

**Original Article**

Describing the Traditional Breeding Practices for Improvement of Genetics of Indigenous Goat Populations in South Gondar, Ethiopia

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ABSTRACT

The study was conducted to describe the breeding objectives, selection criteria, and breeding practices for improvement of genetics of indigenous goat populations in South Gondar. To this effect, 3 districts (Farta, Fogera, and Libokemkem) were selected purposely based on distribution of goat population. Data were collected from 153 randomly selected households and gathered through semi-structured questionnaires, focus group discussions, and field observations. The results indicated that the overall mean of young bucks and does was 7.9% and 10.5%, respectively. The mean number of breeding does per household was 4.55, 5.12, and 5.8 in Farta, Fogera, and Libo-kemkem districts, respectively. The average flock size per household for Fogera, Farta, and Libokemkem was 9.2, 10.5, and 11.7 with an overall average of 10.5 goats. Income generation, meat consumption, and saving ranked first, second and third, respectively for the reason of goat rearing in all districts. About 62.7 % of the respondents owned breeding bucks of which 70.8 % of them were born in the flock. The overall selection criteria of bucks were early maturity, coat color, and appearance with index values of 0.22, 0.2, and 0.19, respectively. Selection criteria of does were appearance, sexual maturity, and litter size with index values of 0.2, 0.19 and 0.14, respectively. About 95% of the households exercise uncontrolled mating. The results

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concluded that breeding does in south Gondar represented the largest proportion of goats and covered 49.8% of the total population of goats followed by kids of both sexes. Goat breeding practiced in the study area was traditional, keeping them primarily for income generation. The breeding system of the goat was characterized by uncontrolled mating which would lead to the occurrence of inbreeding depression in small flocks.

Keywords: breeding practices, mating, indigenous goat, traditional breeding, selection, South Gondar

INTRODUCTION

In Ethiopia, there are 32.73 million goats (CSA, 2018) which are kept for milk and meat, mainly for family consumption, and inhabit a wide range of environments, extending from tropical to cool temperate climates (Dea *et al.*, 2019). They can survive and reproduce in harsh environmental conditions and on poor-quality fibrous feeds. They have a high reproductive performance and are drought resistant as compared to cattle (Peacock, 2005). They can utilize a wide variety of plant species and thus complementary to cattle and camel. Flock sizes of goat population are greater in the lowland mixed crop-livestock and pastoral and agro-pastoral production systems (Gizaw *et al.*, 2010). The efforts to improve the productivity of indigenous goats are very little as compared to the concerns given to other livestock species such as cattle and sheep.

In contrary to the wide distribution and large size of the Ethiopian goat populations, their productivity per unit is relatively low (Befikadu and Kiflay, 2015). For example, carcass weight produced from yearling goat in Ethiopia is only 8.5 kg (FAO, 2004; Hirpa and Abebe, 2008). The poor performance of local goats might be attributed to different factors such as poor quality and quantity of feed, prevalence of diseases, lack of appropriate breed and breeding strategies, and poor understanding of their genetic potential and the production environment in which they have been reared for centuries (Tsegaye, 2009). There is also limited information on the real genetic potentials of local goat populations that are distributed in various regions of the country, which are characterized by contrasting agro-climatic environments.

Although several studies are available on breeding objectives, selection criteria and breeding practices associated with the rearing of indigenous goats in Ethiopia, most of the indigenous goat's genetic resources are still not well-represented (Asefa *et al.*, 2015; Seid *et al.*, Fentahun *et al.*, 2016; Hagos *et al.*, 2016; Seid, 2017). In designing genetic improvement strategies, the first step is identifying traits the farmers need to improve. As a result, indigenous knowledge of traditional animal breeding practices and techniques is important to develop sustainable genetic improvement schemes under smallholder situations. In particular, there is limited information on breeding objectives and practices, trait preferences, and selection criteria of breeding stock used

by owners of goats in South Gondar zone. Therefore, this study was initiated to identify breeding objectives, selection criteria and breeding practices of indigenous goat population owners in the South Gondar zone.

