo	**Kaftahumera**	**Over all**	**F value**	**P value**
	Mean ±SE	**Mean ±SE**	**Mean ±SE**		
Ram lambs (less than 6 months old)	2.99 ±0.34[a]	16.89 ±2.25[b]	9.94 ± 1.27	37.10	<.0001
Rams (6-12 months old)	1.28 ±0.22 [a]	3.43 ±0.65 [b]	2.35±0.35	9.60	0.0023
Ewe lambs (less than 6 months old)	3.94 ±0.36[a]	20.10 ±2.65[b]	12.02±1.49	36.31	<.0001
Ewes (6-12 months old)	5.26 ±0.71[a]	18.08 ±2.75[b]	11.67±1.51	20.34	<.0001
Breeding ewes (older than 1 year)	12.79 ±0.97[a]	45.72 ±5.46[b]	29.26±3.08	35.26	<.0001
Breeding ram (older than 1 year)	1.22 ±0.08[a]	2.03 ±0.24[b]	1.63 ±0.13	9.86	0.0021
Castrates	0.03 ±0.02[a]	0.01 ±0.01[a]	0.02 ±0.01	0.34	0.5628

Means within row with different superscripts vary at α =0.05

Effective population size and Inbreeding Levels~~level of inbreeding~~inBegait sheep

Effective population size and rate of inbreeding coefficient of sheep population in the study area are indicated in Table 5. Majority of the farmers (83.33%) in the study area herded their household flock separately without mixing with other flocks. Hence effective population size and rate of inbreeding in this study were calculated. As indicated in Table 10, the overall N_e and ΔF for Begait sheep were 6.18 and 0.081, respectively. The figure of inbreeding coefficient was higher in Tahtayadyabo district (0.112) than Kaftahumera district (0.064). In case of Kaftahumera the level of inbreeding was almost equal to the maximum acceptable level of 0.063 (Armstrong 2006). Overall average ram to ewe ratio was 1:18, however, this was highly variable among districts (1:10 in Tahtayadyabo and 1:22 in Kaftahumera), irrespective of flock size. The ram to ewe ratio in the study area was higher than the recommended ratio for mature rams in natural mating in tropics which is 1:35 to 1:50 (Ponzoni, 1992) but comparable with the ram to ewe ratio in Hazaragie sheep (Musaviet al 2013). This higher figure of ram to ewe ratio indicates there is low level of inbreeding in the area, because increasing the sire to dam ratio is a simple way to avoid inbreeding in breeding schemes of small size, with very little compromise towards genetic gain or even an increase in the longer time.

Due to small number of ~~male~~males to female ratio (1:10) and small number of effective population size (4:46) in Tahtayadyabo district, rate of inbreeding was higher. Hence, to reduce inbreeding in the successive generation, either effective population size should be increased per household or communal flocking should be practiced. In this regard, the study Jaitner et al (2001) explained that communal flocking practices of the sheep owners in sheep production allows breeding females to mix with males from other flocks and this could minimize the risk of inbreeding. Besides, inbreeding can be minimized by early castration of males related with ewes in the same flock, rotational use of breeding males, by and increasing the effective population size.

Table 5. Effective population size and level of inbreeding for Begait sheep flocks in the study area when flocks are not mixed.

District	N_m	N_f	N_e	ΔF
Tahtayadyabo	1.22	12.79	4.46	0.112
Kaftahumera	2.03	45.72	7.78	0.064

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Comment [AM11]: You need explain about method analysis in material and method section clearly.

Overall	1.63	29.26	6.18	0.081

Where, N_e = effective population size, N_m = number of breeding males and N_f= number of breeding females, ΔF = level of inbreeding.

BegaitSheep production objectives

Purposes of keeping Begaitsheep flock in the study area are shown in Table 6. This study shows that most farmers in both districts keep sheep primarily as source of income (overall index = 0.46) followed by home meat consumption and insurance risk (index = 0.16) and this finding was supported byGornas and Hussein (2012) under tropical environmental conditions, sheep are raised primarily for meat, although milk is also importantand Mohammed et al (2014a), the primary reason for keeping sheep in Habru district was to derive income with an index value of 0.42. This finding also agreed with the report of Amare et al (2012) in similar study area.

