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Management and Breeding Objectives of Indigenous Smallholder Highland Sheep in Northern Ethiopia

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Abstract
Cross sectional survey was conducted to characterize highland sheep production systems and identify breeding objectives. Data were collected through personal interviewing of 120 randomly selected sheep owners using a designed questionnaire. The mean (±SD) family size of the household was 5.33 ± 2.1. The average (±SD) holding of sheep was 10.1± 6.4 and the ratio between intact males to females was 1:5. Body conformation, lambing frequency, and lamb growth were used to selcet breeding rams and ewes. Mothering ability and age at first sexual maturity were used to select breeding rams. Appearance and mothering ability, and milk yield were considered as secondary crietria to select breeding ewes. The average (±SD) age at sexual maturity for male and female sheep were 6.7±1.7 and 7.4±1.8 months, respectively. The average (±SD) age at first lambing and lambing interval were 6.5±0.7 and 12.1±2.5 months, respectively. Coenerosis, Ovin Pasteurellosis, Ovine Pleuropneumonia, Fasciolosis, black leg, Bottle Jaw and Anthrax were the major sheep diseases.
Keywords: Highland sheep, flock size, selection criteria, reproductive performance, and production constraint

1. INTRODUCTION

Livestock production has a great contribution to Ethiopia's national economy and for enhancing the livelihoods of smallholder farmers. Sheep are among the top prioritized livestock in enhancing food security and nutrition under smallholder farmers through providing proteins and minerals. Sheep production is dominant in the highland agro ecological zone with crop livestock mixed production system (Solomon *et al.,* 2010). There is a generally felt need that characterizing the production system is an important and vital step in designing and implementing breeding strategies and associated nutritional and marketing interventions. Atsbiwonberta sheep are one of the potential sheep breeds that have not received the attention of the limited characterization attempts (E.g.,Galal, 1983; DAGRIS 2004; Kassahun and Solomon, 2008). The purpose of the study was to characterize sheep production system, husbandry, management, and production performances. Thus, this study was essential to assess indigenous sheep breeding practices, selection criteria and identifying trait preference of smallholder farmers in the studied area.

2. MATERIALS AND METHODS

2.1. Description of the study area

The study was carried out in Atsbiwonberta district (39 30' E - 39 45' E and 13 30' N- 13 45' N) located in eastern Zone of Tigray about 75 km northeast of Mekelle. Altitude ranges from 1800 -3000 meter above sea level with average annual rainfall exceeding 600 mm and temperature 18 ºC (Mulata, 2013). About 75% of the district is upper highlands (2600 meter above sea level or above) and only 25% is found in midlands (between 1500 and 2600 meter above sea level) and lowlands (below 1500 meter above sea level) (Alembirhan, personal communication held on August 26, 2014). The dominant agricultural production system in Atsbiewonberat is mixed crop-livestock production with barley/wheat/pulses small ruminant dominant sheep production (Solomon et al., 2013).

2.2. SAMPLING PROCEDURE AND DATA COLLECTION

Relevant information was collected through personal interviews conducted with randomly selected 120 sheep owners. Relevant information related to the livestock population and area descriptions of the district were summarize using secondary data obtained from the experts of livestock and extension. The questionnaire gathered information on socio-demographic characteristics of the households (age, gender, educational background, family size), livestock holding, sheep flock composition), purpose of keeping sheep, feeding, breeding practices, perceived important sheep diseases and reproductive characteristics. The SPSS computer software (version 16.0) was used to analyse qualitative and quantitative data. The data were presented mainly in the form of descriptive tabular summaries and graph. Excel Microsoft word was used to calculate an index according to the following formula.

Index = Σ of [(3 for rank 1) + (2 for rank 2)+ (1 for rank 3)] given for particular feed resource, factor of sheep death and lambing season divided by Σ of [(3 for rank 1) + (2 for rank 2)+ (1 for rank 3)] for all feed resource, factor of sheep death and lambing season.

