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Characterization of Indigenous Sheep Mating Experiences and Production Performances in Western Zone 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. Sheep productivity in Ethiopia is below the potential of the genetic resources due to complex technical, institutional, and socio-economic factors. Indigenous sheep productivity can be enhanced by improving management, selecting best animals for future generations, and crossbreeding with exotic breeds. The objective of the survey was to characterize the production performances of indigenous sheep populations and mating experiences of the farmers in the study area. The Statistical Package for Social Sciences software was used for data analysis. Education level of the respondents was significantly different (P<0.05) in the study area in which about one-third (34%) of the respondents were illiterates. The respondents were with an overall mean age of 49.98±10.6 years and family size of 6.73±3.1. Cattle (7.89±19.0 TLU) and sheep (7.91±11.4 TLU) were the major livestock species in the study area where all respondents kept their animals under low input extensive production system. Own ram use, breeding ram source, type of mating, reason(s) for uncontrolled mating, reason(s) for ram use outside own flock and proportion of ram to ewes were significantly different (P<0.05) in the study area. Own ram use for mating (68%), own flock ram birth (51%), uncontrolled mating (66%), rams used outside of their flocks (79%) and pure breeding (86%) collectively contributed to breeding and reproductive performances of the indigenous sheep populations. Unknown ram to ewe ratio (26.9%) and one ram to all ewes in the flock ratio (29.6%) were used. There was similar mean (±SD) age at first lambing between Begait (12.88±2.1) and Rutanna (12.25±2.2) than in Arado (14.93±2.9 months) sheep. There were higher mean number of lambs born in reproductive lifetime of Rutanna (17.91±5.8) ewes than in Begait (14.81±5.1) and Arado (11.01±4.4) ewes. There was longer mean (±SD) lambing to mating interval (days) of Arado ewes (125.00±60.7) than in Begait (93.02±50.1) and Rutanna (82.36±38.2) ewes. Begait (1.29) and Rutanna (1.39) ewes revealed higher mean litter sizes at birth per ewe than Arado (1.05) in 2017 production year. Arado ewes (5.21%) revealed lower twin birth per lambing than Begait (26.43%) and Rutanna (31.07%) in 2017 production year. However, Arado lambs (5.76%) demonstrated higher survival rate as compared to Begait (15.94%) and Rutanna (16.11%) lambs in 2017 production year at different ages of the lambs and were died mainly of diseases (58%). The lactation practice was very poor because only 14% of the Begait respondents, 16% of the Rutanna respondents and none of the Arado sheep respondents were milking their sheep. Rutanna sheep were milked only in the wet season whereas Begait sheep were milked in both dry and wet seasons. The mean (±SD) daily milk yield of Rutanna (0.38±0.1) and Begait (0.47±0.1 liter) sheep was very low. Developing livestock transformation strategy is essential to exploit the biological potential of the indigenous sheep. Selected rams and ewes should be mated in a controlled manner to improve the genetic makeup of the indigenous sheep populations. Ram to ewe ratio, and disease prevention strategies should be the focus of the farmers and stakeholders.

Keywords: Characterization, indigenous sheep, Begait sheep, Rutanna sheep, Arado sheep, production performances, reproduction, age at first mating, age at first lambing, reproductive lifetime

Abbreviations: SD=Standard Deviation; SPSS=Statistical Package for Social Sciences; AFM=Age at First Mating; AFL=Age at First Lambing; RLT=Reproductive Lifetime; TLU=Tropical Livestock Unit

Introduction

Southwest Asia served as a migration route and distribution of domesticated sheep to different parts of the world particularly to Africa along with migrant people [1]. The need to increase livestock production to feed the ever-increasing human population is now more urgent than ever [2]. Production rate in livestock is most importantly affected by reproductive efficiency and reproductive traits are the most important traits affecting profitability in sheep

breeding [3]. Ethiopia has diverse indigenous sheep populations [4]. The conservation and sustainable use of the relatively more adapted available local animal genetic resources need to protect from the expected negative effects of climate change on livestock production [5]. [6] report indicated that 75% of the total sheep population in Ethiopia are found in the highlands where mixed crop-livestock systems dominate whilst 25% of the sheep are found in the lowlands.