MATERIALS AND METHODS

Sampling procedure

First, the relevant second-hand information was gathered from South Gondar zone Agriculture and Rural Development office experts of livestock. This information are essential in identifying the appropriate locations for the intended study. Based on the obtained information, a multi-stage purposive sampling technique was used to select the study districts and kebeles. Kebeles are the smallest administrative units within a district. In the first stage, three districts namely Farta, Fogera, and Libo-Kemkem were selected purposively based on goat population size. In the second stage, based on the distribution of the goat's population, three kebeles from each district were selected purposively. In the third stage, the farmers who possess at least three matured goats of both sexes and have experiences in rearing goat were identified within kebeles with systematic purposive sampling. A total of 153 households (51 from each district and 17 households from each kebeles) were randomly sampled for interview using a semi-structured questionnaire.

In addition, to refine the obtained information through interviews, focal-group discussions were held at each kebele. Individuals are communally known to have high-quality breeding animals, model farmers, and people believed to be knowledgeable about the past and present of the social and economic status of the area and community elders and storytellers were identified and included in the discussion. For focal-group discussions, 15 to 20 farmers were organized at each study site.

Data collection procedures

A semi-structured questionnaire was prepared and pre-tested using randomly selected households and the necessary adjustments were made. Information on the characteristics of the farmers like the number of goats kept and breeding practices like mating type, goat breeding objectives, selection criteria of goat was collected. Moreover, secondary data were collected from the district and zonal offices of agriculture. Information on the management of goats such as breeding system, trait preference in the area, and selection criteria was collected.

Statistical analysis

All the collected data were double-checked and corrected for any types of errors or outliers and then entered into Microsoft excel. The data obtained through the questionnaire were analyzed using descriptive statistics crosstabs and percentage compared across districts using chi-square test through non-parametric statistics. The

data were analyzed using the frequency procedure using a Statistical Package for Social Science (SPSS ver. 20). The rate of inbreeding was calculated in the population. Effective population size for a randomly mated population was calculated using the formula of Falconer and Mackay (1996). The rate of inbreeding (ΔF) was then calculated from N_e as $\Delta F = 1/2N_e$

$$N_e = 4(N_m * N_f) / (N_m + N_f)$$

Where, N_e = effective population size

N_m = number of breeding male population

N_f = number of breeding female population

Indices were calculated using the following formula:

I = index: Index = sum of (3X value of rank 1 + 2X value of rank 2 + 1X value of rank 3) given for an individual attribute divided by the sum of (3X value of rank 1 + 2X value of rank 2 + 1X value of rank 3) for an overall attribute.

RESULTS AND DISCUSSION

Goat flock size

The flock owner determined the composition of the flock based on breeding objective, economic and management considerations. The goat flock (Fig. 1) structure by age and sex in the study area is presented in Table 1. There was a significant difference ($P < 0.05$) among Fogera and other districts in buckling male kids less than six months but in Farta and Libo-Kemkem districts there was non-significant difference. Average numbers of male kids less than six months old per household were 0.8, 1.2, and 0.9 for Farta, Fogera and Libo-kemkem districts, respectively. There was a significant difference ($P < 0.05$) among districts in female kids (doeling) that are less than 6 months old. Average numbers of female kids (doeling) less than 6 months old per household were 0.98, 1.12 and 1.4 for Farta, Fogera and Libo-kemkem districts, respectively. The overall mean of the young buck was 7.9% while young does about 10.5%. The proportion of young male kids (six months up to one-year-old) was lower as compared to young female kids. This was because young male goats are sold at an early age and keep only a few breeding buck as a sire for their flock. As a result, there is a high level of elimination of the majority of born male kids from the flock at their early age of maturity. This indicates that the present of negative selection and affect the improvement of genetics for goat. The finding was similar to that of Seid *et al.*, (2015) in Western Ethiopia and Sheriff *et al.*, (2019) in northwestern Ethiopia.

