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Characterization of Indigenous Goat Mating Experiences and Production Performances in North Western and Western Zones of Tigray Region, Ethiopia

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Abstract: The survey was conducted before the ignition (before October 2020) of the war in Tigray Regional State, Ethiopia. Although Ethiopia is a host for many goat populations, productivity is below their potential. Goats are essential for the resource-poor-farmers of the country. Randomly selected respondents of Begait (102), Hassan (106) and Arado (181) which totaled 389 participated in the survey. Statistical Package for Social Science software was used for data analysis. About 93% of the interviewees were male headed households. Almost all (99%) of the respondents did not practice goat fattening, and was a neglected activity. About 59% of the respondents reported that their bucks were born in their own flock. The respondents used a combination of own buck (68%) and bucks outside of their flocks (83.3%). Uncontrolled mating (77%) was mainly practiced due to the fact that most goats browse in communal lands. Unknown ratios (25%) of buck to does were practiced, and a ratio of one buck to all does in the flock (32%) used. Begait (Tahtay Adiabo) and Hassan (Kafta Humera) goat populations were significantly different ($P<0.005$) in age at first mating (AFM) of both male and female, age at first kidding (AFK), number of kids born per doe Reproductive Life Time (RLT), kidding to mating interval, and single and twin births. Mean (±SD) age at first kidding (AFK) of Begait, Hassan and Arado goats was 13.15±1.9, 12.45±1.4 and 14.56±3.1 months whereas the mean number of kids born in reproductive lifetime of Begait, Hassan and Arado does were 12.41±4.5, 15.15±4.9 and 12.85±4.8, respectively. It was also noted that the mean kidding to mating interval (days) of Begait, Hassan and Arado does was 98.32±26.3, 79.90±41.9 and 112.79±67.9, respectively. There was lower single birth in Hassan goats (70.65%) than in Begait (74.53%) and Arado (73.50%) goats. It was also noted that the litter size at birth of Hassan goat (1.33) was better than the litter sizes of Begait (1.29) and Arado (1.27) goats. However, there was high mortality rate of kids in Begait (26.4%) than in Hassan (16.5%) and Arado (15.7%) kids. The wet season mean (±SD) daily milk yields (liters) and lactation lengths (months) of Arado does (0.38±0.1; 0.75±0.3) were lower and shorter than Begait (0.67±0.3; 1.77±0.4) and Hassan (0.70±0.2; 1.79±0.5) does, respectively. Selection and mating, buck to doe ratio, Begait and Hassan milking practice should be a focus of goat keepers and stakeholders. On-station performance evaluations and genetic characterizations of Begait and Hassan goat populations are essentially needed.

Keywords: Characterization, Production Performances, Begait Goats, Hassan Goats, Arado Goats, Buck Source, Ratio of Buck to Does, Controlled Mating

1. Introduction

Livestock production in developing countries is mostly subsistence oriented and fulfills multiple functions, and contribute more for food security [1, 2]. A projection indicated that the world population will increase by more than two billion people reaching 9.15 billion by 2050 [3]. There are approximately one billion goats worldwide with the majority of goats kept in Asia (58.2%) and Africa (32.7%) [4]. The diverse agro-ecology and climatic zones of Ethiopia

enable to dwell large numbers of goat populations. The estimated numbers of goat in the rural sedentary areas of the country were about 30.2 million heads [5] and 32.7 million heads [6]. Moreover, the world in general and Ethiopia in particular is endowed with numerous goat genotypes [7]. Genetic characterization of Ethiopian goats by [8] was inconsistent with the classification of [9] based on physical description.

Goats are one of the most important livestock species used for meat production around the world producing over 5 million metric tonnes of meat [10]. Goats are valuable for nutrition and income, and an important and major farming activity on vast areas of regions where crop production is impracticable [11]. Goats have short generation interval compared to cattle, high reproductive rates, easy marketing and non-competitiveness for food make them very useful to smallholder farmers [12]. Moreover, goats have lower feed and capital requirements than larger animals, shorter generation intervals, higher prolificacy, small size, and are better able to utilize a wide range of feed stuffs, including crop residues [13]. Goat meat is not subjected to any religious taboos unlike the pork and beef to Muslims and Hindus, respectively [14]. Indigenous goat populations dominate the goat flocks of Ethiopia and have developed certain valuable genetic traits such as ability to perform better under low input condition and climatic stress, tolerance to infectious diseases and parasites as well as heat stresses [15, 16].

