Journal of Applied Life Sciences International

Volume 27, Issue 3, Page 32-48, 2024; Article no.JALSI.116073
ISSN: 2394-1103

Indigenous Goat Populations in Northwestern and Western Zones of Tigray Region, Ethiopia: Characterization of Major Husbandry Practices and Kidding Patterns

Teweldemedhn Mekonnen [a*], Shishay Markos [a], Kibrom Esak [a] and Tesfay Ataklti [a]

[a] Tigray Agricultural Research Institute; Humera Begait Animals Research Center, Tigray, Ethiopia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JALSI/2024/v27i3645

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/116073

Original Research Article

Received: 16/02/2024
Accepted: 18/04/2024
Published: 24/04/2024

ABSTRACT

The survey was conducted before the war (before October 2020) in Tigray Region, Ethiopia. Goats are highly concentrated in the lowland areas than in the highlands of Ethiopia. Sample households of Begait (102), Hassan (106) and Arado (181) goats were randomly involved in the face-to-face interview. Statistical Package for Social Sciences software was used for data analysis. Illiterate respondents were in Begait (42%), Hassan (29%) and Arado (55%). Cattle and goats were the major economic sources in Begait (10.19±9.1 Tropical Livestock Unit (TLU), 4.30±2.8 TLU) and Arado (4.77±3.2 TLU, 1.27±0.9 TLU) respondents. The mean flock size of Arado goat population (12.65±9.9) was significantly (*P*<0.005) lower than the mean flock sizes of Begait (43.02±28.1) and

**Corresponding author: E-mail: teweldem2004@gmail.com;*

Hassan (70.29±52.6) populations. Animals went to water source in most respondents (100.0% of Begait, 67.0% of Hassan and 87% of Arado), and river was the major water source for the animals of about 47% of Begait, 43% of Hassan and 79.0% of Arado respondents. Animals of about 56% of Hassan and 57% of Arado respondents travelled a distance of 1-5 Kilometer (Km) to obtain water, and dry season daily watering frequency of once a day was dominantly practiced in about 88% of Begait and 83% of Hassan respondents. Diseases and external parasites were reported in Begait (96%, 85%), Hassan (98%, 90%) and Arado (67%, 87%) respondents which affected indigenous goat productivity. There was no access to veterinary service centers (VSCs) in about 47% of Begait, 65% of Hassan and 93% of Arado respondents, and some respondents in about 24% of Begait and 17% of Hassan travelled a distance of greater than 10 Km to reach VSCs. Own buck use for mating and buck birth in own flocks were exhibited in Begait (93%, 85%), Hassan (95%, 76%) and Arado (38%, 35%) respondents, respectively. Uncontrolled mating and buck use outside of own flock were practiced in Begait (70%, 73%), Hassan (43%, 65%) and Arado (100.0%, 100.0%) respondents due to most goats graze in communal lands, respectively. Unknown buck to does ratio was practiced in 41% of Begait and 39% of Hassan respondents. Unknown buck to does ratio and a ratio of one buck to all does in the flock were practiced in Arado (8%, 67%) respondents, respectively, and crossbreeding was highly practiced in Begait respondents (41%). The dominant kidding months of Begait and Arado goat populations were in September up to November whilst that of Hassan goat population were in October up to December. Castration and traditional castration method were practiced in Begait (54%, 54%), Hassan (39%, 37%) and Arado (70%, 64%) respondents, respectively. Community education, access to water, access to VSC, buck to doe ratio, kidding pattern improvement and castration to control inbreeding need critical attention.

Keywords: Characterization; indigenous goat; husbandry practices; watering practice; mating practice; kidding patterns.

1. INTRODUCTION

The entire rural areas of Ethiopia including the sedentary and pastoral area hosted an estimated goat population of 46 million, and 99.62% of the total populations made up indigenous goats [1]. “About 27% of goat populations accommodated in the highlands of crop-livestock mixed farms and 73% of goat population usually inhabit in arid and semi-arid lowland areas of Ethiopia” [2]. “National goat microsatellite loci (15) characterization in Ethiopia identified *eight separate goat genetic entities* which comprised of Arsi-Bale, Gumuz, Keffa, Woyto-Guji, Abergelle, Afar, Highland goats, and Eastern and Southeastern goats” [3]. Farmers and/or pastoralists in Ethiopia kept goats as source of food, income generation, socio-cultural considerations and non-food products such as skin and manure [4-6].

“Almost all of the goat populations in Ethiopia are managed by resource poor smallholder farmers (SHFs) and pastoralists under traditional and extensive production systems” [7]. “Hence, the poor performance indicators of goat production kept under SHFs in Ethiopia included slow growth rates of goats, high mortality rate and low commercial off-take rate” [7-8]. “Goats in Ethiopia are managed under extensive traditional system and their productivity is low as compared to the other sub-Saharan African countries” [9]. “Technical, institutional and socio-economic aspects were the different problems for the low productivity of goats in Ethiopia” [10]. “Factors such as poor nutrition, prevalence of diseases, lack of appropriate breeding strategies and poor understanding of the production system might be the factors for low productivity of goats” [4]. The indigenous goat genetic resources of the North Western and Western Zones of Tigray Region, Ethiopia were not included in the study of Tesfaye [3]. The phenotypic and genetic characteristics and husbandry practices of the indigenous goat genetic resources of the study area are not well recognized, and all the national indigenous goat genetic resources are not well characterized.

The goat population in Kafta Humera district has two local names (Hassan and Begait) and the goat population in Tahtay Adiabo district has one local name (Begait). The goat populations in both districts are phenotypically different. Hence, the goat population in Kafta Humera district was represented “Hassan” and the goat population in Tahtay Adiabo district was represented “Begait” for characterization and identification. Improvement plan, sustainable utilization and conservation strategies of a breed at local,

national, regional and global levels depend essentially on characterization [11]. "Zonal characterization information on husbandry practices, mating experiences and production performances of indigenous goats were recently published" [12-13]. However, the characterization information was not population specific on Begait goat population, Hassan goat population and Arado goat population. The population specific information on husbandry practices and kidding patterns will be helpful to develop a breed management plan in conservation, improvement and sustainable utilization of the indigenous goat genetic resources. Hence, the objective of the survey was to characterize the major husbandry practices and kidding patterns of the indigenous goat populations.

2. MATERIALS AND METHODS

2.1 Description of the Study Areas

The survey was carried out in Tahtay Adiabo, Kafta Humera, Tsegede and Welkait districts. Kafta Humera district is the lowland part of Western Zone of Tigray Region, Ethiopia whereas Welkait and Tsegede districts are the highland areas of Western Zone of Tigray Regional State. Tahtay Adiabo district is located in the North Western Zone of Tigray, Ethiopia.

"Kafta Humera district has two agro-ecologies which consist of 86% lowland (*kola*) and 14% midland (*weina dega*)". Kafta Humera district is characterized by an altitude of 500-1849 meter above sea level (masl), rainfall of 650-750 millimeter (mm) and temperature of 25-48 ^{o}c. Welkait district has also two agro-ecologies which include 60% lowland (*kola*) and 40% midland (*weina dega*). Welkait district is characterized by an altitude of 700-2354 masl, rainfall of 700-1800 mm and temperature of 18-25 ^{o}c. Tsegede district has three agro-ecologies which comprise 70% lowland (kola), 22% midland (*weina dega*) and 9% high land (*dega*). Tsegede district is also characterized by an altitude of 680-3008 masl, rainfall of 1200-2500 mm and temperature of 12-35 ^{o}c. The districts have forestry and grazing land uses (Fig. 1) [14].

2.2 Data Collection and Statistical Analysis

Indigenous goat respondents of 102 of Begait, 106 of Hassan and 181 of Arado were randomly involved in the face-to-face interview. However, Tahtay Adiabo (Begait), Kafta Humera (Hassan), Tsegede and Welkait (Arado: highland goats) districts were purposively selected. The Kebelles were also purposively selected for the single visit questionnaire survey.