There was significant difference ($P < 0.05$) among districts in the flock size of breeding does. The mean number of breeding does per household was 4.55, 5.12, and 5.8 in Farta, Fogera, and Libo-kemkem districts, respectively. Libo-kemkem district had slightly higher breeding does than Farta and Fogera districts which could be attributed to the availability of feed resources in the district. In the study area, breeding does represent the largest proportion of the total population of goats and covers 49.8% of

the total population of goats followed by kids of both sexes. This observation was in line with the report of Abraham *et al.*, (2017) and Worku and Ahmed (2018), who reported similar results. This indicates that the practice of retaining does for breeding purposes and the production of more kids.

The ratio between matured males above one-year age and their female counterpart was 1:7. This value was consistent with that of Abegaze (2014) who reported 1:7 in Western Lowland. However, the ratio value observed in the current study was lower than reported by Gebreyesus *et al.*, (2012) for goats around Diradawa and Takele (2014) for goats reared in the Shabelle Zone. The observed differences in the current findings with others could be explained by the existence of suitable production environments and marketing outlets that favor goat rearing in some regions of the country.

Generally, the present study shows that the flock structures of indigenous goats found in the study areas were mainly based on maintaining a large number of female goats. The most plausible reason for this situation is that fewer male goats are required for mating while large numbers of female goats are retained for breeding purposes which is consistent with Mekuriaw *et al.*, (2016). Moreover, male goats grow faster than females and reach marketing at an early age which encourages farmers to sell them as a means of cash income to cover expenses related to major households.

Table 1: Goat flock size per household in the study districts

Class of goat	Farta	Fogera	Libo-Kemkem	SEM	Overall
Buckling (<6 month old)	0.80 ^a	1.20 ^b	0.90 ^a	0.15	0.96
Doeling (<6 month old)	0.98 ^a	1.12 ^{ab}	1.40 ^b	0.09	1.20
Buck (6-12 month)	0.70 ^a	0.86 ^a	0.96 ^a	0.10	0.83
Doe (6-12 month)	1.01 ^a	1.01 ^a	1.31 ^a	0.11	1.10
Does (Doeling >1 year)	4.55 ^a	5.12 ^b	5.80 ^c	0.19	5.20
Buck (Buckling > 1 year)	0.67 ^a	0.73 ^a	0.86 ^a	0.10	0.75
Castrated bucks	0.45 ^a	0.45 ^a	0.61 ^a	0.09	0.50
Total	9.20 ^a	10.5 ^b	11.7 ^c	0.35	10.5

^{a, b, c} Means with different superscript letters are significantly different at $P < 0.05$

SEM = standard error of the mean



Figure 1: Goat flock

Purpose of keeping goats

As shown in Table 2, cash income, saving account, meat consumption, skin, and manure are important reasons for keeping goats in the study area. Income generation, meat consumption, and saving were first, second and third rank, respectively for the reason of goat rearing in all districts. Similar cultures of livestock husbandry practices in the three districts might have resulted in similarities in the purpose of keeping goats. These results clearly showed that goat rearing is considered a viable option to generate income through the sales of live goats to cover major expenses related to household consumptions and purchase of essential inputs for crop productions. The purpose of keeping goats has been also reported for meat consumption which mainly takes place during major religious holidays such as Eastern. The present findings are in agreement with those of Samuel *et al.*, (2016) for Agarfa district, Neme *et al.*, (2018) for Ada Barga and Ejere districts, Seid *et al.*, (15) in Guduru district, and Mekuriaw *et al.*, (2016). On the other hand, Misbah and Belay (2016) and Seid (2017) reported that goats in the arid and semi-arid lowlands of the country are primarily reared for milk production. Functions such as skin and manure received relatively low ranking among the reasons for the keeping of goat and used as by-product from meat for home consumption and ceremony and when rearing used for manure. In addition, goats play important roles in the socio-economy of societies. This includes the payment for social dues, ceremonial feastings, and to show wealth strength.