Index = Σ of [(4 for rank 1)+(3 for rank 2)+(2 for rank 2)+(1 for rank 4)] given for particular importance of livestock species, sheep production constraints, reason for culling sheep and selection criteria of sheep divided by Σ of [(4 for rank 1)+(3 for rank 2)+(2 for rank 2)+(1 for rank 4)] for all importance of livestock species, sheep production constraints, reason for culling sheep and selection criteria of sheep.
Index = Σ of [(5 for rank 1)+(4 for rank 2)+(3 for rank 3)+(2 for rank 4)+(1 for rank 5)] given for purpose of keeping male and female sheep divided by Σ of [(5 for rank 1)+(4 for rank 2)+(3 for rank 3)+(2 for rank 4)+(1 for rank 5)] for all purpose of keeping male and female sheep.

3. RESULTS AND DISCUSSIONS

3.1. General household characteristics

The respondents were household head, spouse of head, son of the household head, daughter of the household head and relatives (Table 1). Male and female-headed households represented about 76.7% and 23.3% of the overall proportion of household heads selected for the interview. This finding is in agreement with the finding of Bosenu et al. (2014) who reported 73.33% of the total interviewed households were male-headed. About 10.0%, 23.3%, 30.0%, 21.7%, 12.7% and 2.5% of the respondents were in the age categories of <30, 31-40, 41-50, 51-60, 61-70 and >70 years, respectively.

Table 3. Characteristics of respondents included in the interview

Descriptors	Variable	N	Percentage
Position in the households	House hold head	101	84.2
	Spouse of head	11	9.2
	Son of head	4	3.3
	Daughter of head	3	2.5
	Brother of head	1	0.8
	Total	**120**	**100**
Gender of the respondent	Male	92	76.7
	Female	28	23.3
	Total	**120**	**100**
Age of the respondent in year	<31	12	10.0
	31-40	28	23.3
	41-50	36	30.0
	51-60	26	21.7
	61-70	15	12.5
	>70	3	2.5
	Total	**120**	**100.0**
Educational level of household head	Illiterate	53	44.2
	Read and write	17	14.2
	Literate	50	41.7
	Total	**120**	**100.0**

About 44.2 % of the total respondents were illiterate whereas 41.7% were literate. The rest 14.1% of the total respondents could read and write. The mean (±SD) family size of the households in the study area was 5.33 ± 2.1. The average family size of the respondents reported in this study is similar with the reports of Gebreegziabher (2005), reported 5 in the Atsbiewonberta district but lower than from the Adiyo Kaka and Horro districts of the western and south-western Ethiopia reported as 8.60 ± 4.48 and 7.30 ± 2.47, respectively (Edea et al., 2012).

Table 4. Age and gender proportion of the household in Atsbiewonberta

Gender	Age	N	Mean	SD
Male	< 15 years age	120	1.58	1.1
	> 15 years age	120	1.5	1.1
Female	< 15 years age	120	1.11	0.9
	>15 years age	11	1.47	1.2
Family size		120	5.33	2.0

3.2. Characterization of the production system

The main occupation of the sampled households was agriculture (77.5%) with mixed crop-livestock production system (97.5%). In addition to the agricultural activities, some of the respondents (20.8%) replied that they had additional source of income from employment. The major crops grown include barley, wheat, and pulse. DAGRIS (2006) indicated that 75% of the sheep population in Ethiopia is found in the highland agro ecological zone dominated by mixed crop-livestock agricultural production systems.

3.3. Land and livestock holding

Mean (±SD) land holding of the sampled households was 0.5±0.53. The land holding reported in this study indicated that land shortage is a critical problem for livestock production in the study area. According to the respondent's point of view, the main reason for the shortage of cultivated land is the increased human population. Major livestock species with their composition for livestock population of the sampled households and mean (±SD) livestock holding per household are presented in Table 3. The mean (±SD) number of cattle, sheep, goat, chicken, and donkey and bee colony per household were 2.5±2.6, 10.1±6.4, 0.2±.9, 4.3±2.8, 1.0±.8, and 0.7±2.8, respectively (Table 3).

