Herd Management and Breeding Practices of Indigenous Goats in Selected Districts of South Gondar Zone, Ethiopia

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Abstract: The study was conducted with the aim to assess herd management and breeding practices of western highland goat types in Lay-Gayint and Semada Districts. Household survey, focused group dissociation and field observation methods were used to collect the information. Purposive sampling technique was used to select 180 households, who own goats. Semi-structured questionnaires were used to collect data. Simple descriptive statistics, ranking trial and chi-square test of SAS ver. 9.40 were used to analyze the collected quantitative and qualitative data. The result of the study revealed mixed farming system was the main production system in the study area. The primary purpose of keeping goat was for cash income across the study areas. Drought and feed shortage were the main production constraints in the study areas. Reproductive performances evaluation works of this study indicated that age at firs maturity of male goat in the Lay-Gayint and Semada districts were 7.85±1.84 and 8.53±2.32 month, while for female goat, it was 7.39±0.88 and 8.32±1.32 months, respectively. In addition, age at first kidding and average kidding interval in Lay-Gayint and Semada goats were (10.48± 1.27 vs 7.01±1.42) and (10.21±1.61 vs 6.94±1.81) months, respectively. The average life span and kid crop per doe per life span for Lay-Gayint and Semada goats were (13.77±2.83 years vs 15.91±3.72 kids) and (11.75±3.07 years vs 14.89±4.16 kids), respectively. On the other hand, the average reproductive life span for Lay-Gayint and Semada male goats were 3.39±0.49 and 3.30±1.24 years, respectively. In the study area, appearance and color were the main selection criteria for both male and female goats. The common breeding practice in the study areas was natural and uncontrolled mating systems. Physical appearance, coat color and performance were used to identify the future generation in the study areas as the two districts share common boundaries and hence, they shared indigenous knowledge about goat breeding and management. From this study, it was concluded that farmers have relatively similar production and breeding objectives. Moreover, the reproductive performances of both Lay-Gayint and Semada goats are similar except for the average lifespan, in which Lay-Gayint goats are better than Semada. The study findings put a baseline for understanding about production and breeding practices of both goat breeds as the first step in designing a sustainable breeding programme.

Keywords: *Breeding practice, Herd management, Indigenous goat, Kidding pattern, Reproductive performance*

Introduction

Livestock sector in Ethiopia plays a significant role in reducing poverty, achieve better food security and livelihood improvement of smallholder farmers, (Helina and Schmidt, 2012; CSA, 2017). In addition, it contributes to national income growth, exports and foreign exchange earnings and climate mitigation and adaptation (Shapiro *et al*., 2015). In Ethiopia, the goat population is estimated to be about 52.5 million, of which 13.70% of them are found in the Amhara Region (CSA, 2021). Accounting for 9% of the African and 3% of the global goat population, Ethiopia stands third in Africa and sixth in the world (FAOSTAT, 2016). With respect to breed type, almost all of the goats are indigenous breed type which accounts about 99.99 % (CSA, 2021). But the production systems are meant for sustenance, and they essentially rely on conventional management methods with little to no external input (Solomon *et al*, 2010). Slow growth rates and low commercial off take rate were the major challenges of smallholder goat production in Ethiopia (Solomon, 2014; Deribe *et al*., 2015). These could be linked to the high death rate caused by the frequency of diseases, insufficient feed supplies, inappropriate breeding techniques to take advantage of the variety of genetic potential, inadequate infrastructure, and inadequate institutional support (Solomon, 2014).

A viable starting point for addressing some of the challenges facing smallholder goat production is to create a sustainable community-based breeding program that takes into account local breeds, farmer trait preferences, and organizational structures (Mueller *et al*., 2015). Goats were raised by farmers and pastoralists to supply a wide range of goods and services to their owners, including meat, milk, skin, hair, horns, bones, manure, security, religious rituals, gifts and medicinal purposes (Tesfaye, 2009; Grum, 2010; Dereje *et al*., 2013). In addition, they are key sources of protein for

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those who are poor and contribute to their extra income and other aids (Notter, 2012). Therefore, improvement programs, targeting on increasing and sustaining productivity of goats, are essential to respond to the growing domestic and foreign demands for live goats and products, especially for highly populous countries like Ethiopia, which have extensive livestock husbandry practices. Goats have a relative advantage over other species due to their small size, wide dietary preferences, ability to adapt to difficult environmental conditions, and short reproductive cycle. This is especially true for livestock owners with little resources (Gurmessa *et al*., 2011). The potential of indigenous goat breeds/type have not been still utilized for improvement inspite of limited attempts of characterization for sustainable utilization and establishing managemental intervention under smallholder production systems. However, knowledge of the adapted goat genetic resources is a prerequisite for designing appropriate breeding and utilization programs.

Lay Gayint and Semeda districts are located in South Gondar Zone, Amhara Region. Both Lay Gayint and Semeda districts have the potential for Western highland goat production. In both districts, goats play significant roles in securing the livelihood of farmers. They are sources of immediate cash sources. Particularly, they are live banks for smallholder farmers and their role for socio-cultural events is tremendous. The presence of a wide range of agroecology demands the need for study on physiological adaptation, productive performance and reproductive performance of indigenous goat population. In smallholder goat production systems, identifying farmer's managemental practices that influence the productivity and survivability of kids leads to an appropriate extension message to meet the needs of farmers (Tatek, 2016). Therefore, this study was designed to assess the goats production system, breeding practices, identify trait preferences, and selection criteria of farmers in the study areas.

Materials and Methods

Description of the Study Areas

The study was conducted in Semada and Lay-Gayint districts of South Gondar Zone of Amhara Regional State, Ethiopia (Figure 1). Debre-Tabor is the zonal capital city, which is located at 11°02'-12°33' N latitude and 37°25'-38°43' E longitudes with an area of 1428.73 sq km (South Gondar Administrative Agriculture Office, 2016).

Lay-Gayint district: This district is located 11°32'-12°16'N latitude and 38°12'-38°19'E longitude. The district shares borders from Mekiate district in the east, Estie and Farita districts in the west, Ebinat in the north and Tach-Gayint in the south directions. The altitude of the district ranges from 1500-4231 m.a.s.l. The annual rainfall and average temperature ranges are 600-1200 mm and 8-20 ^{0}C, respectively. The total area coverage is 154856 hectares. The district is classified into four agro-ecological zones, namely frost (2.71%), highland (45.39%), midland (39.4%), and lowland (12.5%). The district is also rich in livestock resources. In the district, there are 120579 cattle, 82510 sheep, 48758 goats, 4842 horses, 21769 donkeys, 1249 mules and 60583 chickens. Total human population of the district is 201,787, out of it, male and female constitute 102,109 and 99,678, respectively (LGWoA, 2016).