Goat production in Ethiopia contributes significantly to national export earnings and the livelihoods of producers, especially poor rural households. Goats in Ethiopia provide meat, milk, cash, skins, manure and insurance as well as banking and gifts [17]. National goat meat production per annum is estimated to be 62 thousand metric tons, and goats contribute to some 16.8% of the total ruminant livestock output [7]. Ethiopian average annual meat consumption per capita is estimated to be 8 kg/year while the global average is 38 kg [7]. The average carcass weight of Ethiopian goats is 10 kg, which is the second lowest in sub-Saharan Africa [17]. Though Ethiopia has large population of goats, the productivity and the contribution of goat to the economy is far below the potential [17]. The possible causes for low productivity may be due to different factors such as poor nutrition, prevalence of diseases, lack of appropriate breeding strategies and poor understanding of the production system as a whole [18]. Moreover, Ethiopian indigenous goats are genetically less productive as compared to temperate breeds [19].

Characterization of breed can be done through performance evaluation, phenotypic characterization and DNA molecular characterization [20]. Characterization studies are essential for planning improvement, sustainable utilization and conservation strategies of a breed at local, national, regional and global levels [3]. There is a confusion in the name of Kafta Humera goat populations where some give the name Begait goat and some others give Hassan goat (have two local names) whilst lowland Tahtay Adiabo goat populations have only one name called Begait goats. Therefore, characterization of Begait and Hassan goat populations including Arado goat population is paramount important for proper identification of the populations. The production performances of Begait goat population, Hassan goat population and Arado goat population in the lowland and highland areas of Western Zone and lowland areas of North western Zone of Tigray, Ethiopia are not yet characterized and documented. Therefore, there is a need to characterize the production performances of the goat populations to identify the most important reproductive variations of traits and develop a breed management plan. The objective of the survey was to characterize the production performances of the indigenous goat populations and mating experiences of farmers.

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, Ethiopia.

Tahtay Adiabo district is located in the North western Zone of Tigray, Ethiopia. Kebelles in Tahtay Adiabo involved in the survey comprised of Badme, Adi-Tsetser and Adi-Aser which are located at the borders of Eritrea. Kafta Humera district has two agro-ecology 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°C. Kafta Humera district was covered by 33% of forestry land and 5% of pasture land/grazing land.

Welkait district has also two agro-ecology which include 60% lowland (*kola*) and 40% midland (*weina dega*). Welkait district had 18% of grazing land and 19% of forest land. Welkait district is characterized by an altitude of 700-2354 masl, rainfall of 700-1800 mm and temperature of 18-25°C. Tsegede district has three agro-ecology 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°C. Tsegede district accounted 35% of forest land and 22% of grazing land [21].

2.2. Data Collection and Data Analysis

2.2.1. Sample Size and Sampling Techniques

Begait (102), Hassan (106) and Arado (181) goat respondents were randomly selected and involved in the face-to-face interview. However, Tahtay Adiabo (Begait) Kafta Humera (has two local names called Hassan and Begait), Tsegede and Welkait (Arado: highland goats) districts were purposively selected. Although the local

name of the Kafta Humera goat population has both Hassan and Begait names, however, the population is represented as Hassan goat taking the coat color pattern and other phenotypic parameters in to consideration, and Begait goat population represented from Tahtay Adiabo district.

2.2.2. Method of Data Analysis

Statistical Package for Social Sciences [22] software was used for the analysis of the household survey data. Descriptive statistics (frequency, percentages, mean, minimum and maximum) was used to summarize the data. Chi-square (x^2) test was used to test the differences among proportions of variables, and $P<0.05$ was the significance level stated.

3. Results

3.1. Household (HH) Characteristics

Almost all (93%) interviewees were male headed households. Education level was significantly different ($P<0.05$) in the study area. About 45% of the respondents were illiterate whereas 30% of the households interviewed attended lower primary school (Table 1). The mean age and family size of the respondents were 47.33±11.2 years and 6.58±2.1, respectively. Mean (±SD) arable landholding cultivated under rain-fed condition of the respondents was 8.65±38.6 hectare (ha). Cattle (7.16±9.6), goats (3.63±3.9) and sheep (2.59±5.9) were the major livestock species (TLU) in the study area (Table 2).