Ethiopia is a country of diverse agro-ecology and climatic zones that enable to dwell large numbers of sheep population. The estimated numbers of sheep in the rural sedentary areas of the country were about 30.7 million heads [7] and 31 million heads [8]. Many (18) local sheep population types are found in different parts of the natural landscape of Ethiopia kept by different tribes [9]. However, [10] study on sheep resources of Ethiopia revealed that Simien, Sekota, Farta, Tikur, Wollo, Menz, Gumz, Washera, Horro, Adilo, Arsi, Bonga, Afar and Black Head Somali traditionally recognized sheep populations classified in to six breed groups and nine breeds based on FST values, Bayesian clustering and morphological divergence.

Ethiopian sheep are used as sources of income, meat, milk, wool, skin, manure, and others for smallholder keepers in different farming systems and agro-ecological zones [10]. Though Ethiopia has large population of sheep, the contribution of the sheep genetic resources to the national economy is below its potential due to several complex technical, institutional, and socio-economic constraints that hindered sheep productivity [11]. Meat productivity per animal is very low. A major cause contributing to such low meat yield is that animals are commonly slaughtered at immature body weights (18-20 kg) of sheep [12]. Integrated attempts of management and genetic improvement to enhance production is crucially important [13]. The average annual off-take rate and carcass weight per slaughtered animal for the years 2000 to 2007 were about 32.5% and 10 kg, respectively [14]. Sheep at a national level provide some 25% of the domestic meat consumption with a production surplus which is exported mainly as live animals, almost 50% of the domestic wool requirements; about 40% of fresh skins production and 92% of the value of semi processed skins export trade [11]. Sheep productivity in Ethiopia can be improved by improving the management of sheep and improving the potential by practicing selection of best animals for future mating [15]. Moreover, indigenous sheep productivity can be improved by crossbreeding with exotic breeds which is the most rapid way [13].

Planning of genetic improvement, sustainable utilization, and conservation strategies of a breed at local, national, regional, and global levels are essentially based on characterization studies [16]. Characterizing genetic diversity is a key aspect of developing sustainable breed improvement strategies [17]. However, no attempts have been made so far on characterization of sheep genetic resources of the study area. Begait ewes are prolific sheep, for example, an ewe kept under extensive production system of small-scale farmer in Setit Humera of Western Zone of Tigray, Ethiopia gave birth of six lambs per unit birth (Humera livestock research team observation, 2013). Not all Ethiopian sheep genetic resources and their production performances are characterized and documented. For example, indigenous Begait sheep population, Rutanna sheep population and Arado sheep population were not included in the comprehensive study of sheep resources of Ethiopia by [1]. The production performances of indigenous Begait sheep population, Rutanna sheep population and Arado sheep population in the lowland and highland areas of Western Zone of Tigray, Ethiopia are not yet characterized and documented. Therefore, there is a need to characterize the production performances of the sheep populations to develop a breed management plan. The objective of the survey was to characterize the production performances of indigenous sheep populations and mating experiences of farmers in the study area.

Materials and Methods

Description of the Study Areas

The survey was carried out in 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. Kafta Humera district has two agro-ecologies which consist of 86% lowland (kola) and 14% midland (weina dega). Welkait district also has two agro-ecologies which include 60% lowland (kola) and 40% midland (weina dega). Tsegede district has three agro-ecologies which comprise 70% lowland (kola), 22% midland (weina dega) and 9% highland (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 oc. Welkait district is characterized by an altitude of 700-2354 masl, rainfall of 700-1800 mm and temperature of 18-25°c. Tsegede district is also characterized by an altitude of 680-3008 masl, rainfall of 1200-2500 mm and temperature of 12-35°c [18]. Moreover, Kafta Humera district was covered by 33% of forestry land and 5% of pastureland/grazing land, Welkait district had 18% of grazing land and 19% of forest land whilst Tsegede district accounted 35% of forest land and 22% of grazing land [18].

Data collection and data analysis

Sample size and sampling techniques

A total of 253 households of Begait (126), Rutanna (37) and Arado (90) sheep respondents were randomly selected and used for the face-to-face survey interview. However, Kafta Humera (Begait and Rutanna sheep), Tsegede and Welkait (Arado sheep) districts were purposively selected. All selected respondents kept their animals under an extensive production system. The Rutanna sheep population is introduced to Kafta Humera district (May Kadra and Bereket Kebelles) from Sudan; Rutanna sheep is a transboundary breed. The communities of May Kadra and Bereket Kebelles of Kafta Humera district preferred Rutanna

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sheep to Begait due to their fast growth rate and coat color pattern preferences. The Rutanna sheep is highly demanded by the Sudanese people, and there was mass sale of Rutanna sheep to the Sudanese people from the Kebelles of Kafta Humera. The Arado sheep population is also known as common Tigray highland sheep [19].