Table 5. Livestock species and population of the sampled households in the study area

Livestock species	Population Number	% Composition	Mean (±SD) livestock holding per HH
Cattle	300	13	2.5±2.6
Sheep	1215	54	10.1±6.4
Goat	22	1	0.2±0.9
Chicken	511	23	4.3±2.8
Pig	2	0	0.0± 0.2
Donkey	114	5	1.0±0.8
Mules	2	0	0.0±0.2
Camel	4	0	0.0±0.4
Horse	1	0	0.0 ±0.1
Bee colony	79	4	0.7±2.8
Total	**2250**	**100**	**17.9±8.7**

The current finding of holding sheep per households is lower than from the report of Solomon et al., (2010) and Mulata (2013) in the same study area but higher than from the report of Mengistie et al., (2010) 9.58 for Washera sheep in the western highlands of the Amhara National Regional State. Seare et al., (2011) reported that sheep population is increasing through time but sheep holding per individual households is declined in Abergelle sheep population. Sheep, chicken, and cattle are three major livestock species with percent composition of 54%, 23%, and 13%, respectively (Table 3). Sheep, Cattle, bee colony, and poultry were the main livestock species reared by the sampled households. The current study indicated that sheep flocks are the first with an index value of 0.31 the most important livestock species followed by cattle and chicken (Table 4).

Table 6. Livestock importance ranks in the study area

Livestock	N	1st	2nd	3rd	4th	Index
Cattle	107	59	41	7	0	0.28
Sheep	120	57	58	5	0	0.31
Goat	5	1	4	0	0	0.01
Chicken	90	3	17	67	3	0.23
Donkey	41	9	2	18	12	0.11
Camel	6	1	0	3	2	0.02
Bee colony	15	3	1	6	5	0.04

Index = Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] given for importance of livestock species divided by Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] for all livestock species.

3.4. Sheep ownership and composition

Sheep flock ownership was mostly by household heads (husband 42.5%) and head/spouse jointly (28.7%). Edea *et al*. (2012) reported similar ownership patter for Horror and Bongo sheep in western and southwestern Ethiopia. Smallholder sheep flock of the study area composed of ewes (48%), young female (16%), rams (14%), lambs (13%), young male (9%) and castrated (0.1%) (Fig 1). The ratio of young female to young male sheep was 1:1.7 and this is close to the theoretical 1:1 male to female ratio. The main factories that affect sheep flock composition under smallholder farmer are purpose of keeping male sheep, market demand and the existing environmental conditions including the incidence of disease and drought (Zelealem *et al*., 2012).

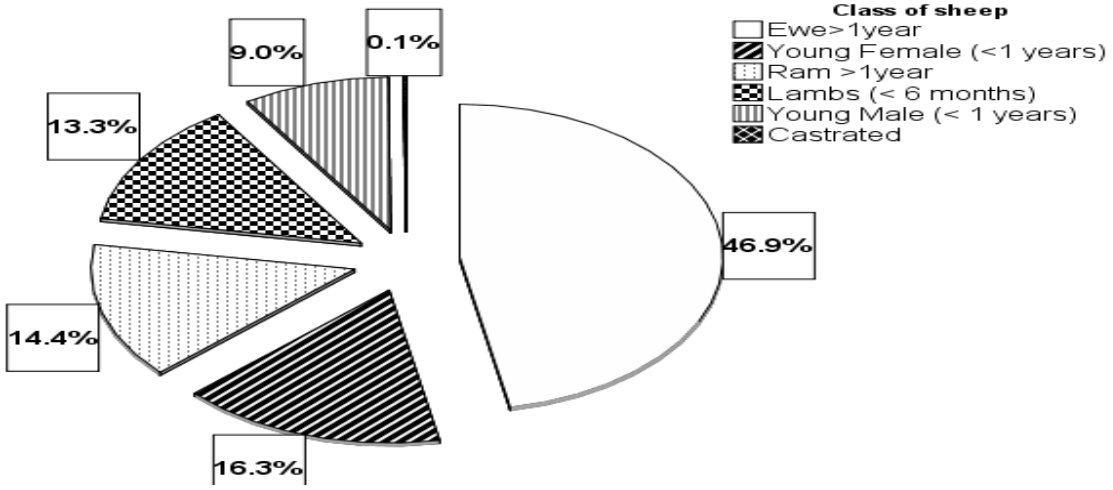

Figure 2. Sheep flock composition in Atsbie

The intact male to female ratio of the sheep flock under study was 1 to 5. There are factors that govern the ratio of intact male to female sheep and it depends on the fate of male sheep (greater than 1 year) either for selling or for slaughtering (Belete, 2009). The current finding of the ratio of breeding male to breeding female sheep is in line to the previous works report (Seare *et al*., 2011; Edea *et al*., 2012; Zelealem *et al.,* 2012) on indigenous sheep breed of Ethiopia.