Table 1. *Gender and educational level (n=389).*

HH head sex and educational level	Frequency (%)	X^2	*P* value
Sex			
Male	361 (92.8)	285.062	0.000
Female	28 (7.2)		
Educational level			
Illiterate	173 (44.5)		
Can only read and write	75 (19.3)		
Lower primary school	117 (30.1)	377.411	0.000
Secondary school	21 (5.4)		
College graduated	2 (0.5)		
University graduated	1 (0.3)		

Table 2. *HH head age, family size, household livestock and honeybee holding (mean±SD).*

HH head age and family size	Begait goat producers (n=102)	Hassan goat producers (n=106)	Arado goat producers (n=181)	Overall (n=389)
Age	46.00±11.3	50.00±10.4	46.58±11.3	47.33±11.2
Family size	6.54±2.1	6.51±2.3	6.64±2.1	6.58±2.1
Landholding (ha)				
Arable landholding	2.33±1.4	27.37±70.7	1.24±1.8	8.65±38.6
Irrigation landholding	0.05±0.2	0.25±1.1	0.01±0.09	0.09±0.6
Grazing landholding	0.03±0.2	1.88±8.1	0.02±0.1	0.53±4.3
Livestock and honey bee				
Cattle holding (TLU)	10.19±9.1	8.34±14.9	4.77±3.2	7.16±9.6
Sheep holding (TLU)	0.75±1.1	8.52±9.1	0.16±0.4	2.59±5.9
Goats holding (TLU)	4.30±2.8	7.03±5.3	1.27±0.9	3.63±3.9
Begait goats (TLU)				4.30±2.8
Hassan goats (TLU)				7.03±5.3
Arado goats (TLU)				1.27±0.9
Chickens holding (TLU)	0.07±0.1	0.09±0.1	0.04±0.1	0.06±0.1
Donkeys holding (TLU)	0.73±0.9	0.61±0.8	0.51±0.4	0.59±0.7
Camels holding (TLU)	0.31±0.5	0.01±0.1	0.02±0.1	0.09±0.3
Honeybees holding (number)	0.08±0.3	0	0.78±1.5	0.38±1.1
Mules holding (TLU)	0	0	0.1±0.1	0.01±0.1
Horse holding (TLU)	0	0	0.11±0.4	0.05±0.3

n=number of respondents, TLU=Tropical Livestock Units

3.2. Indigenous Goats: Buck Source, Proportion of Buck to Does and Mating Practices

About 59% of the respondents reported that their bucks were born their own flocks. A combination of own buck (68%) and bucks outside own flocks (83%) were used for mating. Practice of uncontrolled mating was 77% due to the fact that most goats browse in communal lands. There was significantly different ($P<0.05$) in proportion of buck to does used. Unknown buck to does ratio (25%) and a ratio of one buck to all does in the flock (32%) practiced in the study area (Table 3).

Table 3. *Frequency (%) of mating practice (n=389).*

Mating practices	Frequency (%)	X^2	*P* value
Own buck use			
Yes	264 (67.9)	49.668	0.000
No	125 (32.1)		
Breeding buck sources			
Born in flock	230 (59.1)		
Bought	14 (3.6)	321.756	0.000
Born in and bought	20 (5.1)		
No own buck	125 (32.1)		
Type of mating			
Uncontrolled	298 (76.6)	110.152	0.000
Controlled	91 (23.4)		
Reason(s) for uncontrolled mating			
Community goat graze together	298 (76.6)	110.152	0.000
Controlled	91 (23.4)		
Buck use outside own flock			
Yes	324 (83.3)		
No	65 (16.7)		
Proportion of buck to does			
1: 21-25	51 (13.1)		
1: 10-20	86 (22.1)		
1: 26-40	14 (3.6)		
1: All does in the flock	124 (31.9)	247.532	0.000
Unknown	98 (25.2)		
1: 41-60	14 (3.6)		
1: 61-100	2 (0.5)		

3.3. Reproductive Performance of Indigenous Goat Populations

Begait (Tahtay Adiabo) and Hassan (Kafta Humera) goat populations were significantly different ($P<0.005$) in age at first mating (AFM) of both male and female, age at first kidding (AFK), number of kids born per doe Reproductive Life Time (RLT), kidding to mating interval, single birth and twin birth (Tables 4 and 5). Mean (±SD) AFK of Begait, Hassan and Arado goats was 13.15±1.9, 12.45±1.4 and 14.56±3.1 months whereas the mean number of kids born in reproductive lifetime of Begait, Hassan and Arado does were 12.41±4.5, 15.15±4.9 and 12.85±4.8. It was also noted that the mean kidding to mating interval (days) of Begait, Hassan and Arado does was 98.32±26.3, 79.90±41.9 and 112.79±67.9 (Table 4). There was lower single birth in Hassan goats (70.65%) than in Begait (74.53%) and Arado (73.50%) goats. It was also noted that the litter size at birth of Hassan goat (1.33) was better than the litter sizes of Begait (1.29) and Arado (1.27) goats. However, there was high mortality rate of kids in Begait (26.4%) than in Hassan (16.5%) and Arado (15.7%). The mean (±SD) numbers of single births in 2017 production year of Begait, Hassan and Arado does were 13.72±10.2, 19.88±17.9 and 4.06±4.3 whilst the mean numbers of triple births per kidding of Begait, Hassan and Arado does were 0.29±1.2, 0.52±1.8 and 0.03±0.2. The survey also indicated that the mean numbers of kids died in 2017 production year of Begait, Hassan and Arado goat populations were 6.16±10.6, 6.09±11.3 and 1.10±2.7, respectively (Table 5). Sample photos of each goat population is presented at appendix section of this paper.