Semeda district: It is situated at 11° 02'-11°39'N latitude and 38°06'-38°38'E longitude in the northwestern highland of Ethiopia (SWoA, 2016). According to SWoA (2016), the district has an average altitude of 2460 m.a.s.l. Its mean annual minimum and maximum temperatures were 16 °C and 23 °C, respectively. The mean annual rainfall of the district ranges from 1000 to 1500 mm. The total land coverage is 951363.9 hectares. The district has common borders with South Wollo in the east, East Estie in the west, Tach-Gayint and Lay-Gayint in the north and East Gojjam Zone in the South. Agro- ecologically, Semeda district consists of highland (11%), midland (41%) and lowland (48%). According to CSA (2015), the district has an estimated total human population of about 245757, out of which 122071 were male and 123686 was female. In the district, the estimated livestock population was 144349 cattle, 98568 sheep, 108898 goats, 353 horses, 21617 donkeys, 734 mules and 86944 chickens (SWoA, 2016). The dominating livestock production system was mixed crop-livestock farming with crop production being the primary agricultural activity.

Methods of Sampling and Data Collection

Multi-stage purposive sampling techniques was employed to select the study districts, *kebeles* and respondent households. Secondary information on the distribution, goat population across the different districts in the zone was obtained from agriculture and rural development offices of zone and districts before starting the actual fieldwork. Districts were selected based on the presence of a relatively large numbers of goat population. From each district, 6 *kebeles* were purposively selected based on goat population and accessibility. A preliminary survey was carried out before the main survey to know the distribution and density of indigenous goat population and breeding objectives to establish a sampling framework from the *kebeles*. Information for the rapid survey was collected from the districts Agriculture and Rural Development Office and South Gondar Administrative Agriculture and Rural Development Zonal Office.

A total of 180 households (90 households from each district) were randomly selected using a lottery system. For this, the lists of all the households having goats in each *kebele* were obtained from each *kebele*. A semi-structured questionnaires were used to collect survey data. The questionnaires were pretested before actually administering to the respondents. Oromia livestock breed survey questionnaire (Workneh and Rowlands, 2004) was used as a checklist in designing the questionnaire. The questionnaire was designed to obtain

information from respondents on household socio-economic situations including composition of livestock species, selection criteria for breeding, breeding objectives, breeding methods, flock structure, management practices, farming type, feed resource utilization and availability, animal health condition, mortality and causes of mortality, housing system and production constraints. Three focus group discussions (FGDs) were carried out per district to triangulate the reliability of the survey data. The discussion was held with extension workers, livestock experts, development agents (DAs), model farmers, village leaders, elders, women and socially respected individuals.

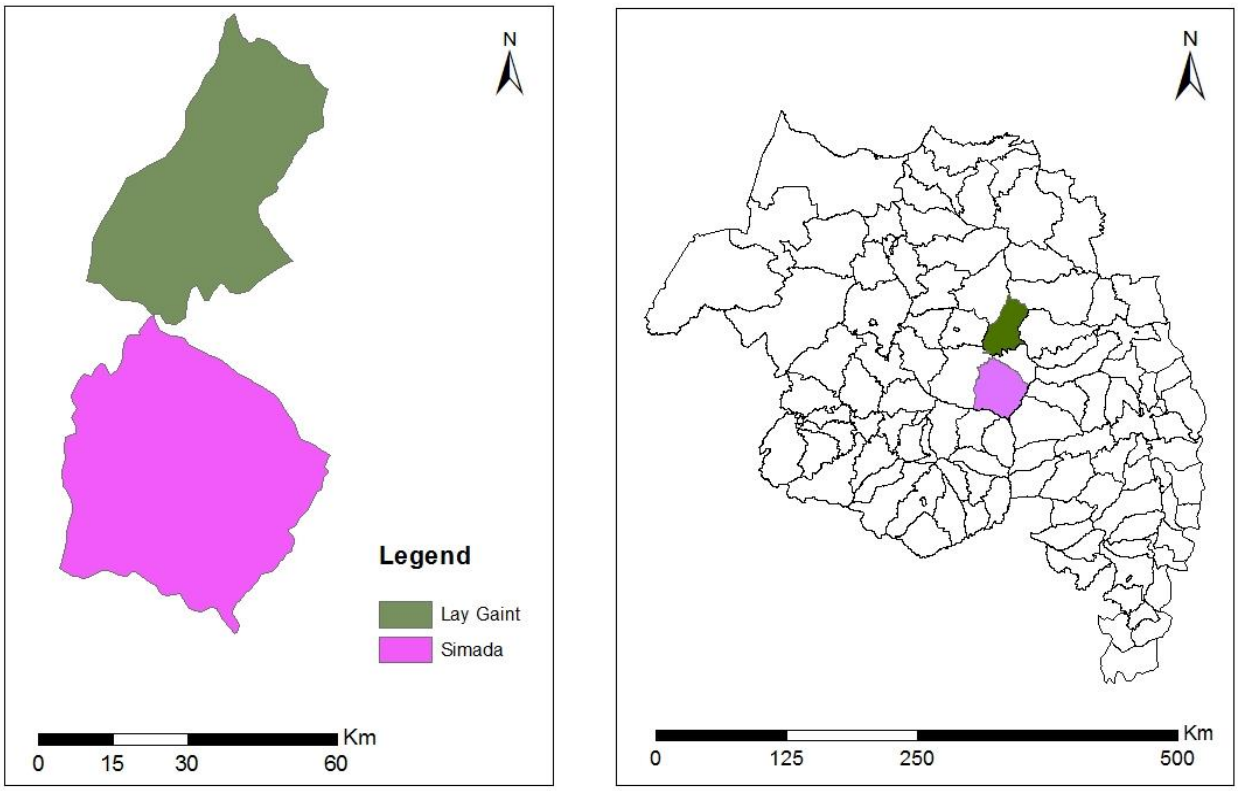

Figure 1. Map of the study areas.

Statistical Data Analysis

The data were checked for completeness and consistency and coded. Different methods of analysis were used depending upon the nature of the data. All the data gathered during the study periods were coded and recorded in Microsoft excel spreadsheet 2019. The survey data were analyzed using descriptive statistics procedure of statistical analysis system (SAS version 9.40, 2013) software. In addition, chi-square test was employed to compare categorical variables across the study areas. Indices were calculated for all ranking data according to the formula: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons (attributes).