Statistical Package for Social Sciences [15] software was used for the analysis of the household survey data. Descriptive statistics (frequency, percentages and mean) was used to summarize the data. Nonparametric chi-square (X^2) test and mean comparison were used to test the differences, and P<0.05 was the significance level stated. Moreover, index ranking [16] was used to know the kidding patterns of indigenous goat populations.

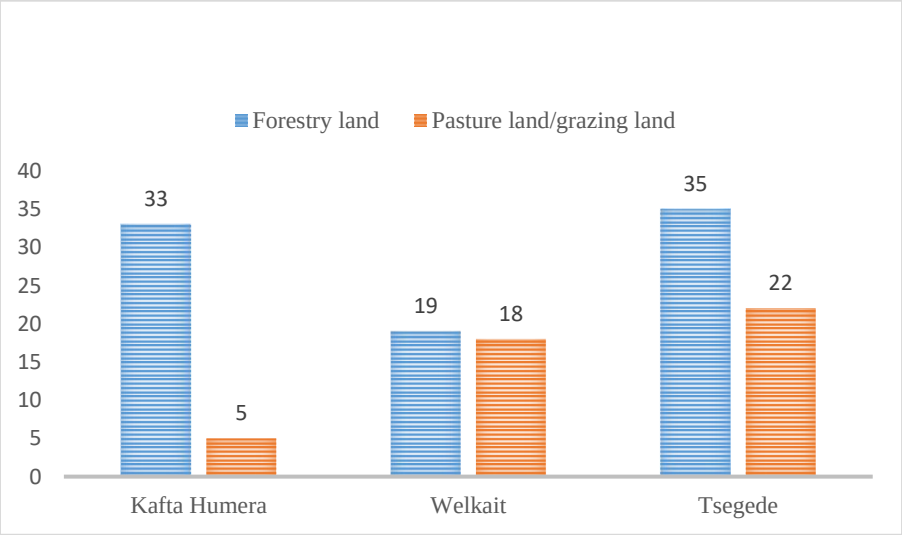

Fig. 1. Forestry and pastureland/grazing land uses (%)

3. RESULTS

3.1 Characteristics of Respondents

Very few (17% of Begait, 1% of Hassan and 6% of Arado) female households were involved in the face-to-face interview (Table 1). About 42% of Begait, 29% of Hassan and 55% of Arado respondents were illiterate whereas 25% of Begait, 43% of Hassan and 26% of Arado respondents interviewed attended lower primary school (Fig. 2). A mean age of 46.00±11.3 years old (Begait), 50.00±10.4 Hassan and 46.58±11.3 Arado respondents, and family size of 6.54±2.1 Begait, 6.51±2.3 Hassan and 6.64±2.1 Arado respondents were involved in the survey. Mean arable landholding cultivated under rain-fed condition of the respondents were 2.33±1.4 hectare (ha) of Begait, 27.37±70.7 ha of Hassan and 1.24±1.8 ha of Arado whereas except in Hassan respondents, cattle and goats (TLU) were dominant livestock species in Begait (10.19±9.1, 4.30±2.8) and Arado (4.77±3.2, 1.27±0.9) respondents (Table 1). The indigenous goat populations were kept under low input extensive production system (Fig. 3, 4 and 5).

3.2 Flock Dynamics of Indigenous Goat Populations in 2017 Production Year

The mean number of males greater than one-year-old in Arado goats (0.57±0.9) was lower than Begait (2.16±1.9) and Hassan (2.97±3.0) goat populations whilst mean number of females greater than one-year-old of Hassan goats (25.21±21.7) was higher than Begait (14.79±12.8) and Arado (5.99±4.9) goats. The mean numbers of females in six months to one-year-old and in greater than one-year-old were the major proportion in the flocks of Begait (8.75±7.8, 14.79±12.8) and Hassan (14.34±12.3, 25.21±21.7) goat populations. It was also noted that the flock dynamics of Begait (-16.55) and Arado (-16.69) goats in 2017 production year were at a decreasing rate of changes (Table 2).

Table 1. Demography, household livestock and honeybee holding

HH head gender and educational level	Begait goat respondents	Hassan goat respondents	Arado goat respondents	*P* value
Gender				
Male	85(83.3)	105(99.1)	171(94.5)	
Female	17(16.7)	1(0.9)	10(5.5)	
Age and family size of HH head: Mean (±SD)				
Age	46.00±11.3	50.00±10.4	46.58±11.3	0.018
Family size	6.54±2.1	6.51±2.3	6.64±2.1	0.871
Landholding (ha)				
Arable landholding	2.33±1.4	27.37±70.7	1.24±1.8	0.000
Irrigation landholding	0.05±0.2	0.25±1.1	0.01±0.09	0.003
Grazing landholding	0.03±0.2	1.88±8.1	0.02±0.1	0.001
Livestock and honey bee				
Cattle holding (TLU)	10.19±9.1	8.34±14.9	4.77±3.2	0.000
Sheep holding (TLU)	0.75±1.1	8.52±9.1	0.16±0.4	0.000
Goats holding (TLU)	4.30±2.8	7.03±5.3	1.27±0.9	0.000
Chickens holding (TLU)	0.07±0.1	0.09±0.1	0.04±0.1	0.000
Donkeys holding (TLU)	0.73±0.9	0.61±0.8	0.51±0.4	0.052
Camels holding (TLU)	0.31±0.5	0.01±0.1	0.02±0.1	0.000
Honeybees holding (number)	0.08±0.3	0	0.78±1.5	0.000
Mules holding (TLU)	0	0	0.1±0.1	0.177
Horse holding (TLU)	0	0	0.11±0.4	0.001

TLU=Tropical Livestock Unit

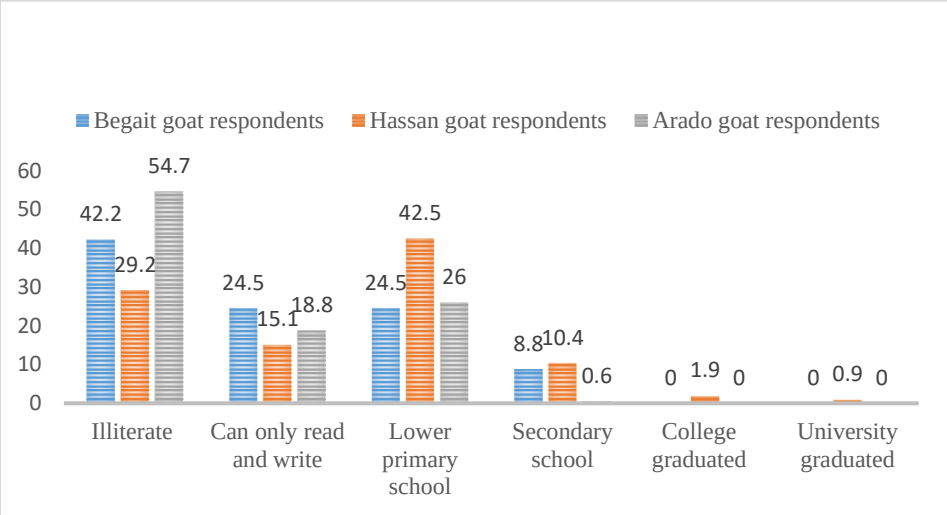

Fig. 2. Education status of household heads (%)