3.5. Production objectives of the highland sheep

Respondents ranking of the production objectives sheep are presented in Tables 5. Sheep provide a variety of products like meat, milk, manure, skin and have socio cultural assets. The main purposes of keeping rams are for meat production, breeding, and as source of income with an index value of 0.24, 0.23, and 0.23, respectively. In cereal-livestock production system, the main breeding objective of Menz sheep is for improving meat production through enhancing body conformation and growth rate (Solomon *et al*., 2013). The main purpose of rearing sheep in the mixed crop-livestock production system of Horror and Bonga district is meat production (Aynalem *et al.,* 2011). The main reasons for keeping female sheep are for meat production, breeding, and source of income ranked as 1st followed by milk and manure production ranked as 2nd and 3rd , respectively.

Table 7. Respondents' Rankings of purposes of keeping ewes and rams

Variables	Ewes						Index	Rams						Index
	N	1st	2nd	3rd	4th	5th		N	1st	2nd	3rd	4th	5th	
Meat	115	4	36	59	12	4	0.19	119	9	50	56	4	1	0.24
Milk	102	9	15	32	44	2	0.17	-	-	-	-	-	-	-
Breeding	115	43	44	13	14	1	0.19	112	19	48	39	6	0	0.23
Manure	97	2	17	11	23	44	0.16	92	0	7	16	69	15	0.19
Skin	50	1	1	2	12	34	0.08	20	0	1	4	15	43	0.04
Income	117	73	8	8	11	17	0.19	114	96	11	4	3	3	0.23

The consumption of sheep milk is related with cultural taboos in Horro and Adiyo Kaka district of the western and southwestern Ethiopia (Edea et al., 2012). Indigenous sheep reared under varied agro ecological zone of Ethiopia are the major source of food security, cash income, savings, fertilizer, socio-cultural functions, and skin (Solomon *et al*., 2013). The respondents indicated that smallholder farmers sell their sheep mostly during the major religious festivals (Easter, New Year and Christmas).

3.6. Sheep flock feed, and drinking water resource and feeding system

Ranking of the different feed resource based on their availability during wet and dry season is presented in Table 5. Hay, agro-industrial by-products, and fallow land are the three major feed resources for sheep flock during wet season (June-August). During the dry season (February-March), the main feeds for sheep flock are hay, concentrate, and private grazing land. During the wet season, croplands and grazing lands are protected except very small fallow land around the homestead. Due to the limited landholding, smallholder farmers kept their sheep flocks around the homestead. During dry season, degraded private grazing land and crop aftermath are used as daytime grazing and when sheep are turned on to their night kraaling, they are provided with hay, concentrate (wheat bran) and crop residues at evening. Some of the respondents replied that they used cut and carry system (33.6%) through utilization of hay as supplementary feed mostly during the dry season. According

to the respondents` point of view, sheep flocks are mostly herded, 62.7% and 93.9% during the wet and dry season, respectively. Smallholder farmers provided supplementary feed mostly hay and concentrated feed (wheat bran) 1st prioritized to pregnant sheep followed by breeding rams and lambs as 2nd and 3rd prioritized, respectively (Fig 2).

Figure 2. Feeding priority for rams (left), lactating ewes and lambs (right) with green feed

Sheep are herded together with other livestock species during the day. During crop harvesting season and in the afternoon, farmers remove their animals from the group-flock and keep them in their respective private grazing land and crop aftermath. These feed resources are poor in nutritional content and palatability (Zelealem *et al*., 2012). To solve the problem of feed shortage, smallholder farmers used some coping mechanisms such as feeding crop residue, supplement with wheat bran and improved forage (tree Lucerne).