Table 4. *Reproductive performance of male and female indigenous goat populations (mean±SD).*

Reproductive traits	Begait (B) goats (n=102)	Hassan (H) goats (n=106)	*P* value (B*H)	Arado goats (n=181)
AFM (months)				
Male	8.29±2.5	6.97±1.9	0.000	7.79±2.5
Female	7.79±2.0	6.58±1.4	0.000	7.68±2.5
AFK (months)	13.15±1.9	12.45±1.4	0.003	14.56±3.1
RLT (years)				
Buck	4.79±1.6	4.77±1.7	0.908	1.83±0.9
Doe	7.53±2.2	8.01±2.2	0.122	8.39±1.9
N of kids born per doe RLT	12.41±4.5	15.15±4.9	0.000	12.85±4.8
Kidding to mating interval (days)	98.32±26.3	79.90±41.9	0.000	112.79±67.9

n=number of respondents, AFM=Age at First Mating, AFK=Age at First Kidding, RLT=Reproductive Life Time

Table 5. *Multiple birth status and kid mortality rates across indigenous goat populations in 2017 (n=389).*

Birth-death status	Begait (B) goats (n=102)	Hassan (H) goats (n=106)	*P* value (B*H)	Arado goats (n=181)
Total N of births	18.56±13.6	28.15±24.6	0.001	5.50±5.2
N of single births	13.72±10.2	19.88±17.9	0.003	4.06±4.3
2 kids per birth	4.29±5.6	7.98±8.8	0.000	1.44±1.6
3 kids per birth	0.29±1.2	0.52±1.8	0.284	0.03±0.2
≥4 kids per birth	0.11±1.1	0.02±0.1	0.408	0
Multiple birth per birth (%)				
Single birth	74.53	70.65	-	73.50
Twin birth	23.32	28.35	-	26.00
Triple birth	1.56	1.86	-	0.50
Quadruple birth	0.59	0.07	-	0.00
Litter size	1.29	1.33	-	1.27
Kids born	23.50±20.7	37.50±35.1	0.001	7.08±6.5
Kids died	6.16±10.6	6.09±11.3	0.963	1.10±2.7
Kid mortality rate (%)	26.4	16.5	-	15.7

3.4. Milk and Milking Performances of Indigenous Goats

The lactation practice and performance of all goat producers and populations were extremely poor because only 61% of the Begait respondents, 30% of the Hassan respondents and 7% of the Arado goat respondents were milking their goats. The respondents who practiced milking indicated that they milked their goats in both dry and wet seasons. About 61.3% of Begait, 37.5% of Hassan and 50.0% of Arado does were milked twice per day in the wet season. The mean (±SD) milk yield of Begait, Hassan and Arado goats in the wet season was 0.67±0.3, 0.70±0.2 and 0.38±0.1 liters, respectively. Begait, Hassan and Arado goats were milked for about 1.77±0.4, 1.79±0.5 and 0.75±0.3 months, respectively in the wet season of the year (Table 6).

Table 6. *Milking practice across goat populations, milk yield (Liter), lactation length and milking frequency of goat populations in wet (n=106) and dry (n=59) seasons.*

Milking practice across goat populations	Yes	No	Total
Begait			
Frequency	62 (60.8)	40 (39.2)	102 (100)
Hassan			
Frequency	32 (30.2)	74 (69.8)	106 (100)
Arado			
Frequency	12 (6.6)	169 (93.4)	181 (100)

Milking frequency per day	Goat populations		
	Begait	Hassan	Arado
Wet season			
Once a day	24 (38.7)	20 (62.5)	6 (50.0)
Twice a day	38 (61.3)	12 (37.5)	6 (50.0)
Dry season			
Once a day	14 (48.3)	9 (50.0)	6 (50.0)
Twice a day	15 (51.7)	9 (50.0)	6 (50.0)