Multiple functions were particularly important in low and medium input production environments but most of the farmers keep sheep for immediate cash needs to solve their financial problems through sale of live animals. Though, Begait sheep are potential in milk yield, none of the respondents mentioned keeping sheep for milk production, which might be associated with cultural taboo against the use of sheep milk for consumption, but the sheep herders milk their sheep in the field for direct consumption.

Table 6. Purpose of keeping Begait sheep flock in the study area.

Description	**Districts (N=144)**											
	Tahtayadyabo				**Kaftahumera**				**Overall**			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
For sale	59	11	-	0.46	55	14	3	0.45	114	25	3	0.46
For home meat conception	-	18	26	0.14	5	22	17	0.18	5			0.16
For savings	5	6	13	0.09	1	22	15	0.14	5	40	43	0.12
For insurance	3	28	13	0.18	7	13	17	0.15	6	28	28	0.16
For manure	5	8	19	0.12	2	1	18	0.06	10	41	30	0.09
For ceremonies	-	1	1	0.01	-	-	-	0.00	7	9	37	0.00
For prestige	-	-	-	0.00	2	-	2	0.02		1	1	0.01

Where, N = number of samples, R1 = rank #1, R2 = rank #2, R3 = rank #3, I = rank index**.**

Husbandry and management of Begaitsheep

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Comment [AM12]: How did you collect initial data for this? Provide the method in material and methods section.

Comment [AM13]: In my opinion, from this point onward, the content should either be presented in a separate article or all aspects should be examined more briefly. Until now, you were discussing the conditions of livestock distribution, and suddenly you addressed the category of breed breeding in detail, which may cause confusion and reduce the reader's motivation.

Flocking practice

The major type of herding management in the surveyed areas was free grazing. In Tahtayadyabo district majority of sheep owner farmers herded their animals during the rainy season, whereas in Kaftahumera district practiced year-round indicating that, there is higher emphasis for sheep management in Kaftahumera than that of Tahtayadyabo district. The result reveals, majority of the farmers (83.33%) were herded individual flocks by their own shepherds without mixing with other flocks in the communities with variations among districts and between farmers (Table 7). Lambs were normally herded separately (74.31%) from the flock and lactating ewes up to 1-2-months to prevent continuous suckling by lambs during grazing not to disturb ewes and to save lambs from predates and this result is in line with the Menz sheep breed (Tesfaye 2008). In the study area, about 59.72% of the Begait sheep owners flock their sheep with goats, 31.25% herded them separately and 9.03% herded mixing together all livestock species due to the high labor demand for other activities and restricted location for grazing. Tethering was not a common practice in both the study districts and the main reason might be the feeding system, almost all (100%) of the respondents manage their sheep in free grazing system.

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Table 7. Sheep flock herding practices across the study districts.

Sheep flocking	**District**					
	Tahtayadyabo		**Kaftahumera**		**Overall**	
	N	**%**	**N**	**%**	**N**	**%**
Flocking type:						
household run as a flock	54	75.00	66	91.67	120	83.33
more than one household run as a flock	18	25.00	6	8.33	24	16.66
Flock herding:						
all livestock species together	11	15.28	2	2.78	13	9.03
sheep and goat	26	36.11	60	83.33	86	59.72
Sheep alone	35	48.61	10	13.89	45	31.25
Tethered	-	-	-	-	-	-