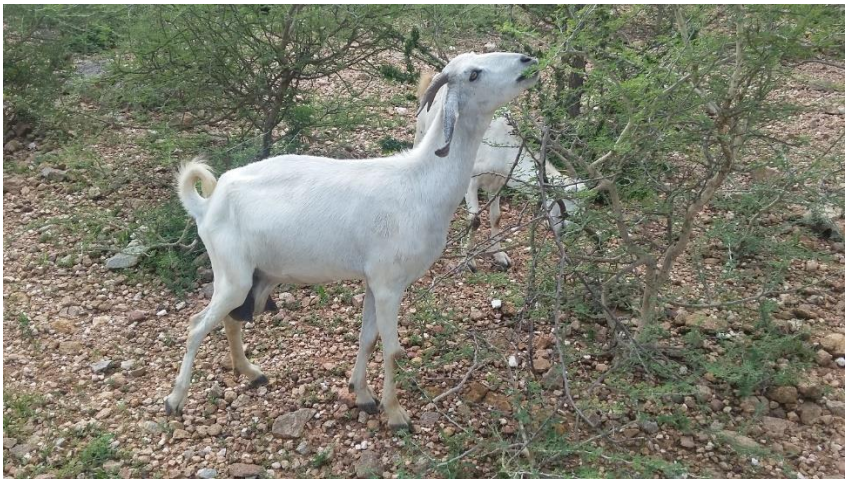

Fig. 3. Begait goats (Adi-Asser, Tahtay Adiabo district)

Fig. 4. Hassan goats (May Weini Ranch, Kafta Humera district)

Fig. 5. Arado goats (Highland Welkait district)

Table 2. Indigenous goat flock structure, flock dynamics of goats across populations in 2017

Flock by age and sex (mean±SD)	Begait goat	Hassan goat	Arado goat	*P* value
N of male kids <6 months old	6.33±4.9	9.04±9.1	1.73±1.5	0.000
N of female kids <6 months old	6.90±5.7	11.47±10.5	2.29±1.8	0.000
N of males 6 months to one year old	3.78±4.1	5.38±6.8	0.73±1.7	0.000
N of females 6 months to one year old	8.75±7.8	14.34±12.3	1.34±2.2	0.000
N of males >1 year old	2.16±1.9	2.97±3.0	0.57±0.9	0.000
N of females >1 year old	14.79±12.8	25.21±21.7	5.99±4.9	0.000
N of castrated males	0.40±0.9	0.21±0.8	0.06±0.4	0.000
Flock size	**43.02±28.1**	**70.29±52.6**	12.65±9.9	0.000
Flock dynamics (%)				
Entries due to birth and others	42.81	42.40	56.66	47.29
Exits due to sale and others	59.36	42.34	73.35	58.35
% change in flock	**-16.55**	+0.06	**-16.69**	**-11.06**

N=Number of heads of animals, SD=Standard Deviation

3.3 Watering Practices in Indigenous Goats in the Dry Season

Most respondents (100.0 of Begait, 67.0% of Hassan and 87% of Arado) reported that their animals go to water source. River was the water source for the animals of about 47% of Begait, 43% of Hassan and 79.0% of Arado respondents. Except in Begait respondents, majority (56% of Hassan and 57% of Arado) of the respondents indicated that their animals travel a distance of 1-5 Kilometer (Km) to obtain water. The survey also revealed that with the exception of Arado, about 88% of Begait and 83% of Hassan respondents reported that their goats drank water once a day in the dry season (Table 3).

3.4 Diseases and External Parasites, and Veterinary Services

The respondents (96% of Begait, 98% of Hassan and 67% of Arado) also reported there were diseases whereas 85% of Begait, 90% of Hassan and 87% of Arado respondents reported there were external parasites (EP) which affected productivity of the indigenous goats. About 55% of Begait and 49% of Hassan respondents reported that the EPs were occurred in the dry season, however, 80% of the

Arado respondents signposted that the EPs were exhibited in both dry and wet seasons (Table 4).

However, access to veterinary service centers (VSCs) was opposite to the occurrences of diseases and EPs. Respondents of about 47% of Begait, 65% of Hassan and 93% of Arado reported that there was no access to VSCs (Table 4). About 24% of Begait and 17% of Hassan respondents received VSC at a distance of greater than 10 km which greatly affected productivity of the indigenous goats. Therefore, access to VSC was a critical challenge in Arado goat production (Fig. 6).

3.5 Mating and Breeding Practices in Indigenous Goats

About 38% of Arado respondents, 93% of Begait and 95% of Hassan respondents used their own buck for mating, and 85% of Begait, 76% of Hassan and 35% of Arado respondents reported that the bucks were born in their own flocks. Uncontrolled mating was practiced in 70% of Begait, 43% of Hassan and 100.0% of Arado respondents due to the fact that most goats graze in communal lands. Moreover, about 73% of Begait, 65% of Hassan and 100.0% of Arado respondents also used bucks outside of their own flocks (Table 5). Arado respondents practiced extremely lower (8%) unknown ratio of buck to does whereas 41% of Begait and 39% of Hassan practiced unknown ratio of buck to does, and about 67% of Arado respondents practiced a ratio of one buck to all does in the flock (Fig. 7). Crossbreeding was highly practiced in Begait respondents (41%) than in Hassan (9%) and Arado (9%) respondents (Table 5).

3.6 Kidding Patterns of Indigenous Goat Populations

The kidding seasons were not synchronized but depends on communal grazing. As the indices and graph revealed (Table 6 and Fig. 8), the dominant kidding times of Begait and Arado goats were in September, October and November whilst the dominant kidding months of Hassan goats were in October, November and December. Some of the three indigenous goats also gave birth in June of the same year (Table 6).

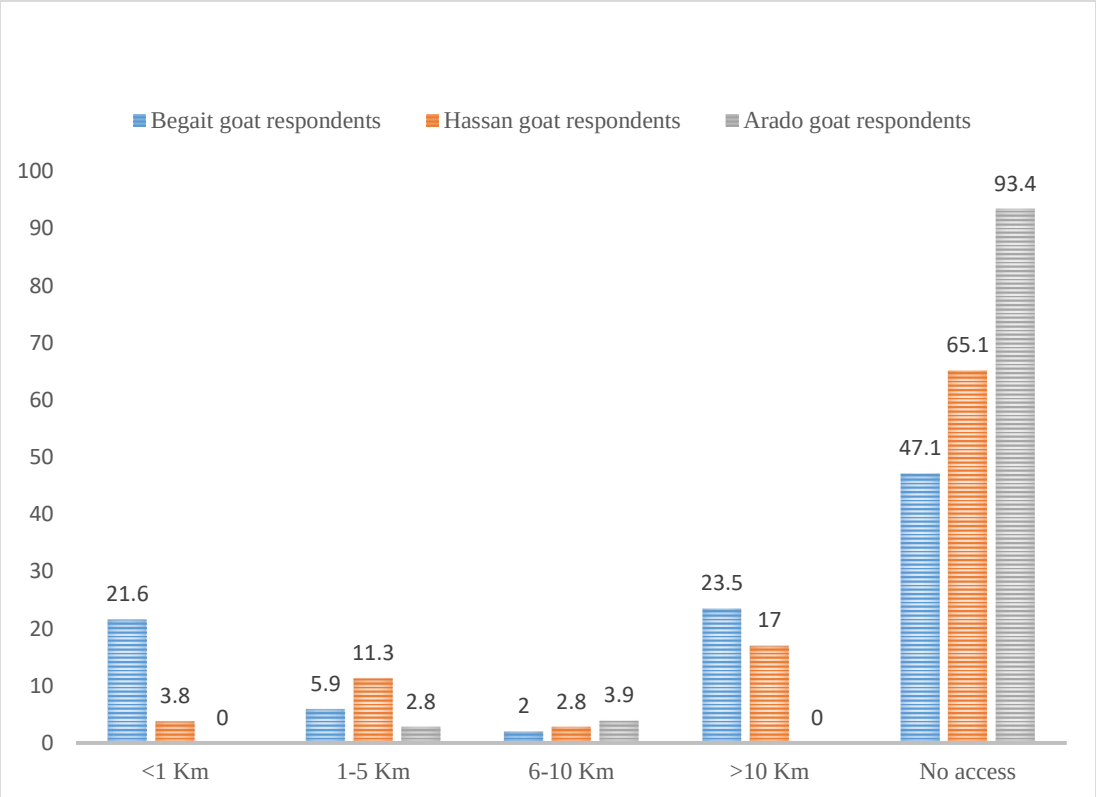

Fig. 6. Distance between veterinary service center and smallholder farmers (%)