Breed (daily milk yield in liters)	Minimum	Maximum	Mean±SD
Begait			
Wet season	0.25	1.50	0.67±0.3
Dry season	0.2	0.50	0.38±0.1
Hassan			
Wet season	0.25	1.00	0.70±0.2
Dry season	0.25	0.50	0.41±0.1
Arado			
Wet season	0.25	0.50	0.38±0.1
Dry season	0.10	0.25	0.20±0.1
Breed (lactation length in months)			
Begait			
Wet season	1.00	2.00	1.77±0.4
Dry season	0.50	1.50	0.86±0.3
Hassan			
Wet season	0.50	2.00	1.79±0.5
Dry season	0.25	1.50	0.90±0.3

Breed (daily milk yield in liters)	Minimum	Maximum	Mean±SD
Arado			
Wet season	0.50	1.00	0.75±0.3
Dry season	0.25	0.50	0.38±0.1

4. Discussion

Almost all (93%) interviewees were male headed households. This is similar with [23] survey report in Abergelle and Central Highland Goat Breeds (94.9%) and [24] survey report in Western Zone of Tigray, Ethiopia (82.22% male headed). Current male household heads (93%) is not in line with [25] survey report in Shabelle Zone, South Eastern Ethiopia (76.2% male headed). The variation might be due to sampling system and involvement of more female headed households in goat production. About 45% of the respondents were illiterate. This is similar with [25] survey report in Shabelle Zone, South Eastern Ethiopia (42% illiterate). Cattle (7.16±9.6) and goats (3.63±3.9) were the dominant livestock species (TLU) in the respondents of the study area.

About 59% of the respondents reported that their bucks were born in their own flocks. A combination of own buck (68%) and bucks outside flock (83.3%) were used for mating services. The current own buck-doe mating (68%) is not in line with [26] survey report in Bati (50.0%) and Siti (83.5%) Ethiopia, [25] survey report in Shabelle Zone, South Eastern Ethiopia (100% own buck), [24] survey report in Western Zone of Tigray, Ethiopia (67.22% no buck) and [27] report in indigenous goat (75%). The differences in own buck breeding and maintenances might be livelihood status of goat keepers, flock size and overall awareness on breeding and conservation. The current own buck-doe mating (68%) is similar with [26] survey report in Borena (64.4%) of own buck use for mating. The current own flock buck birth (59%) does not agree with [28] report on Arab (65.1%) and Oromo goat keepers (81%) in Northwestern Ethiopia and [29] report in Dollo Zone goats, Somali Regional state, Ethiopia (75.0%). Flock size and household livelihood status are the main reasons for the differences in own flock buck birth and maintenances. Uncontrolled mating (77%) practiced due to the fact that most goats browse in communal lands. Uncontrolled mating (77%) practice in Begait, Hassan and Arado goats is not in agreement with [26] survey report in Bati (88.8%), Borena (98.5%) and Siti (98.3%) Ethiopia practiced of uncontrolled mating, [25] survey report in Shabelle Zone, South Eastern Ethiopia (66.7% in Gode, 66.7% in Denan and 62% in Adadle practiced controlled matting), [24] survey report in Western Zone of Tigray, Ethiopia (51.11% uncontrolled mating) and [28] report on Arab (69.8%) and Oromo goat keepers (92%) practiced uncontrolled mating. The differences might be due to breeding experiences of the goat keepers, presence of own buck, production system and access to ample own browsing area. The current uncontrolled mating (77%) practiced in Begait, Hassan and Arado goats is similar with [29] report in Dollo zone goats, Somali Regional state, Ethiopia (75.6%). About 83% of the respondents also indicated that they used bucks outside of their flocks. Some proportions of buck to does were unknown ratio (25%) and a ratio of one buck to all does in the flock (32%). The current buck to does ratio is not comparable with [30] report on indigenous goats of South Western Ethiopia (1:5.3 buck to doe ratio). The differences could be due to flock size, purpose of breeding and access to own buck(s).