Where, N = number of samples

Feeding management

Major Begaitsheep feed resources

The ranks of major feed resource for sheep in the study across districts are summarized in (Table 8).The quantity and quality of feed resources available for animals primarily depends upon the climatic and seasonal factors (Alemayehu et al 2015). Feed resources commonly used by farmers in the study area were; crop residue (index =0.38), range land (index =0.31), hay (index =0.16), and natural pasture (index =0.14). Range land was the major feed source in rainy season across all the studied districts whereas crop residue in dry season mainly sorghum and sesame crop residues and crop aftermath. In addition to the grassing, in range lands mekie (26.39%), gaba (21.53%), gonok (15.97%) and chea (13.89 %) were the major fodder tree plant species for sheep in the study area especially in the beginning of rainy season. There were also other plant species like kenteb, hansse, akuma, tsara and zibe had contribution in sheep feeding but in limited availability in the area. There was no improved forage introduced in the sheep feeding system in both districts and similar finding was reported in (Zelealem and Anal 2014) in the similar region.

Across the two districts nearly all of respondents (94.44%) were identified that there was seasonal fluctuation in feed availability andthere is high feed resource availability in wet season but with extended drought period. Majority of the sheep farmers (93.75%) stated that, their sheep face feed shortage from the end of March up to the beginning of June even forage trees shade their leaves in these months. To cope with feed shortage, farmers provide supplements such as grains, crop-residues, tree leaves, and local brewery by-products.

The major supplementary feeds were crop aftermath, sorghum grain and local brewery by-product (hatela) and in rear farmers sesame cake. There was also supplementation of common salt usually during the wet season. The use of common salt (mineral supplementation) as supplement for sheep was well recognized and practiced by majority of farmers in the study districts and similar practice was reported in Konta sheep farmers (Alemayehu et al 2015). However, none of the respondents reported the use of conventional supplements and improved forages.

Table 8. Major feed types in the study area

Feed resources	**District**											
	Tahtayadyabo (N=72)				**Kaftahumera (N=72)**				**Overall (N=144)**			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
range land	41	14	8	0.37	26	17	19	0.30	58	31	30	0.31

crop residues	31	36	7	0.40	19	44	15	0.37	50	80	22	0.38
Natural pasture	-	3	15	0.05	17	11	-	0.17	26	14	15	0.14
Hay	-	19	33	0.16	10	-	35	0.15	10	19	68	0.16
fallow land				0.02				0.00				0.01
Concentrate	-	-	9	0.00	-	-	-	0.01			9	0.00

Where, N = number of samples, R1 = rank #1, R2 = rank #2, R3 = rank #3, I = rank index**.**

Crop residues as Begaitsheep feed

The major crop residues used as feed source for sheep in the study area were sorghum residue, sesame residue, and maize residue and chickpea residues in their order of importance. But the rank of crop residues used as feed resource for sheep varies among districts due to the difference in common cultivated crops in the districts. Chickpea residue (index=0.26) was the major crop residue in Tahtayadyabo district next to sorghum residue (index=0.45), which farmers used as feed for sheep especially in dry season where as in Kaftahumera district sesame is the 2nd crop residue

.

Table 9. Ranked Crop residues according to their importance

Crop residue	**District**											
	Tahtayadyabo (N= 72)				**Kaftahumera (N=72)**				**Overall (N=144)**			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Sorghum	54	16	2	0.45	65	8	-	0.49	119	24	2	0.48
Sesame	3	5	-	0.04	2	62	-	0.30	5	62	-	0.17
Maize	3	5	35	0.13	-	-	69	0.16	3	5	104	0.14
Millet	7	12	6	0.12	5	-	-	0.03	12	12	6	0.08
chick pea	5	34	29	0.26	-	2	3	0.02	5	36	32	0.14

Where, N = number of samples, R1 = rank #1, R2 = rank #2, R3 = rank #3, I = rank index**.**

Watering distance

It was found that during the dry season 30.56% and 44.44% of household farmers in Tahtayadyabo and Kaftahumera area respectively, have access to water within 1km distance and 59.72% and 22.22% of households in that order should walk over 1 km but within 5km distance to find water for their sheep. However, the distance which animals travel to get water

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decreases in wet season due to the access of rain water. This result is in line with the result of Zulu sheep in South Africa (Bafowethu 2012). The results revealed that livestock water accessibility is better in Tahtayadyabo areas as compared with Kaftahumera areas.