Method of data analysis

Statistical Package for Social Sciences [20] software was used for data analysis. Descriptive statistics (frequency, percentages and mean) were used to summarize the data. Chi-square (X^2) test was used to test the differences among proportions of variables, and significance level was stated at $P<0.05$.

Results

Household characteristics

Male headed households (95%) were dominantly involved in the face-to-face survey interview. Education level of the respondents was significantly different ($P<0.05$) in the study area. About one third (34%) of the respondents were illiterate whereas 44% of the households interviewed attended lower primary school (Table 1). The overall mean age and family size of the respondents were 49.98±10.6 years and 6.73±3.1, respectively. Overall mean arable landholding cultivated under rain-fed condition of the respondents was 38.34±120.3 hectare (ha). The major livestock species (TLU) in the respondents were cattle (7.89±19.0), sheep (7.91±11.4) and goats (3.42±5.1) (Table 2).

Table 1: Gender and educational level of respondents (n=253).

HH Head Sex and Educational Level	Frequency (%)	X^2	P value
Sex		207.277	0.000
Male	241(95.3)		
Female	12(4.7)		
Educational level			
Illiterate	85(33.7)	251.524	0.000
Can only read and write	37(14.7)		
Lower primary school	111(44.0)		
Secondary school	15(6.0)		
College graduated	2(0.8)		
University graduated	2(0.8)		

Table 2: Age, family size and landholding, household livestock and honeybee holding of respondents (Mean±SD)f

Age and family size of household heads	Begait sheep producers (n=126)	Rutanna sheep producers (n=37)	Arado sheep producers (n=90)	Overall (n=253)
Age (years)	51.13±9.7	50.46±9.4	48.18±11.9	49.98±10.6
Family size	6.22±1.9	9.51±5.9	6.30±1.8	6.73±3.1
Landholding (ha)				
Arable land (rain-fed)	14.87±42.2	209.1±244.5	1.02±1.0	38.34±120.3
Irrigation landholding	0.21±0.8	0.33±1.6	0	0.16±0.8
Grazing landholding	1.29±6.9	14.86±36.5	0	2.82±15.5
Livestock and honeybee				
Cattle holding (TLU)	6.62±12.6	21.53±41.7	4.08±2.4	7.89±19.0
Sheep holding (TLU)	8.51±9.0	22.31±17.1	1.17±0.8	7.91±11.4
Begait sheep (TLU)				8.51±9.0
Rutanna sheep (TLU)				22.31±17.1
Arado sheep (TLU)				1.17±0.8
Goats holding (TLU)	4.15±4.4	8.79±7.8	0.19±0.4	3.42±5.1
Chickens holding (TLU)	0.10±0.2	0.21±0.5	0.04±0.1	0.09±0.2
Donkeys holding (TLU)	0.49±0.6	0.14±0.3	0.88±0.6	0.58±0.6
Camels holding (TLU)	0.01±0.1	0	0	0.004±0.1
Honeybee's hives (number)	0	0	0.86±1.4	0.3±0.9

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Mules holding (TLU)	0	0	0.03±0.1	0.01±0.1
Horse holding (TLU)	0	0	0.44±0.8	0.2±0.5

n=number of respondents, TLU=Tropical Livestock Unit

Indigenous sheep: Ram source, proportion of ram to ewes and mating practices

There were significantly different (P<0.05) in own ram use, breeding ram source, type of mating, reason(s) for uncontrolled mating, reason(s) for ram use outside own flock and proportion of ram to ewes. Above half (68%) of the respondents used their own ram for mating, and 51% of the respondents reported that the rams were born in their own flock. Uncontrolled mating was mainly (66%) practiced because most sheep graze in communal lands. Hence, 79% of the respondents also indicated that they used rams outside of their flocks. There was unknown ram to ewe ratio use (26.9%) and a ratio of one ram to all ewes (29.6%) in the flock. It was also noted that 86% of the respondents did not practice crossbreeding (Table 3).