Begait (Tahtay Adiabo) and Hassan (Kafta Humera) goat populations were significantly different (P<0.005) in age at first mating (AFM) of both male and female, age at first kidding (AFK), number of kids born per doe Reproductive Life Time (RLT), kidding to mating interval, single birth and twin birth. The mean (±SD) exhibited AFM of male Begait (8.29±2.5), Hassan (6.97±1.9) and Arado (7.79±2.5) months whereas mean exhibited AFM of female Begait (7.79±2.0), Hassan (6.58±1.4) and Arado (7.68±2.5) months. Mean AFM of female Begait, Hassan and Arado is not in line with [31] survey report in Nuer Zone of Gambella People Regional State, South Western Ethiopia (10.93 months) and [27] report in indigenous goat (9.5±0.2 months). The differences might be due to genotype, browse forage availability and production system. Mean AFM of male Begait, Hassan and Arado is similar with [31] survey report (7.06 months). Moreover, mean AFM of female Begait and Arado is in line with [28] report in Arab goats (7.9±0.9 months) whilst mean AFM of male Arado is in agreement with [28] report in mean AFM of male Oromo (7.6±0.9 months). Mean (±SD) exhibited AFK of Begait (13.15±1.9), Hassan (12.45±1.4) and Arado (14.56±3.1 months) goats. Arado goats mean AFK is similar with [25] survey report in Shabelle Zone, South Eastern Ethiopia (14.75+0.12) goats, [28] report in Oromo goats (14.9±2.4), [27] report in indigenous goat (15.1±0.21 months) and [32] report in Saanen goats (14.2±2.40 months) in Malaysia. But Begait and Hassan goats mean AFK is not similar with [25] survey report in Shabelle Zone, South Eastern Ethiopia (14.75+0.12) goats, [31] survey report in Nuer Zone of Gambella People Regional State, South Western Ethiopia (16.76 months) goats and [27] report in indigenous goat (15.1±0.21 months). The differences might be due to ecology, genotype, follow up on mating, browse forage availability and production system. The present mean (±SD) AFK of Hassan goat is in line with [33] report in Western lowland goat (12.4±1.39 months).

The mean (±SD) exhibited reproductive life time (RLT) (years) buck of Begait (4.79±1.6), Hassan (4.77±1.7) and Arado (1.83±0.9) whereas exhibited reproductive life time (years) of doe of Begait (7.53±2.2), Hassan (8.01±2.2) and Arado (8.39±1.9). RLT (years) of Begait, Hassan and Arado doe is similar with [25] survey report in Shabelle Zone, South Eastern Ethiopia (8.45+0.11) does and [33] report in Abergelle doe

(8.0±2.2) whereas not similar with [31] survey report in Nuer Zone of Gambella People Regional State, South Western Ethiopia (6.45 years) and [27] report in indigenous goat (6.9±0.13 years). Moreover, mean RLT of Begait does is similar with [28] report in Arab does (7.2±2.0 years) and mean RLT of Hassan does is similar with Oromo does (7.9±1.9). The differences in RLT of does could be in ecology, genotype, production system, flock size, livelihood status of the goat keepers and purpose of breeding. The mean RLT (years) of Begait, Hassan and Arado bucks is not in line with [25] survey report in Shabelle Zone, South Eastern Ethiopia (3.74) and [28] report on Arab bucks (3.8±1.5 years) and Oromo bucks (4.1±1.3 years). The differences could be due to purpose of breeding, production system, livelihood status, awareness and experience of breeding. The mean (±SD) exhibited number of kids born in RLT of does of Begait (12.41±4.5), Hassan (15.15±4.9) and Arado (12.85±4.8). The mean numbers of kids born in RLT of Begait, Hassan and Arado does are not similar with [28] report in Arab does (10.7±2.5) and Oromo does (9.7±1.6) in Northwestern Ethiopia. The differences could be due to ecology, genotype, production system, birth type and purpose of breeding. Mean number of kids born in RLT does of Begait and Arado is similar with [25] survey report in Shabelle Zone, South Eastern Ethiopia (13.46+0.20) and [27] report in indigenous goat does (12.4±0.27), [33] report in Abergelle doe (12.2±5.98) whereas mean number of kids born in RLT does of Hassan is not similar with [25] survey report and [33] report in Western lowland (17.3±5.98) and Abergelle (12.2±5.98) does. The differences could be due to genotype, birth type, production system and browse forage availability. It was also noted that the mean kidding to mating interval (days) of Arado (112.79±67.9) does was longer than Begait (98.32±26.3) and Hassan (79.90±41.9) does indicating Hassan does have short postpartum anestrus than Begait and Arado does.