Results and Discussion

Purpose of Keeping Goats in the Study Areas

The purpose of keeping goats/production objectives of smallholder farmers across the study areas are summarized in Table 1. Farmers kept goats for many reasons. The primary purpose of keeping goats in both study areas was income source, manure and meat. This shows goats are live bank for poor farmers and an easy way to get immediate cash by selling them as they have high reproductive rates and short generation intervals. Moreover, since crop production in both districts are the primary farming activity, farmers reared goats to get manure for fertilizing their farmlands. This study result is in agreement with Mahilet (2012), who reported on Hararghe Highland goat; Ahmed (2013), who reported on Ethiopian indigenous goats in Horro Guduru Wollega Zone; and Solomon *et al.* (2013), who reported on Abergelle and Western Lowland goat breeds. In contrast to this study, Bekalu *et al.* (2016) reported that the primary purpose of keeping goats in Gonji Kolela district was for meat consumption followed by saving, wealth status, and manure. In both districts, farmers did not keep goats to obtain milk, but in many parts of Ethiopia such as in Arsi-Bale, Abergelle, Afar, eastern Hararghe, Borena, Shabelle, and Sidama, farmers rear goats for milk production purposes (Tesfaye, 2009; Mahilet, 2012; Hulunim, 2014; Tsigabu, 2015; Ahmed, 2017).

Breeding Practices

Livestock holdings in the study areas: Average livestock holding and livestock composition in the study areas are depicted in Table 2. The major livestock species in the study areas were cattle, goat, sheep, and donkey. Goats took the highest average flock size per household in both districts. This might be due to the fact that goats have high reproductive rate and short generation interval and require low input resources to raise goats (Gurmessa *et al.*, 2011; Bekalu *et al.*, 2016). In addition, goats can thrive well under adverse conditions (feed shortages and drought) due to browsing ability of wide variety of plant species as well as bush encroachments whereas cattle and sheep are considered more sensitive to feed shortages. In this regard, the mean flock sizes of goats per household were 7.78±6.15 and 9.37±5.97 for Lay-Gayint and Semada districts, respectively. This relatively higher average goat flock size in Semeda district could be because large areas of Semeda districts are mid-land and lowlands, which are suitable for goat production as lowlands have relatively large grazing and browsing areas. Moreover, in Lay-Gayint, there is a decrease in browsing trees and natural pastures, because of the diminishing of grazing land and changing them to farmlands.

Table 1. Purpose of keeping goat in the study areas.

Purpose	Districts									
	Lay-Gayint					Semada				
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index
Meat	30	450	256	35	0.25	50	324	176	126	0.22
Sale/income source	840	36	8	0	0.29	750	72	8	7	0.27
Traditional identity	0	0	24	112	0.04	0	36	32	105	0.06
Social status	0	9	8	63	0.03	0	0	16	35	0.02
Saving	10	18	152	301	0.16	10	90	144	238	0.16
Collateral	0	0	0	0	0.00	0	0	0	0	0.00
Dowry	0	0	0	0	0.00	0	0	0	0	0.00
Ceremony	0	0	0	0	0.00	0	0	16	0	0.01
Manure	0	306	264	112	0.23	60	252	304	112	0.27

R1, R2, R3 and R4= Rank 1, 2, 3 and 4, respectively; Index = Sum of (3 for rank 1 + 2 for rank 2 +1rank3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2+1 for rank 3) for overall reason; R= *Rank.*

The overall mean flock size of goats per household in the study areas were 8.57±6.10 which is comparable with the report of Mahilet (2012) for Hararghe highland goats (8.12) and Hulunim (2014) for Bati goats (8.9). However, the current mean goat flock size per household is lower than the report of FARM-Africa (1996) and Mezgebu *et al.* (2022) where the mean flock size of goats found in Long-Eared Somali goats and East Gojjam goats was 37 and 11.52±9.09, respectively. This might be linked to the primary farming activity in the study areas (i.e., crop production). In addition, the browsing or grazing areas have been shifted to crop-land, as there is a rapid increase in human population in the study areas.

Table 2. Livestock composition and number in the study areas.

Species	Lay-Gayint	Semada	Overall
	Mean ±SD	Mean ±SD	Mean ±SD
Cattle	4.6±2.17	3.61±1.63	3.87±2.05
Goat	7.78±6.15	9.37±5.97	8.57±6.10
Sheep	4.02±3.87	2.83±3.37	3.42±3.67
Donkey	1.53±0.84	1.07±0.87	1.30±0.88
Horse	0.13±0.43	0	0.07±0.31
Mule	0.10±0.30	0	0.05±0.22
Chicken	6.89±4.95	6.47±4.87	6.68±4.90
Beehive	0.65±1.10	0.26±0.74	0.46±0.96

SD= Standard deviation.

Flock structure of goats: Flock structures of goats in both districts are described in Table 3. The varied distribution of different animal classes reflects the producers' management choices, which are based on their goals for production (Solomon *et al.*, 2010). In the study areas, breeding does made a major share followed by kids less than 6 months. In Lay-Gayint, the breeding does took up 40% of the flock followed by female kids (16%). Similarly, in Semada, breeding does were the dominat (38 %) followed by male kids (16%) and female kids (13%). The higher proportion of breeding females in the flock followed by suckling age group in both districts is in agreement with the findings of other researchers in Ethiopia (Tsedeke Kocho, 2007; Belete, 2009; Tesfaye, 2009; Solomon *et al.*, 2013; Mezgebu *et al.* 2022). On the other hand, the current finding is contrary to the reports of Alubel (2015) and Hussein (2015), who reported 8.18±11.75 and 8.94 breeding does per head for Central Highland and low land of Aris-bale goats, respectively.

Mating practices: All goat populations in the study areas were pure indigenous goat breeds. Methods of mating in both study areas are presented in Table 4. Farmers across the study areas practiced traditional breeding plans by selecting and preparing preferred bucks. Though farmers follow uncontrolled breeding practices, they allow their own or village-preferred breeding bucks and kept with their does as a source of breeding bucks. Majority of respondents (95%) in Lay-Gayint district kept their own breeding bucks whereas the remaining (4.4%) use neighbor's bucks. In the Semada, the respondents indicated that 93.3% of them keep their own breeding bucks while the remaining

(6.7%) use neighbor's breeding bucks. Due to uncontrolled breeding practices across the study areas, respondents were forced to identify their next generation by using dam or does performances (20%), body conformation (45%), and coat color (35%). Majority of the respondents in both districts were interested for performance history of the family to select the breeding bucks. All the respondents in both districts allow mating of a buck with his mother, sister and daughter. This might be primarily due to small goat flock size, shortage of bucks caused by selling young bucks, and low awareness of the farmers on the negative consequences of inbreeding. They castrated male goats primarily for fattening purposes. Almost all farmers across the study areas had no fixed mating seasons for the goats. Uncontrolled mating within and across the households' flocks was predominant. Similar results were reported by Netsanet (2014) and Hussein (2015).

Table 3. Flock size and structure in the study areas.