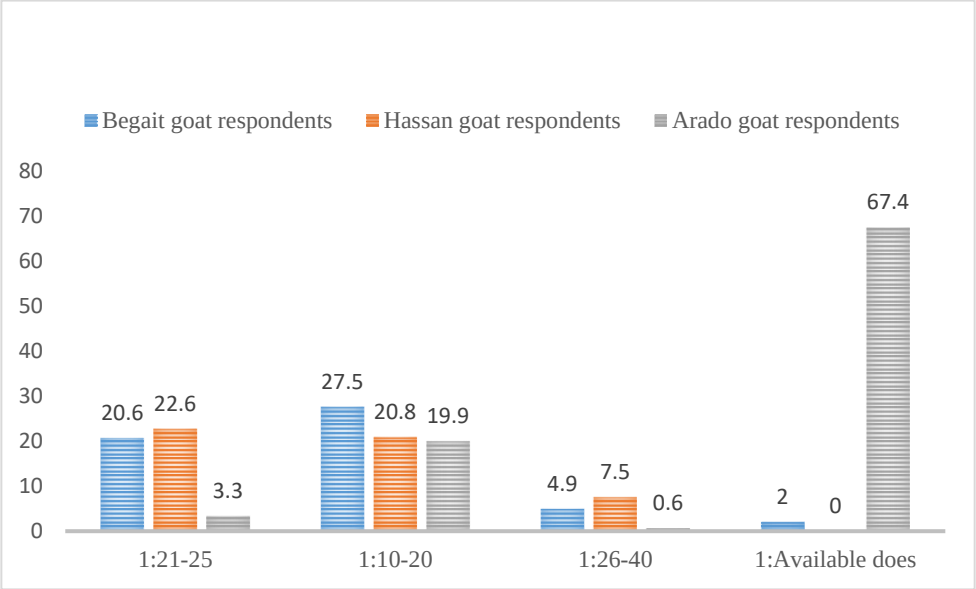

Fig. 7. Ratio of buck to does (%)

Table 3. Frequency (%) of watering practices of indigenous goat populations in the dry seasons (n=389)

How to provide water	Begait	Hassan	Arado
Animals go to water	102(100.0)	71(67.0)	158(87.3)
Water is fetched	0.0	11(10.4)	16(8.8)
Both types	0.0	24(22.6)	7(3.9)
X^2	-	56.39	237.82
P value	-	0.000	0.000
Water source type			
River	48(47.1)	46(43.4)	143(79.0)
Water well	12(11.8)	8(7.5)	30(16.6)
Piped	0.0	3(2.8)	3(1.7)
Borehole	42(41.2)	49(46.2)	5(2.8)
X^2	21.88	67.21	291.55
P value	0.000	0.000	0.000
Watering point distance			
Household site	0.0	7(6.6)	15(8.3)
<1 Km	46(45.1)	21(19.8)	58(32.0)
1-5 Km	46(45.1)	59(55.7)	103(56.9)
6-10 Km	9(8.8)	18(17.0)	5(2.8)
>10 Km	1(1.0)	1(0.9)	0.0
X^2	67.18	96.64	133.32
P value	0.000	0.000	0.000
Watering frequency			
Freely available	0.0	2(1.9)	2(1.1)
Once a day	90(88.2)	88(83.0)	73(40.3)
Twice a day	11(10.8)	9(8.5)	106(58.6)
Once in 3 days	1(1.0)	7(6.6)	0.0
X^2	139.82	191.28	93.62
P value	0.000	0.000	0.000

Table 4. Frequency (%) of diseases and external parasites (EP), access to veterinary service, type of veterinary service center (VSC) and distance between VSC and SHFs

Occurrences of diseases	Begait	Hassan	Arado
Yes	98(96.1)	104(98.1)	122(67.4)
No	4(3.9)	2(1.9)	59(32.6)
Occurrences of EP			
Yes	87(85.3)	95(89.6)	157(86.7)
No	15(14.7)	11(10.4)	24(13.3)
Season of occurrence of EP			
Dry season	56(54.9)	52(49.1)	12(6.6)
Wet season	8(7.8)	0	1(0.6)
Dry and wet seasons	23(22.5)	43(40.6)	144(79.6)
No EP	15(14.7)	11(10.4)	24(13.3
X^2	53.06	26.28	293.19
P value	0.000	0.000	0.000
Access to VSC			
Yes	54(52.9)	37(34.9)	12(6.6)
No	48(47.1)	69(65.1)	169(93.4)
Type of VSC			
Government VSC	54(52.9)	37(34.9)	12(6.6)
No vet service center	48(47.1)	69(65.1)	169(93.4)

VSC=Veterinary Service Center, SHFs=Smallholder farmers

Table 5. Frequency (%) of mating and breeding practices of Indigenous goat populations (n=389)

Own buck use for mating	Begait	Hassan	Arado
Yes	95(93.1)	101(95.3)	68(37.6)
No	7(6.9)	5(4.7)	113(62.4)
Breeding buck sources			
Born in flock	87(85.3)	80(75.5)	63(34.8)
Bought	1(1.0)	10(9.4)	3(1.7)
Born in and bought	7(6.9)	11(10.4)	2(1.1)
No own buck	7(6.9)	5(4.7)	113(62.4)
X^2	198.71	144.79	189.19
P value	0.000	0.000	0.000
Type of mating			
Uncontrolled	71(69.6)	46(43.4)	181(100.0)
Controlled	31(30.4)	60(56.6)	0.0
Reason(s) for uncontrolled mating			
Community goat graze together	71(69.6)	46(43.4)	181(100.0)
Controlled	31(30.4)	60(56.6)	0.0
Buck use outside own flock			
Yes	74(72.5)	69(65.1)	181(100.0)
No	28(27.5)	37(34.9)	0.0
Crossbreeding practice			
Yes	42(41.2)	10(9.4)	17(9.4)
No	60(58.8)	96(90.6)	164(90.6)

Table 6. Index of Kidding Patterns of Indigenous Goat Populations across months of a year

Month	Begait goat				Hassan goat				Arado goat			
	R_1	R_2	R_3	Index	R_1	R_2	R_3	Index	R_1	R_2	R_3	Index
Sep.	31	7	8	0.19	16	1	8	0.09	76	13	10	0.25
Oct.	39	39	14	0.35	48	24	22	0.34	68	83	19	0.37
Nov.	21	39	24	0.27	32	45	18	0.32	12	62	68	0.21
Dec.	0	9	18	0.06	7	20	39	0.16	1	7	48	0.06
Jan.	0	0	5	0.01	1	0	4	0.01	0	1	0	0.00
Feb.	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Mar.	0	0	1	0.00	0	0	0	0.00	0	0	0	0.00
Apr.	0	3	2	0.01	0	0	0	0.00	2	0	0	0.01
May	0	1	4	0.01	1	1	2	0.01	7	6	2	0.03
Jun.	12	1	18	0.09	2	11	6	0.05	14	6	15	0.06
Jul.	0	0	2	0.00	0	1	4	0.01	0	1	1	0.00
Aug.	0	0	1	0.00	0	0	0	0.00	0	0	1	0.00

Sep.=September…Aug.=August,Index = Sum of (3 x number of households who ranked first + 2 x number of households who ranked second + 1 x number of households who ranked third) given for each variable divided by Sum of (3 x number of households who ranked first + 2 x number of households who ranked second + 1 x number of households who ranked third) for all variables