There was lower single birth in Hassan goats (70.65%) than in Begait (74.53%) and Arado (73.50%) goats. It was also noted that the litter size at birth of Hassan goat (1.33) was better than the litter sizes of Begait (1.29) and Arado (1.27) goats. The litter sizes at birth of Begait goats and Arado goats become similar in the 2017 production year. This similarity could be due to declined fertility of Begait goats, inclusion of Hassan and Arado crossbred of goats in the Arado fertility data, disease prevalence and access to browse forages. The percentages of single births in Hassan goats (70.65%), Begait (74.53%) and Arado (73.50%) goats are not comparable with [32] report in Saanen goats (90.0%) in Malaysia. The differences might be due to ecology, genotype and production system. The litter sizes at birth of Begait goats, Hassan goats and Arado goats of the 2017 production year is not in agreement with [34] report in Boer X Central highland goat under extensive production system (1.48), [35] report in Abergelle goats in the production years of 2009 (1.06), 2010 (1.11) and 2011 (1.07) in Ethiopia and [36] report in Central highland goat (1.58), Boer X Central highland goat F_1 (1.48) and F_2 (1.62). The differences in litter size at birth could be due to genotype, birth type and production system. It was noted that there was high mortality rate of kids in Begait (26.4%) than in Hassan (16.5%) and Arado (15.7%) in 2017 production year. The mortality rate of kids in Begait (26.4%) goats is not comparable with [34] report in Boer X Central highland goat under extensive production system (18.3%) and [35] report in the post-weaning kid mortality rate of Boer X Abergelle F_1 kids (16.6%). The differences could be due to ecology, genotype, age and disease prevalence.

The lactation practice and performance of all goat populations was very poor because only 61% of the Begait respondents, 30% of the Hassan respondents and 7% of the Arado goat respondents were milking their goats. The respondents who practiced milking indicated that they milked their goats in both dry and wet seasons. The current milking practice of Begait (61%), Hassan (30%) and Arado (7%) goat respondents is not in line with [23] survey report in Abergelle and Central Highland goat breeds because all respondents in Ziquala and Tanqua Abergelle districts milked their goats whereas Lay Armachiho district respondents did not milk their goats. These deviations might be due to genotype of the does, livelihood status of the goat keepers, production system, access to browse forages and culture of the communities. About 61.3% of Begait, 37.5% of Hassan and 50.0% of Arado does were milked twice per day in the wet season whereas 51.7% of Begait, 50.0% of Hassan and 50.0% of Arado does were milked twice per day in the dry season. The current milking frequency of Begait (61.3%) goat respondents is in agreement with [37] report in Woyto-Guji goat in wet (58%) season. The current milking frequencies on Begait, Hassan and Arado goat populations in both wet and dry seasons is not in agreement with [23] survey report in Abergelle and Central Highland goat breeds because wet season milking frequency is higher in Ziquala district (96.8%) and in Tanqua Abergelle (87.7%) and dry season milking frequency is lower in Ziquala district (36.8%) and in Tanqua Abergelle (39.1%) and [25] survey report in Shabelle Zone, South Eastern Ethiopia (82.5% twice milking). The variation in milking frequency could be due to livelihood status of the goat keepers, genotype, production system, access to browse forages and purpose of breeding.

The mean (±SD) daily milk yield (DMY) of Begait, Hassan and Arado does in the wet season was 0.67±0.3, 0.70±0.2 and 0.38±0.1 liters whereas dry season was 0.38±0.1, 0.41±0.1 and 0.20±0.1, respectively. Arado does have lower DMY in both seasons than both goat populations. Wet and dry seasons DMY of Begait and Hassan does are not in line with [23] survey report in Abergelle and Central Highland goat breeds in Ziquala (0.43±0.24 and 0.15±0.14 liters) and Tanqua Abergelle (0.48±0.24 and 0.19±0.29) districts and [38] report in Woyto-Guji does under agro-pastoral management conditions (0.31 liter). This variation could be due to mainly genotype, birth type and access to browsing forages. Dry season DMY of Arado does is similar with the DMY of Tanqua Abergelle does (0.19±0.29). DMY in wet season of Begait and Hassan does are in line with [25] survey report in Shabelle Zone, South Eastern Ethiopia (0.53±0.1 liter) whilst DMY in dry season

of Begait and Hassan does are in line with [36] report in Boer X Central highland does (0.41) and DMY in wet season of Begait and Hassan does are in line with [32] report in Saanen does (0.63 liter) in Malaysia.