Goat class by age and Sex	Lay-Gayint		Semada		Overall
	%	Mean±SD	%	Mean±SD	Mean±SD
Male kid <6 months	15	1.33±1.36[a]	16	1.99±1.53[b]	1.66±1.49
Female kid < 6 months	16	1.46±1.20$_a$	13	1.70±1.52[a]	1.58±1.37
Male goat 6-12 months	6	0.53±0.88[a]	8	0.97±1.81[b]	0.75±1.06
Female goat 6-12 month	10	0.91±1.27[a]	11	1.44±1.53[b]	1.18±1.43
Male >12 months	7	0.66±0.67[a]	8	1.09±1.53[b]	0.86±1.43
Female >12 months	40	3.56±2.45[a]	38	4.72±2.60[b]	4.14±2.59
Castrated	6	0.53±0.71[a]	6	0.74±1.10[a]	0.64±0.92

Means with the same letter within the same row and class are not significantly different at (p<0.05); N= Number of observations; SD= Standard deviation.

Table 4. Breeding practice and mating system in the study.

Descriptor	Districts		
	Lay-Gayint	Semada	Overall
	%	%	%
Mating system:			
Controlled	8.9	10	9.4
Uncontrolled	91.1	90	90.6
Do you identify sire:			
Yes	85.5	13.2	13.9
No	5.5	87.8	86.1
Source of buck:			
Own farm	95.6	93.3	93.9
From other farm	4.4	6.7	6.1
Do you have cross buck:			
Yes	0	0	0
No	100	100	100
Do you have local buck:			
Yes	58.9	77.8	66.1
No	41.1	22.2	33.9
Giving special management for breeding buck:			
Yes	5.6	10	8.9
No	94.4	90	91.1
Using family history to select breeding goat:			
Yes	92.2	65.6	79
No	7.8	34.4	21
Allowing another buck to mate own flock:			
Yes	96.7	97.8	97.2
No	3.3	2.2	2.8
Allowing a buck to mate his Mather, sister, and daughter:			
Yes	97.8	98.9	98.3
No	2.2	1.1	1.7

Goats trait preferences: In both study areas, goat owners exhibited a strong interest in characteristics related to body size (conformation), rapid growth rate, color, fertility, drought tolerance (adaptability), disease resistance, and reproductive traits (Table 5). Body size and growth rate were the most preferred and frequently ranked trait in Lay-Gayint district (index=0.30), but in the Semada district growth rate and fertility were the most preferable trait (index=0.21 and 0.26, respectively). This implies that designing goat improvement strategy in the Lay-Gayint district is expected to primarily target towards meat production traits. In contrast, in Semada meat and reproductive traits were important and could be considered together. The most important coat color

preferences in both sites were white, brown, red, and roan for cultural as well as production purposes. This observation is similar to the report of Halima *et al.* (2012), Hulunim (2014), and Hussein (2015). The marketing value of goats in Ethiopia is directly impacted by the color of their coat. For example, it is not customary to slaughter goats with completely black coats for domestic meat consumption due to cultural taboos (Halima *et al.*, 2012). This might be due to the cultural belief which meant that the farmers considered using the black goat for slaughtering as bad custom. However, it is thought that black-hued animals, such as goats, are better adapted to cold weather because their dark pigment helps them warm up better than goats with different colored coats (Robertshaw, 2006).

Table 5. Ranking of goat trait preference by farmer.

Trait	Districts									
	Lay-Gayint					Semada				
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index
Size	33	300	297	128	0.30	77	270	153	96	0.18
Color	11	170	288	248	0.28	44	100	234	144	0.16
Growth rate	66	320	162	216	0.30	88	220	189	184	0.21
Heat resistance	0	10	18	16	0.02	11	40	36	56	0.04
Longevity	0	20	27	8	0.02	11	10	18	32	0.02
Drought resistance	0	0	0	24	0.01	0	10	45	88	0.04
Meat quality	0	20	27	16	0.02	44	100	27	24	0.06
Fertility	0	40	9	16	0.02	704	70	36	32	0.26
Horn	0	0	9	40	0.02	0	0	9	48	0.02

Index= Sum of (3 X number of household ranked first+ 2 X number of household ranked second + 1 X number of household ranked third) give for each trait divided by sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for all of the trait for a production system; R= *Rank.*

Breeding Doe and buck selection criteria: Table 6 summarized ranking of the owners' selection criteria of breeding does in the two areas. Farmers in both study areas were concerned more about appearance/conformation by considering meat production potential of does followed by coat color and twining. This fit with the finding of Mahilet (2012) for Hararghe highland goat. The flock's most valuable member is Buck. It establishes the flock's general conception rate and provides 50% of the genetic composition of each borne kid. A key component of goat production is selecting a quality breeding buck. As shown in Table 6, traits such as libido, coat color, growth rate, and conformation were accorded the weight they deserved when choosing a breeding buck in all of the study sites. The body conformation of breeding buck ranked first in Lay-Gayint and Semada districts with an index value of 0.35 and 0.41, respectively. In Lay-Gayint, next to appearance/conformation, coat color and libido were ranked as the most important trait, while in Semada district coat color and growth rate received higher index next to body size in order of appearance. This result concurs with the finding of Mahilet (2012), Ahmed *et al.* (2015), and Alubel (2015). Overall physical appearance is given as first priority criteria of selection and followed by production and reproduction traits.

Table 6. Breeding doe and buck selection criteria in the study areas.

Traits	District							
	Lay-Gayint				Semada			
	R1	R2	R3	Index	R1	R2	R3	Index
Doe selection criteria								
Appearance	306	264	105	0.36	234	248	49	0.37
Color	180	272	140	0.31	198	144	49	0.27
Kid growth	27	32	56	0.06	117	112	49	0.15
Kidding interval	0	0	0	0.00	0	8	0	0.01
Twining	153	88	273	0.27	90	32	154	0.19
Buck selection criteria								
Appearance	360	288	48	0.35	320	324	64	0.41
Color	200	360	104	0.33	350	216	24	0.34
Growth	0	0	0	0	40	811	80	0.12
Adaptation	0	0	0	0	0.00	27	0	0.01
Age	0	0	8	0.002	0	0	0	0.00
Libido	140	36	288	0.24	10	18	72	0.06

Index= Sum of (3 X number of household ranked first+ 2 X number of household ranked second + 1 X number of household ranked third) give for each trait divided by sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for all of the trait for a production system; R= *Rank.*

Respondents' perception about adaptability traits of goats: In the current study, the majority of goat keepers in both districts reported that their native goat varieties had good levels of heat, drought, and feed shortage tolerance in addition to a mix of adaptive features. On the other hand, majority of the respondents (70%) in the Lay-Gayint district reported that their goats had low level of disease resistance capability but in Semada district 55% of the respondent stated medium disease tolerance (Table 7). This might be related to poor disease prevention measures, lack of sufficient and quality feeds, and other predisposing factors. Goats inherently might be disease tolerant, but due to lack of enough feed, water, and other stressing factors, their immune system may be compromised and become susceptible to diseases. Otherwise, it is a well-known fact that indigenous goats are adapted to diverse infectious agents. Overall, the perception of goat owners implied that the goat populations in both study areas have developed varied adaptive characteristics linked with survivability and reproduction, which indicates the need for genetic analysis studies aimed at exploiting future climate change adaptation breeding programs.