Table 7. Frequency (%) of buck castration practices in indigenous goat populations (n=389)

Buck castration practice	Begait	Hassan	Arado
Yes	55(53.9)	41(38.7)	127(70.2)
No	47(46.1)	65(61.3)	54(29.8)
Reason(s) for castration			
Control inbreeding	1(1.0)	0.0	2(1.1)
Improve carcass quality	9(8.8)	17(16.0)	125(69.1)
Control inbreeding and improve carcass quality	45(44.1)	24(22.6)	0.0
No castration	47(46.1)	65(61.3)	54(29.8)
X^2	67.26	38.06	126.38
P value	0.000	0.000	0.000
Castration age			
3-6 months	1(1.0)	0.0	0.0
2-3 years	38(37.3)	25(23.6)	110(60.8)
4-5 years	7(6.9)	3(2.8)	12(6.6)
No castration	47(46.1)	65(61.3)	54(29.8)
3-6 months and 2-3 years	7(6.9)	9(8.5)	0.0
2-3 and 4-5 years	2(2.0)	4(3.8)	5(2.8)
X^2	118.94	127.77	154.58
P value	0.000	0.000	0.000
Method of castration used			
Burdizzo	0.0	1(0.9)	5(2.8)
Traditional	55(53.9)	39(36.8)	115(63.5)
Traditional and burdizzo	47(46.1)	65(61.3)	54(29.8)
No castration	0.0	1(0.9)	7(3.9)
X^2	0.627	110.91	177.34
P value	0.428	0.000	0.000

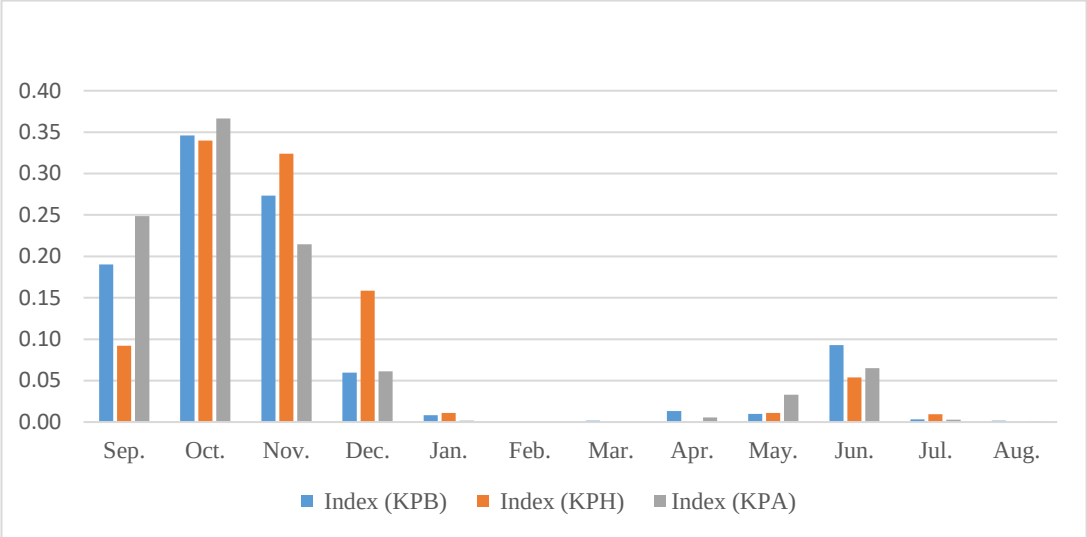

Fig. 8. Kidding patterns of indigenous goat populations across months of a year
KPB=Kidding Pattern of Begait, KPH= Kidding Pattern of Hassan and KPA= Kidding Pattern of Arado

3.7 Buck Castration Practices

About 54% of Begait, 39% of Hassan and 70% of Arado respondents practiced buck castration at different ages of the animals for the purpose of improving carcass quality in Arado respondents (69%), and control inbreeding and improve carcass quality (44% of Begait and 23% of Hassan respondents). Castration as a tool to control inbreeding was a neglected practice. The respondents (37% of Begait, 24% of Hassan and 61% of Arado) also indicated that the major castration age of the animals was in 2-3 years old. Traditional castration method was practiced in 54% of Begait, 37% of Hassan and 64% of Arado respondents (Table 7).

4. DISCUSSION

The mean numbers of males and females greater than one-year-old of Arado (0.57±0.9, 5.99±4.9) goat population were lower than Begait (2.16±1.9, 14.79±12.8) and Hassan (2.97±3.0, 25.21±21.7) populations. In this case, mean numbers of males were extremely lower than females due to early sale and slaughter of the male animals. The mean numbers of females in six months to one-year-old and in greater than one-year-old were the major proportions in the flocks of Begait (8.75±7.8, 14.79±12.8) and Hassan (14.34±12.3, 25.21±21.7) goat populations. The major proportion of females in flocks of Begait and Hassan which are greater than one-year-old are in line with Gatew *et al*. [17] report in Bati area, Borana area and Siti area of Ethiopia. The flock dynamics of Begait (-16.55) and Arado (-16.69) goats in 2017 production year were at a decreasing rate of changes due to death and sale. The mean (±SD) flock size of Arado goats (12.65±9.9) was significantly (P<0.005) lower than Begait (43.02±28.1) and Hassan (70.29±52.6) goat populations. The mean flock size of Arado goat is similar with Alubel, [18] report in Lay Armachiho (10.5±7.5), and the mean flock size of Begait is similar with Gatew *et al*. [17] report in Siti Zone (44.02±3.33). The mean flock sizes of Begait and Hassan goats are higher than the mean flock sizes reported by Alubel [18] in Ziquala (36.1±61.9) and Tanqua Abergelle (38.2±63.9) and Gatew *et al*. [17] report in Borana (23.08±1.94). The differences in mean flock sizes could be due to purpose of breeding, production system, access to browsing area and community livelihood status.

Most respondents (100.0 of Begait, 67.0% of Hassan and 87% of Arado) reported that their animals went to water source. River was the water source for the animals of about 47% of Begait, 43% of Hassan and 79.0% of Arado respondents. These percentages are not in agreement with Alubel [18] report in Ziquala (92.6%), Tanqua Abergelle (82.9%) and Lay Armachiho (95.8%), Alefe [19] report survey at Shabelle Zone of Denan (0%), Gode (90.5%) and Adadle (50%), Tsigabu [20] survey report in Nuer Zone, South Western Ethiopia (71.7%), Hailu [21] report in indigenous goats in North Shewa Zone, Amhara Region, Ethiopia (58.3%)

used river as source of water, and Tariku et al. [22] report on traditional husbandry practices of goats in selected districts of Sidama Zone, Southern Ethiopia (65% used river as water source). The differences might be due to differences in ecological, occurrences of drought and geographical topography. River as source of water in Arado goats is similar with Wendimu *et al*. [23] report on indigenous goat production system in Asossa Zone, Benishangul Gumuz Region, Ethiopia (75.3% used river). Majority (56% of Hassan and 57% of Arado) of the respondents indicated that their animals travelled a distance of 1-5 Kilometer (Km) to obtain water. This is not in line with Alubel [18] report in Ziquala (79.4%), Tanqua Abergelle (67.1%) and Lay Armachiho (66.1%), Alefe [19] report survey at Shabelle Zone of Gode and Adadle and Denan of all levels of distances, and Abdi *et al*. [24] report in Dollo Zone, Somali Regional State, Ethiopia (17.3% travelled 1-5 Km). The differences might be due to ecological natural resources, water source options, production system and household labor forces available. The distances trekked (1-5 Km) by goats of Hassan (56%) and Arado (57%) respondents are similar with Yemane *et al*. [25] report on production systems and husbandry practices of Ethiopian indigenous goats (54.3% trekked 1-5 Km).