Table 10. Watering distance (Km) covered by farmers (%) for sheep in the study area

Distance to the nearest watering point	District					
	Tahtayadyabo (N=72)		Kaftahumera (N=72)		Over all (N=144)	
	WS	DS	WS	DS	WS	DS
<1 km	63.89	30.56	75.00	44.44	69.44	37.50
1-5 km	33.33	59.72	18.06	22.22	25.69	40.97
6-10 km	2.78	6.94	6.94	4.17	4.86	5.56
>10km	-	2.78	-	29.17	-	15.97

Where, N = number of samples, WS = wet season, DS = dry season

Selection and breeding practices in Begait sheep breed

Mating was predominantly natural, uncontrolled and no respondents reported controlled breeding in this study. Out of the total farmers interviewed, about 88.89% kept their own breeding ram and there was no significant difference ($\chi 2$= 0.1326, P>0.05). Out of the 88.89% of households which had own breeding ram, 34.72% of them had two and above breeding rams based on their flock size and the remaining (54.17%) households had a single ram in their flock. For those farmers, who did not have their own (11.11%) breeding rams in their flocks, they got the service from neighbors or from grazing fields at random. The majority (65.28 %) of breeding rams for farmers in Kaftahumera district were originated from own flock and the remaining were purchased from market. Likewise, for Tahtayadyabo district, about 52.78 % of the rams were born in their own flock and the remaining were purchased from market. Breeding rams were kept with an average of 5.04 ±1.39 years per flock in the study area with the range from 2 to 10 years in Tahtayadyabo district and from 1 to 8 years in Kaftahumera district. The farmers rearing one breeding ram in flock for longer period indicated lack of awareness of inbreeding in their flocks because when rams kept in the flock for longer time they could mate with their own daughters, causing inbreeding depression. This was supported byRegina et al (2016), mating with relatives occurs commonly in small populations and can result in a decline in offspring performance (ideally measured as fitness) known as inbreeding depression. Ram exchange between farmers was not a common practice in the study area, this also other source of inbreeding in the breed.

Trait preference

Trait preferences for selection of sheep in the flock are useful to make better informed decisions in developing interventions to improve the contribution of sheep for livelihoods of their keepers. Selection of parents of the next generation in both the rams and ewes was very common among the sampled farmers (Tables 11 and 12). Farmers in both study areas were well experienced in selection of future breeding ewes and rams from own flock of sheep. ~~Overall~~Overall, 99.31 and 87.50 % of the farmers practiced selection for breeding male and females respectively, which is comparable to the report of Mohammed et al (2014b) in north Wollo. Males were selected on an average at the age of 5.94 ±2.91 months with significant difference between districts (P<001) and the corresponding means for females in both districts were 7.07 ± 3.88 and 6.96 ± 3.20 months. Traits like color, body size, tail length, facial profile and appearance were considered in their order of importance to select breeding rams as important traits in Tahtayadyabo district with ranking index values of 0.23, 0.20, 0.20, 0.12 and 0.11, respectively. However, in Kaftahumera district tail length, body size, color, appearance and libido were important traits in the corresponding orders with ranking index values of 0.23, 0.19, 0.16, 0.11 and 0.08, respectively.

White coat color, large body size, long tail, convex facial profile and good body conformation were the most highly rated traits in selecting breeding rams by most of the farmers in both districts. As the farmers, these higher ranked traits used as criteria to differentiate pure breed from crossed with other neighboring breeds because white color, large body size, long and thin tail and markedly convex facial profile are the typical features of pure Begait sheep breed. Unlike Tahtayadyabo district, farmers in Kaftahumera district considered libido as selection criteria for breeding rams indicates that they have better awareness in breeding management. Lambing interval, mothering ability, age at first lambing and twining rate were also considered in selecting breeding females in both districts. Trait preference of farmers in the study is inline in the results in the four (Afar, Bonga, Horro and Menz) Ethiopian breeds (Dugumaet al 2011). Results indicated that producers' trait preferences were heterogeneous except for facial profile in rams and milk yield in ewes, where nearly homogeneous preferences were investigated but the elicited measurable objective traits are important to design community-based Begait sheep breeding plans in their production environments.