Table 7. Some adaptive trait of goat in the study areas.

Tolerance	Districts					
	Lay-Gayint			Semada		
	Good	Medium	Low	Good	Medium	Low
Stress	100%	0%	0%	97.8%	2.2%	0%
Heat	100%	0%	0%	97.8%	2.2%	0%
Drought	98.9%	1.1%	0%	94.4%	5.6%	%
Feed shortage	91.1%	8.9%	0%	87.8%	11.1%	1.1%
Water shortage	78.9%	21.1%	0%	61.1%	32.2%	6.7%
Parasite	48.9%	51.1%	0%	53.3%	34.4%	12.2%
Disease	3.3%	26.7%	70%	22.2%	55.6%	22.2%

Castration and fatting practices of goats: Most of the respondents in the study areas were not practicing goat fattening (Table 8). This could be due to lack of planned and regular fattening practices caused by lack of awareness and shortage of feed and water. In both districts, most of the respondents (81.7%) commonly practiced castration to fatten their animals and get higher sale prices in local markets. Moreover, farmers practiced castration to avoid inbreeding and enhance animals temperament. In the study areas, animals were castrated at the age of greater than 6 months (100%). However, black kids were castrated earlier. This result agrees with the report of Alefe (2014). Majority of the respondents (98.89%) practiced a traditional castration method, which employed the use of a special stone called "alelow" and using sickle back, whereas the remaining relied on modern castration methods conducted by Veterinarians in the nearby clinics.

Table 8. Castration and fattening practice in the study areas.

Parameter	Districts					
	Lay-Gayint		Semada		Overall	
	N	%	N	%	N	%
Fattening practice						
Yes	10	11.1	31	34.4	41	22.8
No	80	88.9	59	65.6	139	77.2
Castration practice						
Yes	74	82.2	73	81.1	147	81.7
No	16	17.8	17	19.9	33	18.3
Reason of castration						
Control breeding	1	1.1	4	4.4	5	2.8
Improve fatting	88	97.8	86	95.6	174	96.6
Better temperament	1	1.1	0	0	1	0.6
Castration method						
Modern	2	2.2	0	0	2	1.1
Traditional	78	97.8	90	100	178	98.89
Age of castration						
<3month	0	0	0	0	0	0
3-6month	0	0	0	0	0	0
>6month	90	100	90	100	180	100

N= Number of observations.

Reproductive performances: The age at sexual maturity of male goats at Lay-Gayint and Semada were found to be 7.85±1.84 and 8.53±2.32 months, respectively. Female goats were first mated at the age of 7.39±0.88 and 8.32±1.32 months in that order (Table 9). The lower age at sexual maturity of Lay-Gayint goats as compared with Semada districts could be due to sample size. The average age at puberty was significantly

($p<0.05$) different for both sexes across the two study areas, with the lowest value in Lay-Gayint districts. This variation might be due to management, availability of forage, environment factors and presence of buck in the flock. This study result is comparable with Belete (2013), who reported similar age at sexual maturity in the Bale Zone. The average age at first kidding for Lay-Gayint and Semada goats were 10.48±1.27 and 10.21±1.61 months, respectively, but with no significant variations ($p<0.05$). This is lower than the report of Tsigabu (2015), who reported 10.93 months for Nuer goat. Moreover, this study result is lower as compared to the report of Hussein (2015), who reported 15.2±0.08 months for Aris-Bale Highland goat. Furthermore, the average kidding interval in the Lay-Gayint and Semada districts were 7.01± 0.15 and 6.94±0.19 months, respectively. This result was comparable with the report of Netsanet (2014) and Hussein (2015), who reported 6.6 and 6.8±0.03 months for Central Highland and lowland area of Aris-Bale goat, respectively. On the other hand, the average reproductive life span of goats in Lay-Gayint and Semada districts were 13.77±2.83 and 11.75±3.07 years, respectively. The low life span in Semada district might be due to water shortage and high disease burden. However, these results are higher than the report of Solomon (2014), who reported 6.6 and 8.0 months for western lowland and Abergelle goats, respectively.

The average number of kids per life span in Lay-Gayint and Semada district was 15.91± 3.72 and 14.89±4.16 kids, respectively, which are comparable with the report of Belete (2013), who reported 14.0±0.30 kids for Rayitu area. On the other hand, it is higher than the report of Belete *et al.* (2015), who reported 11.9 kids for Arsi-Bale Zone. The average reproductive life span of buck in Lay-Gayint and Semada districts was 3.39±0.49 and 3.30±1.24 years, respectively. These results are lower than the report of Belete (2013), who reported 8.6±0.4 years for Aris-Bale area. The reason for lower reproductive life span of buck in both districts is attributed to the practice of castration of bucks after 3 years rather than keeping them for breeding purpose.

Table 9. Reproductive performance of goat population in the study areas.

Traits	Districts			p-value
	Lay-Gayint	Semada	Overall	
	Mean±SE	Mean ±SE	Mean ±SE	
Average at sexual maturity of male	7.85±1.84[a]	8.53±2.32[b]	8.19±2.12	0.029
Average at sexual maturity of female	7.39±0.88[a]	8.32±1.32[b]	7.86±1.21	0.00
Age at first kidding	10.48±1.27[a]	10.21±1.61[a]	10.34±1.45	0.220
Kidding interval	7.01±1.42[a]	6.94±1.81[a]	6.98±1.62	0.783
Average reproductive live span of female	13.77±2.83[a]	11.75±3.07[b]	12.76±3.11	0.000
Average number of litter size per doe	15.91±3.72[a]	14.89±4.16[a]	15.4±3.97	0.084
Average reproductive life span of male	3.39±0.49[a]	3.30±1.24[a]	3.34±0.07	0.528

[a, b]means letter with different superscript in the same row are significantly different ($p<0.05$); SE= Standard error.

Kidding pattern: According to the respondent, kidding occurred at any time of the year but there were seasons when most births occurred (Table 10). In this regard the highest 72.8% births occurred during Kieremit (Ethiopia's summer) during which there is surpless feeds. The lowest birth of 6.1% occurred during Belge (Ethiopia's autumn) during which short rainy season begins. According to a study by Yoseph (2007), breeding is naturally controlled to maximize the utilization of seasonal sexual activity or nutrient availability, as well as to ensure optimal ovulation and the highest chance of establishing pregnancy. According to respondents most type of births in the study districts was both single and twining (68.9%), single (17.8%), and twin (13.3%). This disagrees with the report of Alefe (2014) for Shebelle Zone, where single birth type was dominantly observed and Tsigabu (2015) for Nuer Zone where twining birth type was dominantly observed.