About 88% of Begait and 83% of Hassan respondents reported that their goats drank water once a day in the dry season. The current daily watering frequency is not similar with Alefe [19] survey report at Shabelle Zone of Denan (66.7%), Gode (33.3%) and Adadle (78.6%), Alubel [18] report in Lay Armachiho (65.3%) and Ziquala (97.1%), Gatew *et al*. [17] in Bati area (93.9%), Borana (2.3%) and Siti area (30.4%), Tsigabu [20] survey report in Nuer Zone, South Western Ethiopia (15.6% once a day), Gebrekiros [26] survey report in Western Zone of Tigray, Ethiopia (70.0% once a day), Shegaw et al. [27] report in South Western Ethiopia (70.5% once a day), Abdi et al. [24] report in Dollo Zone, Somali Regional State, Ethiopia (17.3% once a day), Yemane *et al*. [25] report on production systems and husbandry practices of Ethiopian indigenous goats (52.9% drank once a day), and Tariku *et al*. [22] report on traditional husbandry practices of goats in selected districts of Sidama Zone, Southern Ethiopia (71.7% used once a day in the dry season). The differences could be due to purpose of breeding, access to water, intensity of environmental temperature, production system and experiences of farmers. The daily watering frequency of Begait (88%) in the study area in dry season is in line with Alubel [18] report in Tanqua Abergelle (88.6%).

Occurrences of diseases in 96% of Begait, 98% of Hassan and 67% of Arado respondents are not comparable with Tsigabu [20] survey report in Nuer Zone, South Western Ethiopia (occurrence of diseases 43.9%). This might be due to differences in access to veterinary service center (VSC), production system, level of management provided and ecological suitability. About 85% of Begait, 90% of Hassan and 87% of Arado respondents reported there were external parasites (EP) which affected productivity of the indigenous goats. About 55% of Begait and 49% of Hassan respondents reported that the EPs were occurred in the dry season, however, 80% of the Arado respondents signposted that the EPs were exhibited in both dry and wet seasons. Respondents of about 47% of Begait, 65% of Hassan and 93% of Arado reported that there was no access to VSCs. The type of availability of VSC is not comparable with Abdi *et al*. [24] report in Dollo Zone, Somali Regional State, Ethiopia (21.8% private VSC). The difference might be due to the awareness in investment opportunities of VSC, budget availability and leadership commitments. About 24% of Begait and 17% of Hassan respondents reached VSC at a distance of greater than 10 Km which greatly affected productivity of the indigenous goats. This is not comparable with Abdi *et al*. [24] report in Dollo Zone, Somali Regional State, Ethiopia (55.8% travelled >10 Km), and Tariku *et al*. [22] report on traditional husbandry practices of goats in selected districts of Sidama Zone, Southern Ethiopia (66.2% used 1-5 Km). The differences could be due to access to nearby VSC, methodological study, type of VSC, budget availability and leadership commitments.

About 38% of Arado respondents, 93% of Begait and 95% of Hassan respondents used their own buck for mating. This is not comparable with Gatew *et al*. [17] repot in Borana (64.4%), Gebrekiros [26] survey report in Western Zone of Tigray, Ethiopia (67.2% no own buck), Alefe [19] report at Shabelle Zone (100% used own buck), Ambel and Bayou [28] report in West Omo and Bench-Sheko Zone, Ethiopia (75% own buck), Hailu [21] report in indigenous goats in North Shewa Zone, Amhara Region, Ethiopia (89.8%

own buck), and Tariku *et al*. [22] report on traditional husbandry practices of goats in selected districts of Sidama Zone, Southern Ethiopia (55.4% used own buck). The variation might be due to increased awareness in having own buck across time, purpose of breeding, production system, available flock size, livelihood status and extension support. About 85% of Begait, 76% of Hassan and 35% of Arado respondents reported that the bucks were born in their own flocks. The birth of buck in own flock of Hassan is in line with Abdi *et al*. [24] report in Dollo Zone, Somali Regional State, Ethiopia (75% bucks born in own flock). The birth of buck in own flock of Arado is in agreement with Girma *et al.* [29] survey report in Nyangatom and Malle pastoral and agro-pastoral districts of SNNPR, Ethiopia (32% bucks born in own flock). The birth of buck in own flock of Begait, Hassan and Arado goats is not similar with Ambel and Bayou [28] report in West Omo and Bench-Sheko Zone, Ethiopia (99.4% buck born in own flock). The differences could be due to household flock sizes, purpose of breeding, extension support and livelihood status. The birth of buck in own flock of Begait is in line with Hailu [21] report in indigenous goats in North Shewa Zone, Amhara Region, Ethiopia (84.7% bucks born in own flock), and Tariku *et al*. [22] report on traditional husbandry practices of goats in selected districts of Sidama Zone, Southern Ethiopia (91% bucks born in own flock).

Uncontrolled mating was practiced in 70% of Begait, 43% of Hassan and 100.0% of Arado respondents due to the fact that most goats graze in communal lands. These uncontrolled mating practices are not in line with Gatew *et al*. [17] report in Bati area (88.8% practiced uncontrolled mating), Alefe [19] survey report at Shabelle Zone of Gode (66.7%), Denan (66.7%) and Adadle (62%) practiced controlled mating, Gebrekiros [26] survey report in Western Zone of Tigray, Ethiopia (51.1% practiced uncontrolled mating), Tsigabu [20] survey report in Nuer Zone, South Western Ethiopia (81.1% practiced uncontrolled mating), Girma *et al.* [29] survey report in Nyangatom and Malle pastoral and agro-pastoral districts of SNNPR, Ethiopia (83.3% practiced uncontrolled mating), and Abdi *et al*. [24] report in Dollo Zone, Somali Regional State, Ethiopia (75.6% practiced uncontrolled mating). The differences might be due to flock size, lack of own buck, production system, extension support, awareness and experiences of farmers. The practice of uncontrolled mating in Arado (100.0%) respondents is similar with Gatew *et al*. [17] report of uncontrolled mating practice in Borana (98.5%) and Siti area (98.3%). About 73% of Begait, 65% of Hassan and 100.0% of Arado respondents used bucks outside of their own flocks. This outside own flock buck use is not in line with Gatew *et al*. [17] Bati area (50.0%), Borana (35.6%) and Siti area (16.5%) used bucks outside of their flocks. The differences could be due to flock size available, access to buck, extension support and livelihood status of the communities. The present reasons for uncontrolled mating practices are not also similar with Abdi *et al*. [24] report in Dollo Zone, Somali Regional State, Ethiopia (53.2% goats graze together), and Ambel and Bayou [28] report in West Omo and Bench-Sheko Zone, Ethiopia (33.3% goats graze together). The differences might be due to access to own buck, access to own browsing area, production system, extension support and awareness of the communities.

Arado respondents practiced extremely lower (8%) unknown ratio of buck to does whereas 41% of Begait and 39% of Hassan practiced unknown ratio of buck to does, and about 67% of Arado respondents practiced a ratio of one buck to all does in the flock. Unknown buck use in some flocks greatly affected the genetic makeup and productivity of the indigenous goats. Crossbreeding was highly practiced in Begait respondents (41%) than in Hassan (9%) and Arado (9%) respondents due to inflow of other genotypes of goats (highland goats) to the breeding tracks of Begait goats. The kidding seasons were not synchronized but depends on communal grazing and extensive production system. The dominant kidding months of Begait and Arado goats were in September, October and November whilst the dominant kidding months of Hassan goats were in October, November and December. This kidding season is similar with Gebrekiros [26] survey report in Western Zone of Tigray, Ethiopia (64.4% in Autumn). However, the kidding patterns of Begait, Hassan and Arado goats are not in agreement with Netsanet *et al*. [30] report in Woyto-Guji and Central Highland goat breeds under traditional management system in Ethiopia (May, September), and Dereje and Ermias [31] report in Woyto-Guji goats under traditional management systems in Konso District, Ethiopia (November to January). The differences could be

due to ecology, production system, access to browsing forages, level of management practices provided and reproductive biological behavior of the genotypes with the photoperiod.