Table 2: Ranking of the purpose of keeping goats in the three districts

Purpose of goat keeping	Farta				Fogera				Libo-kemkem			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Meat	15	20	16	0.33	16	16	12	0.31	13	23	9	0.31
Cash income	22	14	12	0.35	18	21	6	0.33	22	12	12	0.33
Saving	14	15	20	0.3	12	8	25	0.25	15	7	23	0.27
Skin		1	2	0.013	2	4	5	0.06	1	7	2	0.06
Manure		1	1	0.01	3	2	3	0.05		2	5	0.03

Index = Σ of $[3 \times \text{number of household ranked } 1^{\text{st}} + 2 \times \text{number of household ranked } 2^{\text{nd}} + 1 \times \text{number of households ranked } 3^{\text{rd}}]$ given for particular valued purpose divided by Σ of $[3 \times \text{number of households ranked } 1^{\text{st}} + 2 \times \text{number of household ranked } 2^{\text{nd}} + 1]$

Buck management

In the study area, about 62.7 % of the respondents had their breeding buck are presented in Table 3. The finding is higher than that of Neme *et al.*, (2018) and Seid *et al.*, (2015) for goats reared in West Shoa and Wollega zone, respectively. However, the current observations were lower than reported by Derib (2017) and Alemu (2015) for local goats reared in Hamer district and Ziquala, respectively. The type of breeding practices used in different production environments could cause such variations.

The main source of their breeding buck was born in the flock (70.8 %) followed by purchased from the market (18.8%) and a flock of friends and neighbors (10.4%). This observation is in agreement with that of Takele (2014) and Derib (2017) who reported similar practices. Using breeding buck from own flock may lead to increased occurrence of inbreeding depression within the flock resulting in loss of economic traits.

About 91.7% of the respondents in the study area did not make special management for a buck. The remaining few respondents were provided drugs (Albendazole), which is traditionally called “*Madaberia/kenina*” and supplementary feeds such as salt and food leftover. The purpose of breeding bucks in the study area was for a mating purpose (63.5%) followed by for fattening (15.6%) and for mating, social culture and fattening (13.5%) and social culture (7.3%).

Table 3: Buck management in the study areas (%)

Parameter	Farta	Fogera	Libo-kemkem	Overall	X ² value
Do you have own breeding buck					3.52 ns
Yes	54.9	60.8	79.5	62.7	
No	45.1	39.2	27.5	37.3	
Sources of bucks					4.19 ns
From own flock	60.7	83.9	67.6	70.8	
From the flock of friends/neighbors	14.3	6.5	10.8	10.4	
From market/ unknown sources	25	9.7	21.6	18.8	
If didn't have buck, how do you mate?					5.15 ns
From Friends/neighbors	47.8	25	14.3	31.6	
pasture area	52.2	75	85.7	68.4	
Is there any special management for the breeding buck					2.59 ns
Yes	10.7	12.9	2.7	8.3	
No	89.3	87.1	97.3	91.7	
Purpose of keeping buck					4.97
Mating	64.3	61.3	64.9	63.5	
Socio-cultural	7.1	6.5	8.1	7.3	
Fattening	21.4	19.4	8.1	15.6	
For mating ,socio-cultural and fattening	7.1	12.9	18.9	13.5	

*The chi-square values indicate there is a significant difference across the row

Traditional selection practices of goats

Selection is the prerequisite to replace stocks by considering their own morphological and production characteristics. Selection practices of breeding buck and does in the study areas are present in Table 4. About 64.7% and 71.9% of respondents have been practicing selection of breeding buck and do, respectively. This observation is in line with that of Asefa *et al.*, (2015) who reported that the majority of the respondents practiced selection of males and female goats in the studied areas. The present study showed that selection of breeding young buck and does were commonly practiced at the age of 9.2 and 11.5 months, respectively, and selection was applied after sexual maturity at 7.76 months for a young buck and 8.66 young does. Bucks were selected earlier than a female, which indicates that males are selected based on physical appearance while females have based on a reproductive trait-like age at first puberty, litter size, kid growth, and kidding interval.