Table 10. Kidding pattern and types of birth in the study areas.

Parameters	Districts					
	Lay-Gayint		Semada		Overall	
	N	%	N	%	N	%
Kidding pattern						
Summer	58	64.4	73	81.1	131	72.8
Winter	13	14.4	6	6.7	19	10.6
Spring	12	13.3	7	7.8	19	10.6
Autumn	7	7.8	4	4.4	11	6.1
Type of birth						
Single	10	11.1	22	22.2	32	17.8
Twining	13	14.4	11	12.2	24	13.3
Both	67	74.4	57	63.3	124	68.9

N= Number of observations.

Description of the Goat Management Practices

Farming activity in the study areas: Concerning farming activities, mixed farming was practiced by 100% and 93.3% of the respondents in Lay-Gayint and Semada areas, respectively (Table 11), which was characterized by traditional and unimproved management practices. The result is in agreement with the reports of Bekalu *et al.* (2016). The major crops produced in Semada were teff, sorghum, haricot bean, and maize, whereas barley, wheat and potato were the dominant crops produced in Lay-Gayint district.

Table 11. Farming activities in the study areas.

Farming activity	Study areas					
	Lay-Gayint		Semada		Total	
	N	%	N	%	N	%
Mixed farming	90	100	84	93.3	174	96.7
Livestock production only	0	0	1	1.1	1	0.6
Crop production only	0	0	5	5.6	5	2.7

N= Number of observations.

The housing system in the study areas: Housing systems of goats observed in the study areas depend on the flock size and it was similar in both districts (Table 12). Farmers in the Lay-Gayint district penned their goats at night in separate house (60%), yard (38.9%) and house without shelter (fenced veranda) (1.1%) to prevent from predators, coldness and thieves. Likewise, farmers in Semada penned their goats at night in separate house (63.4%), yard (33.3%) and without shelter (fenced veranda) (3.3%). This study's results are in line with the reports of Wondwosen (2007) and Muluken (2006) in the country. In Semada, when goats were housed in confinement, suffocation occurred due to larger flock size-induced overheating. Hence, they preferred open camp than fully enclosed shelter, except during the rainy season, during which the goats were kept in roofed house that was built with stone and wood floor above ground (Figure 2). On the other hand, kids were housed in isolated rooms and joined the flock during day times. This study result was in agreement with the report of Netsanet (2014) and Hussein (2015).

Figure 2. Goat house used in Lay Gaiynt (left) and Semada district (right).

Feed resources and browsing method: The main feed resources during wet season was natural pasture in Lay-Gayint and Semada areas with index of 0.29 and 0.30, respectively followed by shrubs (0.27 and 0.29, respectively) (Table 13). This was in agreement with the report of Alubel (2015) in North Gondar Zone in that natural pasture was the dominant feed for goats during wet season. The main feed resource during dry seasons was shrub 0.30 and 0.26 in Lay-Gayint and Semada areas, respectively followed by natural pasture. In the study areas, feed shortage was mainly observed during dry season, which is linked to shortage of rainfall patterns and lack of awareness to preserve feed for goat during the dry season rather they provide for cattle and equine in some extent.

Table 12. Goat housing system in the study areas.

Type of housing system	Districts			
	Lay-Gayint		Semada	
	N	%	N	%
Separate house	54	60	57	63.4
Verenda	1	1.1	3	3.3
Yard	35	38.9	30	33.3

N= Number of observations.

Table 13. Way of feeding and feeding practice of goats in the study areas.

Feed source	Districts									
	Lay-Gayint					Semada				
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index
Dry season										
Natural pasture	80	189	30	5	0.27	104	350	78	25	0.26
Established pasture	0	7	0	0	0.00	24	0	0	0	0.01
Hay	0	0	18	10	0.01	16	14	0	0	0.01
Shrubs and bushes	584	84	24	0	0.30	512	119	18	10	0.26
Crop residue	32	14	96	55	0.08	48	91	216	25	0.18
By product	0	0	6	260	0.11	0	21	114	12	0.15
Fallow land	8	21	366	95	0.21	8	7	84	140	0.11
Concentrate	8	0	0	0	0.00	8	0	0	0	0.01
Wet season										
Natural pasture	432	217	24	0	0.29	400	364	12	0	0.30
Established pasture	0	0	0	0	0.00	16	0	6	0	0.01
Hay	16	14	6	5	0.02	0	0	0	5	0.00
Shrubs and bushes	184	371	72	0	0.27	264	364	14	10	0.29
Crop residue	0	0	78	60	0.06	0	0	96	110	0.09
Fallow land	72	28	354	70	0.22	16	28	300	80	0.19
By product	0	0	6	285	0.13	16	0	84	130	0.11
Concentrate	0	7	0	0	0.01	8	7	0	0	0.01

Index= Sum of (3 for rank 1 + 2 for rank 2 +1for rank3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2+1 for rank 3) for overall reason; R= Rank.

Browsing practices: Concerning browsing, it was similar in both dry and wet seasons. Majority of goat owners in both Lay-Gayint (index=0.38) and Semada area (index=0.34) practiced free grazing/browsing followed by rotational grazing/browsing during dry season. During wet season, farmers in the Lay-Gayint district practiced rotational grazing/browsing (index=0.36) (Table 14). This result is not in line with the report of Netsanet (2014) from Meta-Robi district in which natural pasture and hay were the main feed source in both seasons. On the other hand, paddock, tethering, and zero-grazing were less practiced in both areas, attributed to a lack of awareness about grazing land management. Grazing land ownership in Lay-Gayint district was 15.6% private, 22.2% communal, and 62.2% both, while it was 16.7% privet, 50% communal and 33.3% both in Semada. This result is contrary to the finding of Alefe (2014), who reported 100% communal for Shabelle Zone grazing land, which may be due to shifting in cultivation practice in the current study area.

Table 14. Common grazing/browsing method in the study areas.

Grazing method	Districts							
	Lay-Gayint				Semada			
	R1	R2	R3	Index	R1	R2	R3	Index
Dry season								
Free grazing/browsing	336	165	4	0.38	222	205	48	0.35
Rotational grazing	204	255	20	0.36	26	110	20	0.26
Herding	0	5	268	0.20	30	80	216	0.24
Tethering	0	0	40	0.03	6	0	0	0.00
Zero-grazing	0	15	28	0.03	54	60	64	0.14
Wet season								
Free grazing/browsing	120	280	32	0.32	37	105	20	0.38
Rotational grazing	354	115	28	0.36	11	280	16	0.31
Herding	18	15	264	0.22	42	50	268	0.27
Paddock	0	0	12	0.01	0	0	4	0.00
Tethering	48	10	14	0.05	0	0	0	0.00
Zero-grazing	0	20	16	0.04	6	5	40	0.04

Index = Sum of (3 for rank 1 + 2 for rank 2 +1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2+1 for rank 3) for an overall reason; R= Rank.