Table 3: Own ram use status, breeding ram source, selection of sheep for breeding, prevention of mating of related animals, type of mating, reason(s) for uncontrolled mating, ram use outside own flock, proportion of ram to ewes and crossbreeding practice (n=253).

Own ram use	Frequency (%)	X^2	*P* value
Yes	173(68.4)	34.186	0.000
No	80(31.6)		
Breeding ram source			
Born in flock	129(51.0)	126.621	0.000
Bought	23(9.1)		
Born in and bought	21(8.3)		
No own ram	80(31.6)		
Selection practice			
Yes	253(100)		
No	0		
Type of mating			
Uncontrolled	166(65.6)	24.668	0.000
Controlled	87(34.4)		
Reason(s) for uncontrolled mating			
Community sheep graze together	166(65.6)	24.668	0.000
Controlled	87(34.4)		
Ram use outside own flock			
Yes	201(79.4)		
No	52(20.6)		
Reason(s) for ram use outside own flock			
No own ram	80(31.6)	76.111	0.000
To get better ram	76(30.0)		
No control	42(16.6)		
To avoid inbreeding	3(1.2)		
Only own ram use	52(20.6)		
Proportion of ram to ewes			
1:21-25	42(16.6)	132.885	0.000
1:10-20	39(15.4)		
1:26-40	19(7.5)		
1: all ewes in the flock	75(29.6)		
Unknown ratio	68(26.9)		
1:41-60	6(2.4)		

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1:61-100	4(1.6)		
Crossbreeding practice			
Yes	35(13.8)		
No	218(86.2)		

Reproductive performance of indigenous sheep populations

Mean (±SD) age at first lambing (AFL) of Begait, Rutanna and Arado sheep was 12.88±2.1, 12.25±2.2 and 14.93±2.9 months whereas the mean number of lambs born in reproductive lifetime of Begait, Rutanna and Arado ewes were 14.81±5.1, 17.91±5.8 and 11.01±4.4, respectively. It was also noted that the mean lambing to mating interval (days) of Begait, Rutanna and Arado ewes was 93.02±50.1, 82.36±38.2 and 125.00±60.7 (Table 4). The mean litter sizes at birth per ewe of Begait, Rutanna and Arado were 1.29, 1.39 and 1.05 in 2017 production year, respectively whilst the percentages of twin births per lambing per sheep population in 2017 production year of Begait, Rutanna and Arado ewes were 26.43%, 31.07% and 5.21% of the total births, respectively. The survey also indicated that the percentages of lambs died in 2017 production year in Begait, Rutanna and Arado sheep were 15.94%, 16.11% and 5.76% of the total lambs born. The lambs were largely died of diseases (58%) in 2017 production year (Table 5).

Table 4: Reproductive performance of male and female sheep across indigenous sheep populations (Mean±SD)

Reproductive traits	Begait (B) sheep (n=126)	Rutanna (R) sheep (n=37)	P value (B*R)	Arado sheep (n=90)
AFM (months)				
Male	7.62±2.3	7.54±2.4	0.859	8.17±2.6
Female	7.15±1.9	7.24±2.4	0.81	8.61±2.8
AFL (months)	12.88±2.1	12.25±2.2	0.109	14.93±2.9
RLT (years)				
Ram	5.4±1.9	5.65±2.3	0.601	2.38±1.1
Ewe	8.01±1.9	8.37±2.2	0.332	8.20±1.9
N of lambs born per ewe RLT	14.81±5.1	17.91±5.8	0.002	11.01±4.4
Lambing to mating interval (days)	93.02±50.1	82.36±38.2	0.24	125.00±60.7

Table 5: Multiple birth status (Mean±SD), lamb death across sheep populations in 2017, and causes of lamb death (n=252)

Birth-death status	Begait (B) sheep (n=126)	Rutanna (R) sheep (n=37)	P value (B*R)	Arado sheep (n=90)
Total N of births	29.22±25.4	112.82±93.1	0.000	5.12±2.8
N of single births	21.13±20.7	82.50±80.5	0.000	4.86±2.8
2 lambs per birth	7.74±7.8	34.85±33.2	0.000	0.27±0.5
3 lambs per birth	0.26±0.9	1.06±2.0	0.001	0
≥4 lambs per birth	0	0	-	0
Multiple birth per birth	**%**	**%**		**%**
Single birth	72.41	73.06	-	94.79
Twin birth	26.43	31.07	-	5.21
Triple birth	0.86	0.97	-	0.00
Quadruple birth	0.00	0.00	-	0.00
Litter size	1.29	1.39	-	1.05
Lambs born	37.59±31.9	148.00±121.8	0.000	5.40±2.9
Lambs died	5.89±6.7	23.69±35.2	0.000	0.31±0.9
Lambs loss due to death (lamb mortality rate)	%	%		%
	15.94	16.11	-	5.76