There were significant differences ($P < 0.05$) among districts in replacement of does. About 67% of respondents obtained, their replacement does from farm-born kids followed by purchasing from the market (16.3%). In Libo-kemkem, about 80.4% of does were obtained from their own flock.

Table 4: Traditional selection practices of breeding bucks and does in the studied districts (%)

Parameter	Farta	Fogera	Libo-kemkem	Over all	X ² value
Do you practice selection of breeding buck					0.69 ^{ns}
Yes	68.9	64.7	60.8	64.7	
No	31.4	35.2	39.2	35.3	
Do you practices selection of breeding does					1.61 ^{ns}
Yes	78.4	68.6	68.6	71.9	
No	21.6	31.4	31.4	28.1	
From where do you get the replacement does					25.09*
Farm born kids	41.2	78.4	80.4	66.7	
from the market	23.5	13.7	11.8	16.3	
From friends and neighbors	19.6	3.9	3.9	9.2	
from farm born and market	15.7	3.9	3.9	7.8	
Age of selection young buck(male)mean month	9.3 ^a	9.2 ^a	8.9 ^a	9.2	
Age of selection young does(female)mean month	11.61 ^a	11.31 ^a	11.53 ^a	11.5	

^{ns} ($P > 0.05$) non-significant; *The chi square values indicate there is significant difference

Traditional selection criteria for breeding bucks

The selection of good breeding buck is the main driver of ongoing genetic improvement in the flock under traditional production systems (Seid, 2017). Selection criteria for breeding bucks are presented in table 5. The overall selection criteria of bucks were age, coat color, and appearance with indices values of 0.22, 0.2, and 0.19, respectively. For bucks reared in Farta and Libo-kemekem districts, age, physical appearance, and coat color were chosen as the first, second, and third-ranked criteria of selection, respectively. In Fogera district, coat color, age, and physical appearance of bucks were ranked as the first, second, and third criteria of selection, respectively. These observations are consistent with those of Abegaze (2014) who reported that coat color and physical body appearance were found as the most important selection criteria for selecting breeding bucks. In all districts, the most preferred colors by the owners were white and a combination of white and red while none of the goat owners preferred black color. These findings are consistent with those reported by Gatew *et al.*, (2015), Seid *et al.*, (2015), and Samuel *et al.*, (2016). In general, farm animals with black hair coat color do not fetch good prices at marketing them due to various reasons related to traditional superstitious beliefs.

Table 5: Traditional selection criteria used by households to select their breeding bucks

Traits	Farta	Fogera	Libo-kemekem	Over all	
	Index	Index	Index	index	rank
Appearance	0.21	0.17	0.2	0.19	3
Behavior/temperament	0.07	0.07	0.04	0.07	
Coat color	0.19	0.21	0.19	0.2	2
Growth rate	0.17	0.14	0.18	0.16	4
Present / absent of horn	0.06	0.09	0.04	0.06	
Libido	0.07	0.13	0.1	0.1	5
Age	0.23	0.19	0.25	0.22	1

Traditional selection criteria for breeding does

Traits considered for selection of does were survivability of kids, kidding interval, physical appearance, behavior, coat color, age at sexual maturity, litter size, and mothering ability (Table 6). The overall selection criteria of does were appearance, sexual maturity, and litter size with an index value of 0.2, 0.19 and 0.14, respectively. In Farta district, physical appearance, age of sexual maturity, and litter size of breeding do with an index value of 0.21, 0.18, and 0.14, respectively. In Fogera district, the major criteria for selection of breeding do were physical appearance, age of sexual maturity, and kidding interval with an index value of 0.21, 0.19, and 0.14,

respectively. For does rear in Libo-kemkem district, age of sexual maturity, physical appearance, and litter size were ranked first, second and third, respectively. Consistent with the current findings, Derib (2017) reported that body size (appearance), early maturity, and litter size were considered as the first three reasons for the selection of does for breeding purposes. On contrary, Takele (2014) reported that milk yield was the main selection criteria of does.