Table 11. Trait preferences of the community for the selection of male sheep

Trait	**District**

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	Tahtayadyabo (N =72)				Kaftahumera (N =72)				Overall (N =144)			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Appearance	7	11	3	0.11	8	10	6	0.11	15	21	9	0.11
Color	23	8	16	0.23	5	9	24	0.16	28	17	40	0.20
tail length	11	18	17	0.20	23	15	9	0.23	34	33	26	0.21
body size	11	20	12	0.20	20	9	9	0.19	31	29	21	0.19
facial profile	8	10	7	0.12	2	1	1	0.03	10	11	8	0.07
Pedigree	5	3	8	0.06	7		3	0.05	12	3	11	0.06
Libido	2	-	3	0.03	1	17	-	0.08	3	17	3	0.05
Testicle size	4	-	-	0.02	-	1	12	0.05	4	1	12	0.04
ear length	1	-	-	0.01	2	-	3	0.02	3	-	3	0.01
Fast growth	-	1	6	0.02	-	-	1	0.00	-	1	7	0.01
Hair type	-	1	-	0.01	1	3	3	0.04	1	4	3	0.02
Lamb survival	-	-	-	0.00	2	4	-	0.03	2	4	-	0.01
Drought resistance	-	-	-	0.00	-	2	-	0.01	-	2	-	0.00
Non-selective	-	-	-	0.00	1	1	1	0.01	1	1	1	0.01

Where, N = number of samples, R1 = rank #1, R2 = rank #2, R3 = rank #3, I = rank index**.**

Table 12. Trait preferences of the community for the selection of female sheep

Trait	**Districts**											
	Tahtayadyabo (N=72)				**Kaftahumera (N=72)**				**Overall (n=72)**			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Appearance	3	24	3	0.13	3	17	6	0.11	6	41	9	0.12
Color	16	8	18	0.19	8	15	5	0.14	24	23	23	0.16
tail length	12	11	5	0.14	18	2	4	0.13	30	13	9	0.14
body size	2	9	12	0.11	6	9	18	0.13	8	18	30	0.12
facial profile	12	-	7	0.09	-	2	-	0.02	12	2	7	0.05
Pedigree	-	-	-	0.00	-	-	-	0.00	-	-	-	0.01
Milk yield	13	6	9	0.14	19	5	20	0.18	32	11	29	0.16
Lamb survival	-	1	-	0.00	4	-	-	0.02	4	1	-	0.01
ear length	2	-	-	0.01	1	1	-	0.01	3	1	-	0.01
Fast growth		1	4	0.02	-	1	2	0.01	1	2	6	0.02
Hair type	-	-	3	0.01	-	1	1	0.03		1	4	0.01
Udder size	-	1	-	0.01	2	-	-	0.01	2	1	-	0.02
Drought resistance	-	-	-	0.00	3	1	-	0.02	3	1	-	0.01

Mothering ability	-	-	-	0.00	-	-	-	0.00	-	-	-	0.00
Litter size	-	-	-	0.00	1	5	9	0.05	1	5	9	0.03
Lambing interval	-	-	-	0.00	-	6	-	0.03	6	-	-	0.02
Continued…												
Age at first maturing	-	-	-	0.00	-	-	-	0.01	-	-	-	0.00
Non-selective	11	11	11	0.24	7	7	7	0.01	18	18	18	0.12

Where, N = number of samples, R1 = rank #1, R2 = rank #2, R3 = rank #3, I = rank index.