Herding practices: In the present study, about 21.9% and 90% of households in Lay-Gayint and Semada districts, respectively practiced mixed-livestock herding (herding goats with sheep, cattle and equine) while 78.1% and 10% of respondents in Lay-Gayint and Semada, respectively practiced goat herding with sheep only (Table 15). The privatization of communal grazing/browsing areas for the purpose of better protection and shortage of animals herders were among the reasons for practicing of multi-species grazing system in the study areas. While concurrently managing multiple animal species presents management challenges (Animut and Goetsch, 2008), the biological and economic benefits of mixed animal species herding could overshadow the challenges. In particular, on landscapes that support heterogeneous plant species, a mixed-species grazing system may be one of the most economically and biologically feasible options available to producers (Anderson *et al.*, 2012). A major advantage of mixed different animal species herding is the better utilization of the standing plants, grasses, shrubs, and forbs which could satisfy the needs of top and bottom grazers, and browsers.

Table 15. Way of herding of goat in the study areas.

Parameter	Districts					
	Lay-Gayint		Semada		Overall	
	N	%	N	%	N	%
Flock herding						
Male and female separate	1	1.1	3	3.3	4	2.2
Kids are separate	84	93.3	68	75.6	152	84.4
All class herded together	5	5.6	19	21.1	24	13.9
Way of herding						
Goat of one house hold run as flock	80	90	88	97.8	169	93.9
Goat of more than one house hold run as flock	10	10	2	2.2	11	6.1

N= Number of observations.

Common sources of water and watering frequencies: The availability of different water sources varied between study sites and seasons of the year (Table 16). The important sources of water comprise traditional hand dug wells, rivers/streams, ponds and tap water. Rivers was the most frequently stated water source in Lay-Gayint (85.56%) and Semada district (88.89 %). In both areas, the traditional hand dug wells were important source of water supply during water shortage followed by spring and steam. A group of elected community members oversaw the intricate set of laws and regulations that governed each traditional hand-dug well or pond. Similarly, Belay *et al.* (2011) documented that during rainy seasons, in addition to permanent water sources, temporary water sources such as rainwater collected in the depression on grazing lands were used irregularly to satisfy the thirst of livestock in Ginchi watershed.

Table 16. Major source of water in two seasons in the study areas.

Attribute	Districts			
	Lay-Gayint		Semada	
	N (90)	%	N (90)	%
Source of water during wet season:				
Spring water	2	2.22	0	0
River	77	85.56	80	88.89
Well	8	8.89	3	3.33
Streams	3	3.33	7	7.78
Source of water during dry season:				
Spring water	3	3.33	3	3.33
River	72	80	78	86.67
Well	4	4.44	7	7.78
Stream	11	12.23	2	2.22

N= Number of observations.

Watering frequencies: Watering frequencies during the dry season for goat herds in the Lay-Gayint and Semada districts were 2.2% and 4.4% freely available and 97.8% and 95.6 available once a day, respectively (Figure 3). This result is similar to the report of Endashaw (2007) in the Dale district in that young and sick goats were watered at home. On the other hand, it contradicts with the study of Mengistu (2007), who showed that during the dry season, short-eared Somali goats went without water for almost three days. Watering is a crucial management tool, hence studies are needed to determine how much goat productivity in arid regions is affected by watering frequency.

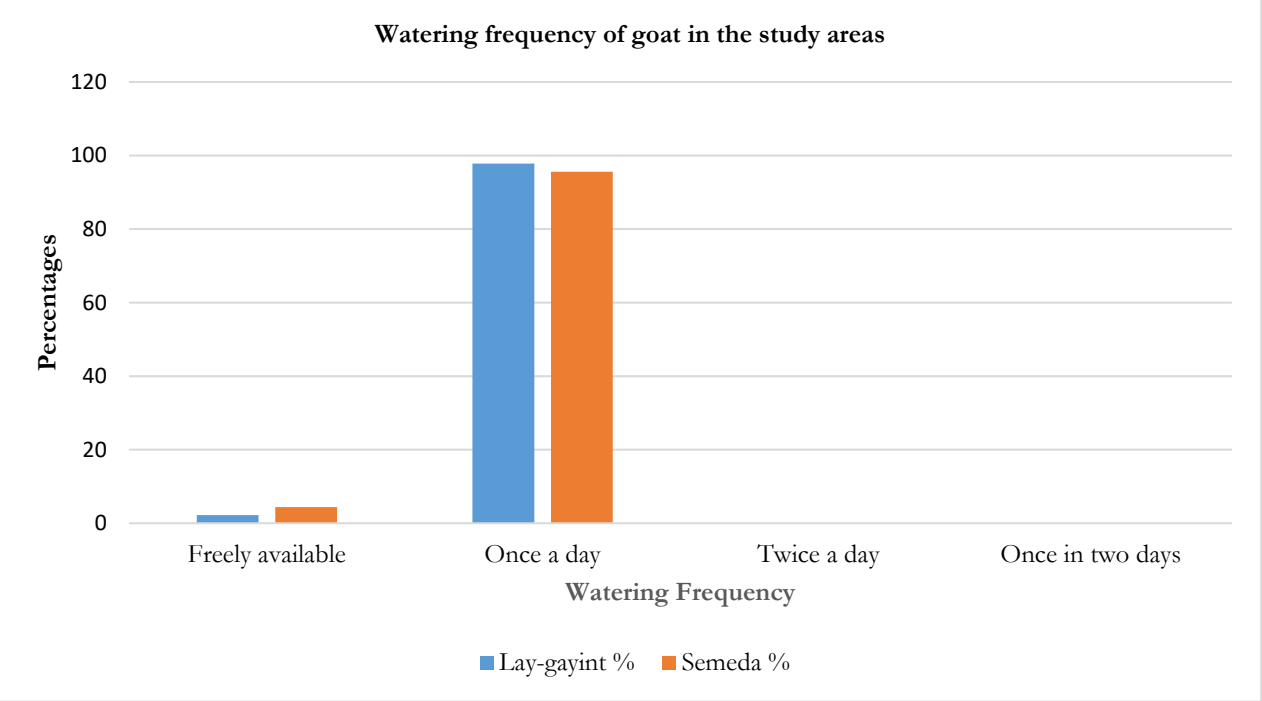

Figure 3. Watering frequency of goat in the study areas.