Table 6:. A traditional selection criterion of breeding does in the study areas

Traits	Farta	Fogera	Libo-kemkem	Over all	
	Index	Index	Index	Index	Rank
Survivability of kids	0.11	0.08	0.08	0.09	7
Kidding interval	0.07	0.14	0.1	0.1	6
Appearance/performance	0.21	0.2	0.18	0.2	1
Behavior/temperament	0.05	0.04	0.04	0.04	8
Coat color	0.11	0.12	0.12	0.12	4
Age sexual maturity	0.18	0.19	0.21	0.19	2
Litter size	0.14	0.12	0.16	0.14	3
Kid growth	0.13	0.11	0.11	0.12	4

Mating practices

As shown in Table 7, the major (95.4%) mating type was uncontrolled mating, which is consistent with previous reports by various scholars, (Fantahun *et al.*, 2016; Abraham *et al.*, 2017; Tkue *et al.*, 2017; Bireda *et al.*, 2018). The main reasons for practicing uncontrolled mating are browsing together (51.4%) followed by an insufficient number of bucks (11.6%) and lack of awareness (6.8%). One advantage of uncontrolled mating is that it allows all year-round breeding among the flocks. However, uncontrolled mating together with a small flock size and poor record keeping on pedigree is expected to result in severe inbreeding depression.

About 89.6% of households allowed their buck to mate with other does and there does to be mated by other buck provided its color is not black. The study further identified that about 69.3% of respondents do not know the sire of kids born in their flocks. About 93.5% of households are not aware of the negative effect of inbreeding on the general performances of their livestock and thus, they allowed a buck to mate his mother, daughter, and sister due to lack of the inbreeding (93.5%) concept. This result shows that respondents may not know negative effect of inbreeding (Fig. 2).