Table 5. Feed resources for sheep flock in the study area during wet and dry seasons

Season	Variables	N	1st	2nd	3rd	Index
Wet	Communal grazing land	8	4	2	2	0.02
	Private grazing land	64	30	11	23	0.14
	Fallow land	74	12	33	29	**0.16**
	Crop residue	51	8	7	36	0.11
	Improved forage	67	18	18	31	0.15
	Concentrate	92	32	46	14	**0.20**
	Hay	93	37	24	32	**0.21**
Dry	Communal grazing land	5	2	0	3	0.01
	Private grazing land	70	44	7	19	**0.16**
	Crop after month	48	5	14	29	0.11
	Crop residue	61	1	12	48	0.14
	Improved forage	49	8	17	24	0.11
	Concentrate	98	20	56	22	**0.22**
	Hay	110	52	33	25	**0.25**

Index = Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for availability of feed resource divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all for availability of

None of the respondents reported the use of local beer brewery residue (Atella), urea molasses treated straw, and urea molasses nutrient block supplementation. The majority of the respondents indicated that small earth dams is the main source of the drinking water for sheep flocks during the dry 63.3% and wet season 58.3%. They obtained the source of drinking water for their sheep flock within less than one km during the dry (36. 7%) and wet (66.7%) seasons. Majority (61.7%) of the respondents reported that their sheep flocks had an access to drinking water once a day but 25% of the respondents reported that their sheep flock had access to drinking water once in three days. Zelealem *et al.*, (2012) reported that the indigenous sheep populations in the regional government of Tigray have an access to drinking water once a day or 3-4 times a week during the dry season. During the wet season, majority (59.2%) of the respondents indicated that their sheep flocks had free access to drinking water.

3.7. Mating system and breeding management

About 53% of the respondents reported that they mixed their sheep flock with neighbor farmer's flock that indicates mating is multi sire and possible through the year mainly from July to August and September to October. Ewe mating system is with random rams while grazing is in daytime. Some farmers used control mating to reduce bad phenotype (dwarfism and black color) in both breeding ewes and rams. According to the farmer's response, the main sources of breeding rams were replacement rams of the flock. Some farmers obtained the source of breeding rams from neighbor flock and rams purchased from market. This report is

similar with the report of Bosenu *et al.*, (2014). The possibility of mating with brother-sister, sire-daughter, and son-mother is higher when sheep flocks graze together and breeding rams are remained with ewe throughout the year. The current study found that the possible effect of inbreeding on production performance of the highland sheep might be higher. This is in line to the previous report that suggested mating of more related ram and ewe might result in poor production performance of the sheep flock kept under traditional management system (Zelealem *et al*., 2012 and Mulata, 2013).

3.8. Selection of breeding sheep and trait preferences

Majority of the respondents indicated that smallholder farmers in the study area practiced selection of breeding rams using the criteria listed in Table 6. Body conformation, growth of the lambs and age at sexual maturity with an index value of 0.22, 0.21, and 0.18, respectively, are the major criteria used to select breeding rams. Bosenu et al. (2014) reported similar criteria where rams with good appearance are selected first for breeding purpose in Selale area of Central Ethiopia. Smallholder farmers in the study area used lamb growth and lambing frequency ranked first to select breeding ewes with an index value of 0.17.

Table 8. Selection criteria for breeding male sheep from their flock

Variable	N	1st	2nd	3rd	4th	Index
Body conformation	111	43	13	55	0	**0.22**
Color	38	3	21	14	4	0.08
Horn	32	0	7	25	8	0.08
Character	25	2	3	20	1	0.05
Growth of lambs	104	18	62	24	1	**0.21**
Libido	27	10	3	14	7	0.07
Walking long distance	12	3	3	6	5	0.03
Age at first maturity	86	50	14	22	3	**0.18**
Pedigree	12	1	1	10	4	0.03
Adaptability	12	1	1	10	4	0.03

Index = Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] given for selection criteria of male sheep divided by Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] for all selection criteria of male sheep.

Bosenu *et al.,* (2014) suggested, "Breeding programs should be geared towards functional traits top ranked and management practices such as better feeding and health should go in line with genetic improvement programs".Body size /appearance of the breeding ewe are used as second criteria of selection. Milk yield and age at first maturity are used to select breeding ewes as third criteria of selection (Table 7). Breeding ewes are selected for multiple traits consisted of body size, coat color, lambing frequency, mothering ability, age at first lambing and twining rate (Table 7).