Begait, Hassan and Arado does were milked for about 1.77±0.4, 1.79±0.5 and 0.75±0.3 months in the wet season of the year, respectively whereas dry season lactation length (LL) of each population was Begait (0.86±0.3), Hassan (0.90±0.3) and Arado (0.38±0.1 month) does. LL of Begait, Hassan and Arado does in both wet and dry seasons is not comparable with [23] survey report in Abergelle and Central Highland goat breeds at Ziquala (4.21±2.02 and 4.32±1.40 months) and Tanqua Abergelle (3.59±2.11 and 4.46±2.0) districts, [25] survey report in Shabelle Zone, South Eastern Ethiopia (3.6±0.66 months), [36] report in Boer X Central highland does (3.5 months) and [37] report in Woyto-Guji goat in wet (4.79±0.94 months) and dry (4.65±1.04) seasons. These deviations might be due to culture, purpose of breeding, ecology, genotype, production system, household dependency on goat production and access to browse forages.

5. Conclusion

Although Ethiopia is a host for a huge goat population, productivity is below the potential of the genetic resources available. Cattle (7.16±9.6 TLU) numbers of the respondents preceded goat numbers (3.63±3.9), therefore, indigenous goats were economically important species in the study area. Communal browsing exposed the goat keepers to uncontrolled mating (77%) practice. Own buck use for mating (68%), buck born in their own flock (59%), buck use outside of their flocks (83%) could introduce undesirable traits to the flocks due to uncontrolled mating practices of the respondents. Unknown ratio (25%) of buck to does and a ratio of one buck to all does in the flock (32%) negatively affected the reproductive performance of goats in the study area.

Mean (±SD) age at first kidding (AFK) of Hassan does (12.45±1.4 months) was shorter than Begait (13.15±1.9) and Arado (14.56±3.1) does. Moreover, mean (±SD) number of kids born in reproductive lifetime of Hassan (15.15±4.9) does was higher than Begait (12.41±4.5) and Arado (12.85±4.8) does. Mean (±SD) kidding to mating interval (days) of Hassan does (79.90±41.9) was also shorter than Begait (98.32±26.3) and Arado (112.79±67.9) does. Therefore, there was better reproductive performance of Hassan goats than Begait and Arado goat populations.

About 61% of Begait, 30% of Hassan and 7% of Arado respondents were milking their goats in the wet and dry seasons. There was lower wet season mean (±SD) daily milk yield (0.38±0.1 liters) and shorter lactation length (0.75±0.3 months) of Arado goats than Begait (0.67±0.3; 1.77±0.4) and Hassan (0.70±0.2; 1.79±0.5) goat populations, respectively.

Therefore, selection and mating, buck to doe ratio, Begait and Hassan milking practice should be a focus of goat keepers and stakeholders. On-station performance evaluations and genetic characterizations of Begait and Hassan goat populations are essentially needed.

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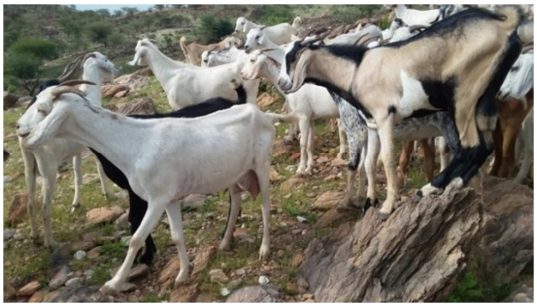
Conflicts of Interest

The authors declare no conflicts of interest.

Appendix

Sample Photos of Begait, Hassan and Arado Goat Populations

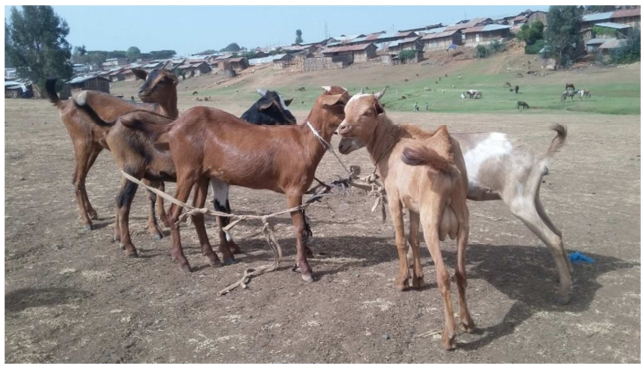


Flock size (TLU): minimum (0.7) and maximum (13.5)

Figure 1. *Sample photo of Begait goat (Adi-Tsetser, Tahtay Adiabo).*

Flock size (TLU): minimum (1.0) and maximum (21.0)

Figure 2. *Sample photo of Hassan goat (Maykadra, Kafta Humera).*



Flock size (TLU): minimum (0.2) and maximum (7.5)

Figure 3. *Sample photo of Arado goat (Ketemma Nigus, Tsegede).*

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