About 54% of Begait, 39% of Hassan and 70% of Arado respondents practiced buck castration. The practice of castration in Begait respondents is similar with Tariku *et al*. [22] report on traditional husbandry practices of goats in selected districts of Sidama Zone, Southern Ethiopia (60% practice castration). The current practice (54% of Begait, 39% of Hassan and 70% of Arado respondents) of buck castration is not comparable with Alefe [19] survey report at Shabelle Zone (93.7%) practiced castration, Tsigabu [20] survey report in Nuer Zone, South Western Ethiopia (85.6% no buck castration practice), Gebrekiros [26] survey report in Western Zone of Tigray, Ethiopia (60.0% no buck castration), Girma *et al.* [29] survey report in Nyangatom and Malle pastoral and agro-pastoral districts of SNNPR, Ethiopia (89.3% practice buck castration), Shegaw *et al*. [27] report in South Western Ethiopia (90.6% practice buck castration), and Hailu [21] report in indigenous goats in North Shewa Zone, Amhara Region, Ethiopia (78.9% practiced buck castration). The differences might be due to purpose of breeding, extension support, awareness and experiences of farmers. Buck castration was practiced for the purpose of improving carcass quality in Arado respondents (69%), and control inbreeding and improve carcass quality (44% of Begait and 23% of Hassan respondents). The current reasons for castration are not similar with Alefe [19] survey report at Shabelle Zone that castration was practiced for improved fattening (77.8%), control breeding (19%) and better temperament (3.2%), Shegaw *et al*. [27] report in South Western Ethiopia (91.4% to improve carcass quality), Hailu [21] report in indigenous goats in North Shewa Zone, Amhara Region, Ethiopia (73.1% to improve carcass quality), and Tade *et al*. [32] report on husbandry practices of indigenous goat populations in South Gondar Zone, Ethiopia (52.9% fatten and sell). The differences could be due to purpose of breeding, market demand, access to extension support, community preferences and awareness of farmers. The respondents (37% of Begait, 24% of Hassan and 61% of Arado) also indicated that the major castration age of the animals was in 2-3 years old. It was noted that bucks were not castrated at their earlier ages. Traditional castration method was practiced in 54% of Begait, 37% of Hassan and 64% of Arado respondents. These traditional castration practices are not comparable with Alefe [19] survey report at Shabelle Zone (61.9% used Burdizzo castration), and Hailu [21] report in indigenous goats in North Shewa Zone, Amhara Region, Ethiopia (89.5% used traditional method). The differences might be due to access to extension support, access to Burdizzo and awareness of farmers. The traditional castration practice of Hassan respondents is similar with Teshager and Wondim [33] report on indigenous goats in pastoral areas of West Guji zone, Southern Oromia, Ethiopia (34.4% practiced traditional castration).

5. CONCLUSION AND RECOMMENDATIONS

Illiterate Arado respondents (55%) were significantly higher than Begait (42%) and Hassan (29%) illiterate respondents and greatly influenced productivity. The indigenous goat populations were kept under low input extensive production system. However, the indigenous goat populations were second pillar economic sources in Begait (4.30±2.8 Tropical Livestock Unit- TLU), Hassan (7.03±5.3 TLU) and Arado (1.27±0.9 TLU) respondents. The mean flock size of Arado goat population (12.65±9.9) is not comparable with the mean flock sizes of Begait (43.02±28.1) and Hassan (70.29±52.6) goat populations due to ecological and socioeconomic differences of the communities. The flock dynamics of Begait (-16.55) and Arado (-16.69) goats in 2017 production year were at a decreasing rate of changes due to death in Begait (39.7% of the exits) and sale in Arado (53.7% of the exits).

There was a difference in water provision among the indigenous goat populations because the animals in 100.0% of Begait respondents were brought to water source whilst water was fetched by about 10% of Hassan and 9% of Arado respondents for their animals. There was also a difference in water source type among the indigenous goat populations because river was a water source for about 79.0% of Arado respondents whereas borehole was a water source for about 41% of Begait and 46% of Hassan respondents. The distance to watering points was not comparable in that the animals of 45% of Begait and 32% of Arado respondents travelled less than one kilometer (Km) whilst

animals of 17% of Hassan respondents travelled a distance of 6-10 Km to obtain water. The dry season daily watering frequency of the animals in 11% of Begait and 59% of Arado respondents was twice a day whereas animals in 7% of Hassan respondents was once in three days. The productivity of the indigenous goat populations was affected by diseases (96% of Begait, 98% of Hassan and 67% of Arado respondents) and external parasites (EP) (85% of Begait, 90% of Hassan and 87% of Arado respondents). The EPs were occurred in the dry season (55% of Begait and 49% of Hassan respondents) and the EPs were also exhibited in both dry and wet seasons (80% of the Arado respondents). However, there was no access to veterinary service centers (VSCs) in 47% of Begait, 65% of Hassan and 93% of Arado respondents. Moreover, 24% of Begait and 17% of Hassan respondents accessed to VSC at a distance of greater than 10 Km which greatly affected productivity of the indigenous goat genetic resources.

Own buck use for mating and buck birth in own flock were extremely lower in Arado respondents (38%, 35%) as compared to Begait (93%, 85%) and Hassan (95%, 76%) respondents. Uncontrolled mating and buck use outside own flock were practiced in Arado respondents (100%, 100%) whilst uncontrolled mating and buck use outside own flock were practiced in Begait (70%, 73%) and Hassan (43%, 65%) respondents due to most goats graze in communal lands. Unknown buck to does ratio was practiced in 41% of Begait and 39% of Hassan respondents, and about 67% of Arado respondents practiced a ratio of one buck to all does in the flock. It was also noted that crossbreeding was highly practiced in Begait respondents (41%) than in Hassan (9%) and Arado (9%) respondents due to the introduction of highland goats to the breeding tracks of Begait. The kidding patterns indicated that the indigenous goats of the study area are seasonal breeders which greatly affected by feed scarcity. Buck castration was highly practiced in Arado respondents (70%) as compared to Begait (54%) and Hassan (39%). Arado respondents castrated the animals for the purpose of improving carcass quality (69%). Castration as a tool to control inbreeding was a neglected practice. Castration was practiced in animals of 2-3 years old (37% of Begait, 24% of Hassan and 61% of Arado respondents). Traditional castration method was practiced in 54% of Begait, 37% of Hassan and 64% of Arado respondents.

Community education, access to water, access to VSC, buck to does ratio, kidding pattern improvement and castration to control inbreeding need future critical attentions.