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Causes for the death of lambs		Frequency (%)
Diseases		145(57.5)
Drought		1(0.4)
Poor management		2(0.8)
No death		104(41.3)

Milk and milking performances of indigenous sheep

The lactation practice and performances of all sheep populations was very poor because only 14% of the Begait respondents, 16% of the Rutanna respondents and none of the Arado sheep respondents were milking their sheep. Rutanna sheep were milked only in the wet season whereas Begait sheep were milked in both dry and wet seasons. The mean (±SD) daily milk yield of Rutanna sheep was 0.38±0.1 whilst the mean daily milk yield of Begait sheep was 0.47±0.1 litre in the wet season, and Begait and Rutanna sheep were milked for about 1.85±0.3 and 1.25±0.6 months in the wet season. However, Arado sheep were not used for milk production (Table 6).

Table 6: Milking practice across breeds, milk yield (Liter), lactation length and milking frequency of sheep populations in wet (n=23) and dry (n=8) seasons.

Milking across populations	Yes	No	Total
Begait			
Frequency	17(13.5)	109(86.5)	126(100.0)
Rutanna			
Frequency	6(16.2)	31(83.8)	37(100.0)
Arado			
Frequency	0	90(100.0)	90(100.0)
Milking frequency	Indigenous sheep populations		
	Begait	Rutanna	
Wet season			
Once a day	10(58.8)	4(66.7)	14(60.9)
Twice a day	7(41.2)	2(33.3)	9(39.1)
Dry season			
Once a day	4(50.0)	0	4(50.0)
Twice a day	4(50.0)	0	4(50.0)
Breed (milk yield/day in liters)	Minimum	Maximum	Mean±SD
Begait			
Wet season	0.25	0.5	0.47±0.1
Dry season	0.25	0.3	0.26±0.02
Rutanna			
Wet season	0.25	0.5	0.38±0.1
Dry season	-	-	-
Breed (lactation length in months)			
Begait			
Wet season	1	2	1.85±0.3
Dry season	0.5	1	0.88±0.2
Rutanna			
Wet season	0.5	2	1.25±0.6
Dry season	-	-	-

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Discussion

Male headed households (95%) were dominantly involved in the face-to-face survey interview. This is similar with [21] survey report in indigenous sheep in Eastern Ethiopia (92.2% male headed in agro-pastoral and 90% in pastoral), [22] survey report on indigenous sheep in the northwest highlands of Ethiopia (95.4% male headed), [23] survey report on small ruminants at Jimma Zone, Western Ethiopia (94.4% male headed). Education level of the respondents was significantly different ($P<0.05$). About one third (34%) of the respondents were illiterate whereas 44% of the households interviewed attended lower primary school. Illiterate people (34%) are similar with [23] survey report on small ruminants at Jimma Zone, Western Ethiopia (30% illiterate). The current education status is not in agreement with [21] survey report in indigenous sheep in Eastern Ethiopia (21.1% read and write in agro-pastoral and 65.6% in mixed crop-livestock system), [22] survey report on indigenous sheep in the northwest highlands of Ethiopia (32.7% read and write, 29.2% attended primary school), [24] survey report in Habru Woreda North Wollo Zone of Amhara, Ethiopia (52.5% illiterate, 25% read and write). The differences may be due to community culture and access to education institutions. The major population of livestock species (TLU) in the respondents were cattle (7.89±19.0), sheep (7.91±11.4) and goats (3.42±5.1). All the indigenous sheep populations (Begait, Rutanna and Arado) were kept under low input extensive production system. This is not similar with [24] survey report in Habru Woreda North Wollo Zone of Amhara, Ethiopia (5% practiced semi-intensive production system). The differences may be due to experience sharing, training and awareness creation.

There were significantly different ($P<0.05$) in own ram use, breeding ram source, type of mating, reason(s) for uncontrolled mating, reason(s) for ram use outside own flock and proportion of ram to ewes. Above half (68%) of the respondents used their own ram for mating, and 51% of the respondents reported that the rams were born in their own flock. Own ram use for mating (68%) is in line with [24] survey report in Habru Woreda North Wollo Zone of Amhara, Ethiopia (67.5% have their own ram).