Table 7. Selection criteria for breeding ewes

Variables	N	1	2	3	4	Index
Size/ appearance	64	25	7	32	9	0.13
Color	15	3	3	9	14	0.05
Lamb growth	85	5	37	43	8	0.17
Lamb survival	37	2	17	18	3	0.07
Lambing frequency	81	21	28	32	12	0.17
Twining ability	34	10	16	8	16	0.09
Mothering ability	41	18	18	5	12	0.10
Milk yield	44	15	15	14	17	0.11
Age at first maturity	52	46	1	5	6	0.11

Index = Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] given for selection criteria of female sheep divided by Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] for all selection criteria of female sheep.

According to the respondents' point of view, coat color is related to socio-cultural practices and market demand. The breeding rams and ewes with coat colors such as white color belted on black, red, and light brown are preferable and selected for breeding purpose. Black colored sheep are grossly not preferred by consumers and are not given the chance to reproduce with other preferred colors. Bosenu *et al.,* (2014) reports similar sheep coat color preference of the community found in Selale central Ethiopia.

3.9. Reproductive management

3.9.1. Culling unwanted male and female sheep

According to the majority of the respondents, the main reasons for culling male sheep from reproduction were old age, sterility, and diseases and were ranked as 1st and 2nd, and 3rd with an index value of 0.19, 0.18, and 0.17, respectively (Table 8).

Table 8. Reasons for culling male sheep in the study area

Reasons for culling	N	1	2	3	4	Index
Disease	74	58	6	10	1	**0.17**
Old age	85	7	59	19	1	**0.19**
Poor physical condition	73	10	11	52	0	0.16
Stunted growth	73	10	11	52	0	0.16
Sterility	77	25	25	27	2	**0.18**
Low lamb growth	14	3	5	6	3	0.04
Un wanted phenotype	28	3	6	19	3	0.07
Poor libido	11	5	2	4	4	0.03

Index = Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] given for reasons of culling male sheep divided by Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] for all for reasons of culling male sheep.

The main reasons for culling female sheep from the flock were old age, disease, and poor body condition (Table 7).

Table 9. Reason for culling female sheep in the study area

Reason for culling	N	1st	2nd	3rd	4th	Index
Disease	71	34	23	14	1	0.16
Old age	91	10	33	48	2	0.21
Poor body condition	61	3	9	49	1	0.14
Stunted growth	54	8	23	23	4	0.13
Low milk	48	18	11	19	6	0.12
Sterility	45	22	7	16	1	0.10
Un wanted phenotype	13	2	2	9	2	0.03
Poor mothering ability	47	19	15	13	2	0.11

Index = Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] given for reasons of culling female sheep divided by Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] for all for reasons of culling female sheep.

Culling of male and female sheep with unwanted body colour (uniform black and white colour), bad phenotype (Dwarfism, very thin and aggressive behaviour) and sterility is important for early selection of breeding sheep.

3.10. Reproductive performance

The mean (±SD) age at first mating for male and female highland sheep was 6.7±1.7 months and 7.4±1.8 months and the mean (±SD) age at first lambing of ewes was 12.1±2.5 months. This value is within the ranges reported for other indigenous sheep population reared under cereal-livestock production system in Ethiopia (Edea *et al*., 2012; Zelealem *et al*., 2012; Helen *et al.,* 2015). The respondents believed that there is no fixed age at first sexual maturity for both male and female, it depends on the management of the growing ram, and ewe lambs. The mean (±SD) lambing interval was 6.5 ± 0.7 months, which is within the range of the previous work done reported as 8.92 ± 2.13 months for Bonga and 9.23 ± 2.44 months for Horro sheep (Edea et al., 2012). The lambing interval for indigenous sheep population found in Eastern of Ethiopia under cereal-livestock production system is 6.63±0.19 (Helen et al., 2015). The possibility of three lambs within two years depends on the availability of feed and improved management. Lambing season of the highland sheep in the sampled area of Atsbiwonberta is reported in Table 10. It is more concentrated in October, September, and November.