ACKNOWLEDGEMENTS

The authors would greatly like to thank to Humera Agricultural Research Center (HuARC) of Tigray Agricultural Research Institute (TARI) for its transport and financial supports.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. CSA (Central Statistical Agency) Agricultural Sample Survey 2021/22 [2014 E.C.], Volume II, Report on Livestock and Livestock Characteristics (Private Peasant Holdings). Statistical Bulletin 594, March 2022, Addis Ababa, Ethiopia; 2022.
2. Mohammed B, Aynalem H, Hailu D, Tesfaye A. Estimates of genetic and phenotypic parameters for milk traits in Arsi-Bale goat in Ethiopia. Livestock Research for Rural Development. 2012;24, Article #98.
3. Tesfaye Alemu Tucho. Genetic Characterization of Indigenous Goat Populations of Ethiopia Using Microsatellite DNA Markers, PhD Dissertation, Karnal-132 001 (Haryana) India; 2004.
4. Tsegaye T. Characterization of Goat Production Systems and On-Farm Evaluation of the Growth Performance of Grazing Goats Supplemented with Different Protein Sources in Metema Woreda, Amhara Region, Ethiopia. MSc. Thesis, Haramaya University, Ethiopia. 2009;108.
5. Gebreyesus G. Community-based participatory characterization of the short eared Somali goat population around dire Dawa. Thesis, Haramaya University, Ethiopia. 2010;129.
6. Tadesse D, Urge M, Animut G, Mekasha Y. Perceptions of households on purpose

of keeping, trait preference, and production constraints for selected goat types in Ethiopia. Trop. Anim. Health. Prod. 2013;46:363-370.
7. Solomon AK, Mwai O, Grum G, Haile A, Rischkowsky B, Solomon G, Dessie T. Review of goat research and development projects in Ethiopia. ILRI project report. Nairobi, Kenya: International Livestock Research Institute; 2014.
8. Talore DG, Abebe G, Tegegne A. The influence of non-genetic factors on early growth of halaba kids under smallholder management systems, southern Ethiopia. Experimental Agriculture. 2015;51(3):344–354.
9. Workneh A, Rischkowsky B, King JM, Bruns E. Crossbreds did not create more net benefits than indigenous goats in Ethiopian smallholdings. Agri-Systems.2003;76:1137-1156.
10. Solomon G, Azage T, Berhanu G, Dirk H.. Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement. IPMS (Improving Productivity and Market Success) of Ethiopian farmers project working paper 23. International Livestock Research Institute (ILRI), Nairobi, Kenya. 2010;58.
11. FAO (Food and Agriculture Organization). Phenotypic characterization of animal genetic resources. FAO Animal Production and Health Guidelines No. 11. Rome; 2012.
12. Teweldemedhn Mekonnen, Shishay Markos, Kibrom Esak, Tesfay Ataklti. Characterization of Indigenous Goat Husbandry Practices in Northwestern and Western Zones of Tigray Region, Ethiopia. Asian Journal of Applied Science and Technology (AJAST). 2023a;7(3):2456-883X, Pages 224-241, July-September 2023, Available:https://doi.org/10.38177/ajast.2023.7316
13. Teweldemedhn Mekonnen, Shishay Markos, Kibrom Esak, Tesfay Ataklti. Characterization of indigenous goat mating experiences and production performances in north western and western zones of Tigray region, Ethiopia. American Journal of Life Sciences. 2023b;11(6):83-92. Available:https://doi.org/10.11648/j.ajls.20231106.11
14. Tesfay B, Tsegay G, Haftu K, Teferi A, Bereket H (eds.) Participatory Agricultural Production Constraints Appraisal: Implication for Research and Development Interventions in Southern, North Western and Western Zones of Tigray. Tigray Agricultural Research Institute and Agricultural Growth Program-II, Proceedings of the Workshop held 09-15 November 2018, Capital Hotel, Wukro, Tigray, Ethiopia and Working paper no. 1; 2019.
15. SPSS. Statistical Package for Social Sciences (SPSS) software, version 26; 2019.
16. Kosgey IS. Breeding objectives and breeding strategies for small ruminants in the Tropics. ISBN: 90-5808-990-8, PhD. Thesis, Wageningen University, Netherlands; 2004.
17. Gatew H, Hassen H, Kebede K, Haile A, Lobo RNB, Yetayew A, Rischkowsky B. Husbandry practices and phenotypic characteristics of indigenous goat populations in Ethiopia. African Journal of Agricultural Research. 2017;12(36);1991-637X:2729-2741, 7 September, 2017, DOI:10.5897/AJAR2016.11282, Article Number: C3FA75665887
18. Alubel Alemu. On-Farm Phenotypic Characterization and Performance Evaluation of Abergelle and Central Highland Goat Breeds as an Input for Designing Community-Based Breeding Program. MSc. Thesis, Haramaya University, Haramaya, Ethiopia; 2015.
19. Alefe Takele Alemu. Phenotypic characterization of indigenous goat types and their production system in shabelle zone, South Eastern Ethiopia. Thesis, Haramaya University, Haramaya, Ethiopia; 2014.
20. Tsigabu Gebreselassie. Phenotypic characterization of goat type and their husbandry practices in nuer zone of Gambella people regional state, South Western Ethiopia. Thesis, Haramaya University, Ethiopia; 2015.
21. Hailu Tilahun. Assessment on rearing and husbandry practices of indigenous goats in North Shewa Zone, Amhara Region, Ethiopia, Journal of Applied Animal Research. 2023;51(1):242-255. DOI:10.1080/09712119.2023.2185625

22. Tariku Woldeyohannes, Amsale Hankamo, Sandip Banerjee. Traditional Husbandry Practices of Goats in Selected Districts of Sidama Zone, Southern Ethiopia. Research Square. 2021;1-27. Available:https://doi.org/10.21203/rs.3.rs-561858/v1
23. Wendimu B, Oumer S, Habtamu A (2018). Characterization of the Indigenous Goat Production System in Asossa Zone, Benishangul Gumuz Region, Ethiopia. Afr. J. Food Agric. Nutr. Dev. 2018;18(3):13558-13571. DOI:10.18697/ajfand.83.17260
24. Abdi Abdilahi, Kawnin Abdimahad, Abdulahi Mahamed. Characterization of Goat Husbandry Practices in Dollo Zone, Somali Regional State Ethiopia. American Journal of Aquaculture and Animal Science (AJAAS). 2023;2(2):2835-8945. Available:https://doi.org/10.54536/ajaas.v2i2.1780
25. Yemane G, Melesse A, Taye M. Evaluation of production systems and husbandry practices of Ethiopian indigenous goats. Online J. Anim. Feed Res. 2020;10(6):268-277. Available:https://dx.doi.org/10.51227/ojafr.2020.36
26. Gebrekiros Hagos. On-Farm Phenotypic Characterization of Begait (Barka) Goats and Their Production System in Western Zone of Tigray, Ethiopia. MSc. Thesis, Haramaya University, Ethiopia; 2014.
27. Shegaw Ambel, Elias Bayou, Dessalegn Genzebu. Indigenous Goat Husbandry Practices and Its Production Environment in Case of South Western Ethiopia. American Journal of Zoology. 2021;4(1):1-8. Available:10.11648/j.ajz.20210401.11
28. Ambel S, Bayou E. Study on Reproductive Performance, Breeding Practice and Selection Criteria of Indigenous Goat in West Omo and Bench-Sheko Zone, Ethiopia. J Fisheries Livest Prod. 2022;10:347;10(5):2332-2608.
29. Girma M, Banerjee S, Birhanu T. Breeding practice and phenotypic characteristics of indigenous Woyito-Guji goat breeds reared in Nyangatom and Malle pastoral and agro-pastoral districts of SNNPR, Ethiopia. Int J Anim Sci. 2020;4(8). Available:https://dx.doi.org/10.36876/ijas788354
30. Netsanet Zergaw, Tadelle Dessie, Kefelegn Kebede. Growth performance of Woyto-Guji and Central Highland goat breeds under traditional management system in Ethiopia. Livestock Research for Rural Development. 2016;28(1):2016.
31. Dereje Dea and Ermias Eramo. Performance of the woyto-guji goats under traditional management systems in Konso district, Ethiopia. Journal of Biology, Agriculture and Healthcare. 2018;8(1): 2225-093X.
32. Tade Tilahun. Assessment on rearing and husbandry practices of indigenous goats in North Shewa Zone, Amhara Region, Ethiopia, Journal of Applied Animal Research. 2023;51(1):242-255. Available:10.1080/09712119.2023.2185625.
33. Teshager Muluneh, Wondim Awoke. Indigenous Goat Selection and Breeding Practices in Pastoral areas of West Guji zone, Southern Oromia, Ethiopia. Research Square. 2021;1-16. Available:https://doi.org/10.21203/rs.3.rs-1194530/v1

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/116073