The current own ram use (68%) is not similar with [22] survey report on indigenous sheep in the northwest highlands of Ethiopia (46.2% own ram), [23] survey report on small ruminants at Jimma Zone, Western Ethiopia (26.9% have their own ram), [25] survey report on indigenous sheep in Bensa District, Southern Ethiopia (60.9% have their own ram). The differences could be due to flock size, production system, purpose of breeding, livelihood status and awareness of farmers. The current own flock ram birth (51%) is similar with [26] survey report on Watish Sheep in Singa locality, Sinnar State, Sudan (56% own flock ram birth). But the current own flock ram birth (51%) is not similar with [22] survey report on indigenous sheep in the northwest highlands of Ethiopia (36.8% own flock ram birth), [25] survey report on indigenous sheep in Bensa District, Southern Ethiopia (82.05% own flock ram birth). The variations could be due to flock size, purpose of breeding, livelihood status and awareness of farmers.

Uncontrolled mating was mainly (66%) practiced since most sheep graze in communal lands. The current uncontrolled mating (66%) is not comparable with [22] survey report on indigenous sheep in the northwest highlands of Ethiopia (100% uncontrolled mating), [27] survey report on phenotypic characterization of Zulu sheep (100% uncontrolled mating), [25] survey report on indigenous sheep in Bensa District, Southern Ethiopia (90.6% controlled mating), [24] survey report in Habru Woreda North Wollo Zone of Amhara, Ethiopia (80% in Srinka and 90% in Antto Kebele practiced uncontrolled mating). The variation may be due to access to own ram, flock size, breeding experiences of farmers and awareness of farmers. About 79% of the respondents also indicated that they used rams for mating from outside of their flocks for different reasons. The present result on ram use from outside of their flocks (79%) is not similar with [24] survey report in Habru Woreda North Wollo Zone of Amhara, Ethiopia (25% in Sirinka farmers and 30% in Anto farmers used rams from neighbors. An unknown ram to ewe's ratio (26.9%) and a ratio of one ram to all ewes (29.6%) in the flock were used as mating options in the study area. The current ram to ewe ratio is not in agreement with [22] survey report on indigenous sheep in the northwest highlands of Ethiopia (100% was 1:11 of ram to ewe ratio). The differences could be due to flock sizes, livelihood status and awareness of the farmers. It was also noted that 86% of the respondents did not practice crossbreeding which greatly contributed to conservation of indigenous sheep populations whilst the remaining 14% affected conservation of the populations.

Arado sheep (14.93±2.9 months) was late in mean (±SD) age at first lambing (AFL) than Begait (12.88±2.1) and Rutanna (12.25±2.2) sheep. Mean AFL of Begait and Rutanna is similar with [28] review report on Horro sheep (13.3±1.7 months), Ethiopia, [25] survey report on indigenous sheep in Bensa District, Southern Ethiopia (12.84±0.24 months), [26] survey report on Watish Sheep in Singa locality, Sinnar State, Sudan (12.30±0.90 months). But mean AFL of Begait and Rutanna is not in agreement with [29] survey report (16.04±2.11 months in Meket sheep and 15.57±1.57 in Gidan) of North Wollo Zone, Ethiopia, [21] survey report in indigenous sheep in Eastern Ethiopia (13.8±0.27 months in agro-pastoral and 14.7±0.28 in pastoral), [30] survey report on Blackhead Somali sheep in Shinile and Erer Districts of Shinile Zone, Ethiopia (23.56±3.63 months), [31] survey report on Washera sheep at Yilmanadensa and Quarit Districts of the Amhara National Regional State, Ethiopia (15.5 months). The differences could be due to genotype, ecology, production system and access to feed.