Management of animal health: All respondents in the study areas reported the incidence and symptoms of economically important several goat diseases like depression, circling, accidental death, miscarriage, coughing, severe nasal discharge that obstructs the nose, diarrhea with a foul odor and blood in it, lameness, mouth inflammation, vesicles forming on the mouth and foot, nodules on the lips and eyes, skin irritation, and scratching with fixed items. This finding is in line with the report of Aklilu (2008), Tesfaye (2009); and Grum (2010) for some Ethiopian goats. All of the respondents (100%) reported that that they got health care services for their goat at government clinic. In addition to this, they were applying indigenous knowledge (cultural treatments) such as branding of swellings; topical application of medicinal plant extracts; fumigation; discharging blood; and external application of oil, gas, used motor engine oil, and soap. Similar experiences were reported in Zimbabwe (Homann *et al.*, 2007).

Farmers and key informants of the study areas were able to identify the types of diseases affecting their animals by recognizing the common symptoms through experience. The most prevalent animal diseases (conditions) were pasteurellosis, pneumonia, goat pox, peste des petitis ruminants (PPR) particularly in the lowland area after the main rainy season (Table 17). Similar result was reported by Wondwosen (2007), Netsanet (2014), and Hulunim (2014). When the animals get sick farmers try to manage the diseased animals through separate housing and feeding management and provide cultural treatment until the animals get formal treatment through veterinarians visit.

Table 17. Common goat disease in the study areas.

Common diseases	Districts							
	Lay-Gayint				Semada			
	R1	R2	R3	Index	R1	R2	R3	Index
Pasteurellosis	243	192	119	0.31	126	144	147	0.25
Goat pox	126	112	140	0.21	99	152	77	0.20
Anthrax	198	120	98	0.23	369	104	63	0.32
PPR	9	8	7	0.01	9	0	0	0.01
Pneumonia	117	112	42	0.15	0	8	31	0.02
FMD	72	32	7	0.06	90	152	70	0.19
Conjunctivitis	9	32	0	0.02	0	24	21	0.03

Index= Sum of (3 X number of household ranked first+ 2 X number of household ranked second + 1 X number of household ranked third) give for each disease divided by sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for all of the disease for a production system; R= Rank.

Constraints associated with goat production: The constraints are similar across the study area though their importance varied (Table 18). In Lay-Gayint district, feed shortage, drought and predator ranked 1st, 2nd and

3rd as major goat rearing constraints while recurrent drought, feed shortage and disease were ranked in Semada district in order of importance. The main driving forces for feed shortage in the study areas were scarcity of private and communal grazing/browsing areas due to shifting cultivation, drought, and human population growth. The report of Arse *et al.* (2013) also shown that severe feed shortage, high disease prevalence and predatory were the main serious problems in Arsi Nagelle and Fentale districts. Water and labor shortages, and market inaccessibility were among the minor factors determining goat-rearing practices in the study areas. However, existence of predators received a little higher proportion around Lay-Gayint area as compared with Semada area. In both areas, almost all of the respondents did not rank about lack of appropriate genotype/breed as a constraint. This might indicate that farmers have good perception about their indigenous goats' adaptability and productivity characteristics and/or it might be due to lack of awareness about improved breeds.

Almost no respondents ranked the lack of an adequate genotype or breed as a limitation in either category. This may be a sign that farmers are confident in the production and adaptability of their native goats, or it may be the result of their limited knowledge about better breeds. Therefore, before implementing any breed development projects, the goat herders must be made aware of the benefits of upgrading the local goat breeds. According to the farmers' rating of the restrictions (indices) associated with goat rearing in the current study, professional and supportive services, which require the involvement of stakeholders, are their top priorities.

Weaning practices: In the study areas, three types of milk feeding up to weaning were practiced (Table 19). In this regard, most of the respondents practiced unrestricted milk feeding (92.7%), while the rest 6.7% and 0.6% practiced restricted and bucket feeding, respectively. The average weaning age of kids was <3 month (2.8%), 3-4 month (20 %), 4-5 month (39.4%) and > 5 month (37%) (Table 19). After weaning the practices of giving supplementary feeds for weaned kids alone is low in both districts except for few farmers who gives green feeds for their weaned kids. Most of the time weaning was done naturally by the does in both districts. This result disagrees with the report of Belete (2013) and Alefe (2014) for Balie and Shebelle Zones, respectively.

Table 18. Goat production constraints as perceived by the respondents in the study areas

Main constraint	Districts									
	Lay-Gayint					Semada				
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index
Drought	243	208	161	48	0.29	384	184	140	6	0.28
Shortage of feed	207	248	175	54	0.30	153	304	203	12	0.27
Shortage of water	27	8	0	144	0.06	9	32	35	84	0.06
Disease	153	112	21	192	0.10	126	168	231	78	0.24
Market problem	0	16	7	6	0.01	0	16	0	6	0.01
Predator	63	88	35	114	0.13	9	0	7	54	0.03
Shortage of labor	99	48	53	66	0.12	81	0	20	0	0.11
Lack of superior genotype	0	0	0	0	0	0	0	0	0	0

Index= Sum of (3 X number of household ranked first+ 2 X number of household ranked second + 1 X number of household ranked third) give for each constraint divided by sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for all of the constraint for a production system; R= *Rank.*

Table 19. Weaning time and milk feeding system in the study areas.

Parameter	Districts					
	Lay-Gayint		Semada		Overall	
	N	%	N	%	N	%
Milk feeding:						
Unrestricted	87	96.7	80	88.9	169	92.7
Restricted	2	2.2	10	11.1	12	6.7
Bucket feeding	1	1.1	0	0	1	0.6
Weaning age:						
<3month	1	1.1	4	4.4	5	2.8
3-4month	20	22.2	16	17.8	30	20
4-5month	41	46.6	30	33.3	71.l	39.4
>5month	28	31.1	40	44.4	68	37.8

N= Number of observations.

Conclusion

Mixed farming system was the major farming activities in the study areas, and goat rearing was practiced with low input with multi production objective in which the goats mostly herded with sheep in the study areas. In both study districts, natural pasture was the main feed source with free grassing/browsing method. The housing system depends upon the agro-ecology and flock size. The major goat production constraints across the study areas were feed shortage, drought, disease outbreak, predator, and shortage of labor, but out of these, shortage of feed was the major problem in Lay-Gayint than Semada areas. In the study areas, goat population has no variations in reproductive performance, but average reproductive life span of Lay-Gayint female goat is longer than Semada female goat population. Natural and uncontrolled mating system was dominantly practiced, and as the result of this matting system, physical appearance, coat color and performance were used to identify the future generation in the study area. Moreover, body size and coat color were the most important traits for goat selection criteria. Hence, farmers have relatively similar production and breeding objectives across the study area. In order to improve production and reproductive performance of goat population in the study areas, future interventions are expected to focus on the treatment and improvement of crop residues and demonstrating conservation mechanisms of excess feeds existing during the rainy season. In addition, demonstration and scaling up strategies for improved forage production practices have paramount importance in mitigating feed scarcity during dry seasons. Furthermore, strengthening the existing extension and veterinary service is required to reduce losses of goats caused by diseases.

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Conflict of Interests

The authors declare that they have no competing interests.

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