BegaitSheep production constraints

Identifying and prioritizing major constraints of sheep production is a basis to bring solutions for obstruction in sheep genetic improvement and is essential in planning suitable breeding program. The major production constraints in the study area were disease, feed shortage, water problems, and limitation of grazing land, predator, market demand, and lack of veterinary service, labor shortage and drought in their order of importance (Table. 13). This result is an agreement with the result of Abera (2017) in east Gojam sheep. There was a significant difference among districts in the constraints ($\chi 2 = 0.223$, $P< 0.01$). Seasonal feed shortage was the prior problem in Tahtayadyabo district (index=0.26) followed by disease (index= 0.24) while shortage of grazing land was for Kaftahumeradistrict (index= 0.31) followed by disease (index= 0.16). Previous study of Zelealem and Anal (2014) in the same area supported that feed shortage especially in the long dry season is critical problem in the production system.

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Disease prevalence is often regarded to be major limiting factors for the productivity of sheep raised by most rural farmers in the tropics and sub tropics and the farmers are not able to achieve the expected amount of benefit from sheep production (Dagnew et al 2017). It was identified that, the economically important diseases which affect Begait sheep productivity in the present study area were verminous pneumonia, coenuruses, pasturellosis and sheep and goat pox. From the respondents, veterinary service is also relatively poor. Vaccination was provided for 92.36% of the respondents but for few common diseases and the service was provided only during seasonal outbreak. Farmers indicated that, the problem was not only the access to veterinary service but ineffectiveness of vaccines and inefficacy of drugs also a problem in the study area which forced farmers especially around borders to use outside

sourced animal drugs from Sudan private drug suppliers. This might be due to the disease-causing agents develop resistance to drugs through time.

Table 13. Major sheep production constraints in the study area.

Constraint	District											
	Tahtayadyabo (N = 72)				Kaftahumera (N = 72)				Overall N = 144)			
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
Feed shortage	18	21	25	0.26	5	18	8	0.13	23	39	33	0.19
Diseases	19	28	7	0.24	19	12	2	0.16	38	40	9	0.20
Market demand	5	-	5	0.04	5	4	7	0.06	10	4	12	0.06
Labor shortage	3	4	-	0.03	2	2		0.02	5	6	-	0.03
Veterinary service	4	-	-	0.02	1	3	17	0.07	5	3	17	0.04
Predator	11	9	5	0.12		2		0.01	11	11	5	0.07
grazing land	8	3	6	0.08	40	19	3	0.31	48	22	9	0.20
Drought	4	-	-9	0.02	-	-	1	0	4	-	1	0.01
Water shortage	-	7	2	0.04		9	2	0.04	-	16	4	0.04
Theft	-	-	-	0	-	-	1	0.02	-	-	1	0.01
Urbanization	-	-	-	0	-	1	-	0	-	1	-	0
Extension service	-	-	-	0	-	-	2	0.01	-	-	2	0
Un identified	-	-	22	0.13	-	2	29	0.16	-	2	51	0.15

Where, N = number of samples, R1 = rank #1, R2 = rank #2, R3 = rank #3, I = rank index**.**

Conclusion and recommendation

The natural breeding tract of Begait sheep encompasses mainly the lowlands of north western and western Zones of Tigri with variation in the relative proportion of the breed among flocks.The area is known not only by its potential of Begait sheep population, but also goat and cattle species, with high hitherto unknown various genetic strains within the species and livestock farming has equal consideration with crop cultivation as a major source of livelihood income.Begait sheep was predominant species and larger flock size than other parts of the country ~~was~~were obtained in the area, their contribution as income source was more than any other livestock farming activities makes the breed of paramount importance in the livelihood of the community. The breed is relatively promising in production and reproduction potential of diversified strains resulting in high litter size, early maturity, short lambing interval and high milk yield. However, its genetic integrity is highly threatened due to lack of designed breeding program and by neighboring sheep introgression results in genetic dilution and numeric scarcity. To halt this situation and to utilize this unique and

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potential sheep breed for food and agriculture production, there is urgent need of planning a community-driven and government-supported conservation and breed improvement program. To explore the genetic architecture of this potential sheep breed, it is recommending an in depth extensive research study of the three sub populations (Barka, Gerej and Hassan) of Begait sheep especially under on-station and molecular characterization.

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