The mean reproductive lifetime (RLT) of Arado rams (2.38±1.1 years) was shorter than Begait (5.4±1.9) and Rutanna (5.65±2.3 years) rams. The mean RLT of Begait and Rutanna rams are not in line with [29] survey report (6.95±1.27 in Meket rams and 6.53±1.26 in Gidan) of North Wollo Zone, Ethiopia, [22] survey

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report on indigenous sheep in the northwest highlands of Ethiopia (2.26 years), [26] survey report on Watish Sheep in Singa locality, Sinnar State, Sudan (6.47±1.33 years). The variation could be due to livelihood status, purpose of breeding and awareness of the farmers. There was similar mean RLT among Begait (8.01±1.9 years), Rutanna (8.39±2.2) and Arado (8.20±1.9) ewes. This is similar with [29] survey report (7.46±1.10 years in Meket ewes and 7.72±0.89 in Gidan) of North Wollo Zone, Ethiopia, [28] review report on Horro sheep (7.9±3.1 years), Ethiopia, [25] survey report on indigenous sheep in Bensa District, Southern Ethiopia (8.1±0.11 years). But the mean RLTs of Begait, Rutanna and Arado ewes are not similar with [30] survey report on Blackhead Somali sheep in Shinile and Erer Districts of Shinile Zone, Ethiopia (9.12±1.60 years), [26] survey report on Watish Sheep in Singa locality, Sinnar State, Sudan (9.93±0.41 years). The variations could be due to ecology, production system, access to feed resources and purposes of breeding. It was also noted that the mean lambing to mating interval (days) of Arado ewes (125.00±60.7) was longer than Begait (93.02±50.1) and Rutanna (82.36±38.2).

Mean number of lambs born in reproductive lifetime (RLT) of Rutanna ewes (17.91±5.8) was higher than Begait ewes (14.81±5.1) and Arado ewes (11.01±4.4). Mean RLT lamb crop of Rutanna and Begait ewes is in line with [28] review report on Horro sheep (15.3±4.3), Ethiopia. But mean RLT lamb crop of Rutanna and Begait ewes are not in line with [29] survey report (8.92±1.53 in Meket ewes and 9.77±1.70 in Gidan) of North Wollo Zone, Ethiopia, [21] survey report in indigenous sheep in Eastern Ethiopia (9.13±0.19 in agro-pastoral and 8.60±0.24 in pastoral), [30] survey report on Blackhead Somali sheep in Shinile and Erer Districts of Shinile Zone, Ethiopia (8.18±2.27), [25] survey report on indigenous sheep in Bensa District, Southern Ethiopia (8.69±0.185). The differences could be due to genotype, ecology, production system and access to feed.

The mean litter size at birth per ewe of Arado (1.05) was lower than Begait (1.29) and Rutanna (1.39) in 2017 production year. The present result on litter size of all sheep ewes is not in line with [32] report in Kermani Sheep (0.94) of Kerman province, Iran, [33] report on Assaf sheep ewe (1.57) kept under intensive management system in Israel. The factors for differences could be due to type of study, genotype, ecology, sample size and data management, and management practices of the sheep populations. But the mean litter size at birth per ewe of Arado ewes (1.05) is similar with [34] report on Mehraban sheep ewes (1.12) in Hamedan province, western Iran whilst the mean litter size at birth per ewe of Begait (1.29) is in line with [33] report on Awassi ewe (1.28) kept under intensive management system in Israel. Moreover, the mean litter size at birth per ewe of Rutanna (1.39) is in line with [23] report on indigenous sheep (1.37 from flock monitoring and 1.4 from diagnostic survey) in Goma District of Jimma Zone, Western Ethiopia.

The percentage of twin births per lambing in 2017 production year of Begait, Rutanna and Arado ewes were 26.43%, 31.07% and 5.21% of the total births, respectively. The lamb mortality rates at different age groups of Arado sheep (5.76%) were lower than Begait (15.94%) and Rutanna (16.11%) of the total lambs born in 2017 production year due to ecological and genotypic effects. However, the lamb survival rates of the present result are better than the lamb survival rates of Menz (81.3%) and Horro (50.6%) at six months of age reported by [35], Horro (pre and post-weaning death rates of 25.3 and 34.2%) Menz sheep (19.3% post-weaning death rate) reported by [9], indigenous sheep (20.9% suckling age and 18.1% post-weaning age) in Goma District of Jimma Zone, Western Ethiopia reported by [23]. The differences in lamb survival rates could be due to genotype, ecology, adaptations, and production system. Lambs of the study area were largely died of diseases (58%) in 2017 production year.