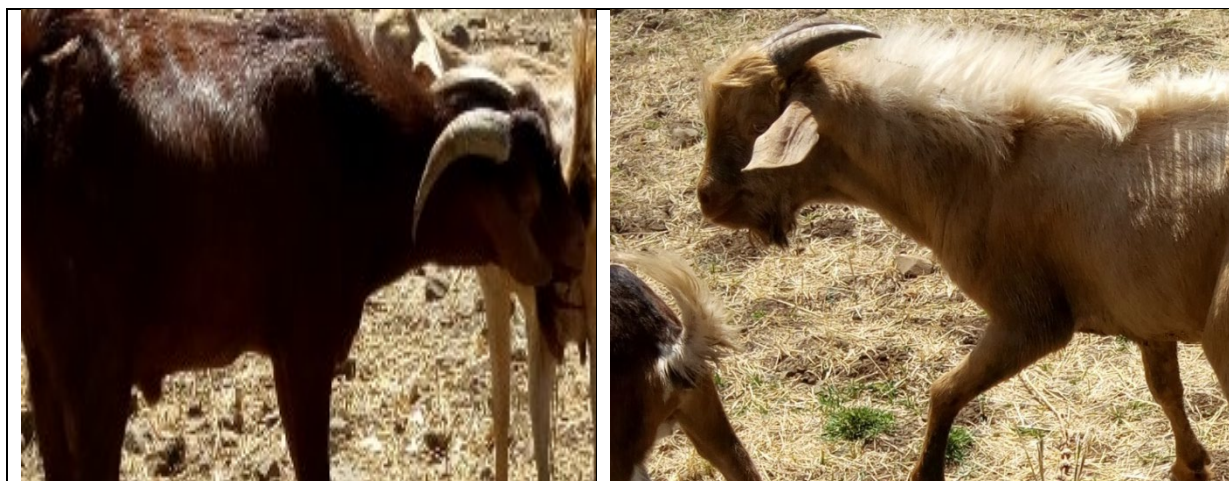


Figure 2: Natural mating of goat

Table 7: Types of mating practiced in the study areas %

Parameter	Farta	Fogera	Libo-kemkem	Overall	X ² value
Type of mating					0.3
Controlled	5.9	3.9	3.9	4.6	
Uncontrolled	94.1	96.1	96.1	95.4	
Reason of using uncontrolled mating					16.98 *
Goats grazed &/or browse together	35.4	55.1	63.3	51.4	
Lack of awareness	12.5	6.1	2	6.8	
Insufficient number of bucks	22.9	6.1	6.1	11.6	
Goat graze together and lack of awareness	8.3	4.1	6.1	6	
Goat grazing together ,lack of awareness and insufficient number of buck	20.8	28.6	22.4	24	
Do you allow your buck to serve does other than yours					2.67 ns
Yes	82.1	90.3	94.6	89.6	
No	17.9	9.7	5.4	10.4	
Are you able to identify the sire of the kid in your flock?					0.8 ns
Yes	35.3	27.5	29.4	30.7	
No	64.7	72.5	70.6	69.3	
If" Yes" indicate the methods by which you can identify the sire					0.8 ns
As mating observed	27.8	18.6	26.7	27.7	
By coat color of kid unique	61.1	50.0	53.3	55.3	
All	11.1	21.4	20.0	17.0	
Do you aware of the term Inbreeding					
Yes	5.9	3.9	9.8	16.5	
No	94.1	96.1	90.2	93.5	

Effective population size and rate of Inbreeding

The effective population size (N_e) and level of inbreeding (ΔF) were calculated for indigenous goats using the averaged breeding males and females (Table 8). In this study, the estimates of N_e were 2.34, 2.56, and 3.00 for Farta, Fogera and Libo-kemkem district, respectively with the mean estimate of N_e was 2.65 whereas the corresponding inbreeding values were 0.21, 0.19 and 0.17 with the mean value 0.19. The result a line with Asefa *et al.*, (2015) who reported the mean inbreeding rate was 0.21 in Bale zone. The current results show, the rate of inbreeding in the study area is beyond the threshold level 6.25% (0.0625) maximum acceptable inbreeding coefficient (Armstrong, 2016). The reason may be due to using of buck from own flocked and uncontrolled mating practiced with small flock size in the study area.

Table 8: Effective population size and rate of inbreeding of goats flock in the study area

Districts	When flocks are not mixed			
	Nm	Nf	N_e	ΔF
Farta	0.67	4.55	2.34	0.21
Fogera	0.73	5.12	2.56	0.19
Libo-kemkem	0.86	5.80	3.00	0.17
Mean	0.76	5.16	2.65	0.19

Nm= number of male; Nf = number of female; N_e = effective population size; ΔF =rate of Inbreeding

CONCLUSIONS

Breeding does in south Gondar represented the largest proportion of goats and covered 49.8% of the total population of goats followed by kids of both sexes. The main purpose of goat rearing is seen as an option to generate income, meat, and saving. Selection of breeding young buck and does were commonly practiced at the age of 9.2 and 11.5 months, respectively. The overall selection criteria of bucks were early maturity, hair coat color, and appearance while the selection criteria of does were appearance, sexual maturity, and litter size. The breeding system of goats in the study area was characterized by uncontrolled mating which would lead to the occurrence of inbreeding depression in small flocks. Should be provided training for farmers about inbreeding depression, way of improvement goat genetics, and the effect of selling early mature bucks.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest involved in this study.

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List Of Abbreviations

ΔF =rate of inbreeding, N_e = effective population size; N_f = number of female; N_m = number of male; SEM = standard error of the mean

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