The lactation practice and performances of all sheep breeds was very poor because only 14% of the Begait respondents, 16% of the Rutanna respondents and none of the Arado sheep respondents were milking their sheep. Rutanna sheep were milked only in the wet season whereas Begait sheep were milked in both dry and wet seasons. The daily mean (±SD) milk yield of Rutanna (0.38±0.1) and Begait (0.47±0.1 litre) sheep in the wet season was very low due to the poor husbandry practices in the study area. The daily mean milk yield of Begait sheep is in line with [25] survey report on indigenous sheep in Bensa District, Southern Ethiopia (0.476 liter). However, the daily milk yield of Ratanna and Begait sheep is not similar with [21] survey report in indigenous sheep in Eastern Ethiopia (0.91±0.02 liters in agro-pastoral and 0.86±0.03 in pastoral), [33] report on on-station study on Assaf sheep (1.9 liter) and Awassi sheep (2.4) in an intensive management system, Israel. The variations may be due to type of study, genotype, ecology, production system, daily milking frequency and access to feed resources. Wet season lactation lengths of Rutanna sheep (1.25±0.6 month) and Begait (1.85±0.3) are not comparable with [21] survey report in indigenous sheep in Eastern Ethiopia (3.13±0.07 months in agro-pastoral and 2.87±0.12 in pastoral), [33] on-station study on Assaf sheep (5.8 months) and Awassi sheep (7.1) in an intensive management system, Israel, [25] survey report on indigenous sheep in Bensa District, Southern Ethiopia (3.5±1.2 months in the highland). The differences could be due to type of study, genotype, ecology, production system and access to feed resources.

Conclusion and Recommendations

Ethiopian sheep productivity is below the potential of the sheep genetic resources due to the complex technical, institutional, and socio-economic constraints. Indigenous sheep productivity can be enhanced by improving management practices, best animal selection for future mating and crossbreeding with exotic breeds. The indigenous sheep populations of the study

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area were kept under low input extensive production system. Own ram use for mating (68%) and uncontrolled mating (66%) affected reproductive and productivity of the indigenous sheep populations due to inbreeding depression and introduction of undesirable traits to the flocks. There was an unknown ram to ewe ratio (26.9%) and a ratio of one ram to all ewes (29.6%) in the flock. There was pure breeding practice in 86% of the respondents where the 14% affected conservation of the indigenous sheep of the study area.

All respondents practiced selection of ram and ewe, however, about 66% of the respondents practiced uncontrolled mating. The experiences and awareness of the respondents to avoid inbreeding in their flock was almost none (1.2%) due to lack of awareness. Mean (±SD) age at first lambing of Arado sheep (14.93±2.9 months) was slightly longer than in Begait (12.88±2.1) and Rutanna (12.25±2.2) sheep. Moreover, Begait and Rutanna sheep have shorter age at first lambing than most other indigenous sheep of Ethiopia. There was lower mean (±SD) number of lambs born in reproductive lifetime of Arado ewes (11.01±4.4) than in Begait ewes (14.81±5.1) and Rutanna ewes (17.91±5.8) due to genotypic and fertility differences. It was also noted that the mean lambing to mating interval (days) of Arado ewes (125.00±60.7) was longer than in Begait ewes (93.02±50.1) and Rutanna ewes (82.36±38.2).

Under extensive production system, Begait (1.29) and Rutanna (1.39) ewes revealed higher mean litter sizes at birth per ewe than Arado (1.05) in 2017 production year. Begait (1.29) and Rutanna (1.39) sheep demonstrated excellent and comparable litter sizes with the exotic sheep genetic resources. Arado ewes (5.21%) revealed lower twin birth per lambing than Begait (26.43%) and Rutanna (31.07%) in 2017 production year. However, Arado lambs (5.76%) demonstrated higher survival rate as compared to Begait (15.94%) and Rutanna (16.11%) in 2017 production year at different ages of the lambs. The lambs of the three sheep populations were largely died of diseases (58%). The lactation practice of Begait (14%) and Rutanna (16%) sheep was very poor whilst Arado sheep were not milked due to their low milk yield potential. Wet season daily mean (±SD) milk yield of Rutanna (0.38±0.1) and Begait (0.47±0.1 litre) sheep was very low due to poor husbandry practices.

Developing livestock transformation strategy is essential where intensive production system is one of the critical factors that enable farmers to exploit the biological potential of sheep genetic resources in the study area. Strategic tools which comprise selection and mating to improve genetic makeup of the indigenous sheep populations, ram to ewe ratio, avoid crossbreeding, and disease prevention strategies should be the focus of the farmers and stakeholders.

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