Table10. Lambing season of highland sheep in the Atsbiwonberta district

Lambing season	N	1st	2nd	3rd	Index
September	116	105	8	3	0.21
October	119	7	104	8	0.22
November	90	0	7	83	0.17
December	41	2	2	37	0.08
January	41	1	2	38	0.08
February	19	1	2	16	0.03
March	49	5	2	42	0.09
April	36	1	5	30	0.07
May	17	2	0	15	0.03
June	4	0	2	2	0.01
July	1	1	0	0	0.00
August	10	7	0	3	0.02

Index = Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for lambing season divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all lambing season**.**

The breeding season in the study area mostly took from April to June and August to October, although year

round mating is observed in some farms. This is in line with Mengistie et al. (2010) observation that mating is year round for most sheep breed of Ethiopia and this is dictated by the availability of green feed (Dhaba et al., 2012). The mean (±SD) productive life span of the male and female highland sheep was 4.9±1.9 years and 7.7±2.3 years, respectively, which is higher than the previous report for male as 2.2±0.1 years and female 4.8±0.2 years in Tigray sheep population (Zelealem *et al*., 2012). The respondents indicated that they retain breeding ewes beyond the full mouth permanent teeth.

3.11. Sheep disease prevalence

Common diseases easily identified by respondents are listed down in Table 11. *Coenerosis (Zarty), Ovin Pasteurellosis* (Mieta), *Ovine Pleuropneumonia (Samba), Fasciolosis* (Tselam kebdi), *black leg (*Halafyo*)*, *Bottle Jaw* (Fig.5) and *Anthrax* (Megerem) were reported as major diseases affecting sheep production in the study area. This finding is in line with previous reports on major sheep diseases in different part of Ethiopia (Mulata, 2013; Solomon *et al*., 2010; Zelealem *et al*., 2012; Edea *et al*., 2012). Bloating and FDM (Foot and Mouth disease) were also among the sheep disease, which affect sheep production under traditional management system. Internal parasite like interties and external parasite such as *Menge mites*, ticks, fleas and lice are affecting sheep production in the study area. Animal health services in the study district provided vaccines and treatments for *Ovine Pasturulosis*, *Menge mite* and FMD. According to the respondents' point of view treatment for *Coenerosis (Zarty),* are not effective and sheep owner considered the disease as untreatable. Helen *et al*. (2015) reported that ovine Pasturulosis, *ovine Pleuropneumonia*, Fasciolosis and Anthrax were major diseases affecting sheep productivity and survival in mixed crop-livestock system.

Table 11. Major sheep disease and their symptom in the study area of Atsbi

Common name	Local name of the disease (Tigrigna)	Symptom of the disease
Fasciolosis (Liver fluke)	Tselam kebdi	Reduced appetite
Ovine Pleuropneumonia	Samba	Coughing and fever
Coenerosise	Zarti	Circling
Black leg	halafyo (Weqie)	Reduced appetite
Interties (internal parasite)	Effil	Diarrhea
Bottle jaw	Gurgurit	Swelling on the dorsal face
Ovine Pasturulosis	Mieta	Sudden death and fever
Bloating	Menfahti	Increased size of the rumen
FMD	Afemar	Scabs on mouth and skin
Anthrax	Taffia (Megerem)	Coughing, sudden death
Menge mite /skin disease	Hafew	Scabs and itching

The average (±SD) sheep died within the last 12 months was 2.95±0.4 per households from which 37.5%, 17.1%, 19.3%, 13.4%, 11.8% and 0.8% was ewes, young ewes, rams, and lambs, respectively. The factors for the death of the sheep flock are listed in Table 12. The prevalence of disease, predator, accidence and the prolonged effect of drought ranked as 1st, 2nd, 3rd and 4th with an index value of 0.31, 0.30, 0.17, and 0.14, respectively were the major cause of sheep death under smallholder farmers. According to Mulata (2013), drought and disease are the main cause of sheep death reported in the same district.

Table 12. Causes for the death of sheep under smallholder farmers

Cause	N	1	2	3	Index
Predator	83	35	21	27	**0.30**
Disease	86	34	43	9	**0.31**
Accident	48	4	5	39	**0.17**
Drought	38	10	12	16	0.14
Poisoning	17	7	6	4	0.06
Unknown	6	3	3	0	0.02
Parasite	2	1	1	0	0.01

Index = Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for factor of death sheep divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all factor of death sheep.

3.11. Constraints to sheep ruminant production

Major constraint of sheep production as ranked by respondents in the study area is presented in Table 13. Disease, drought, feed shortage, and parasite infestation ranked as 1st, 2nd, 3rd and 4th with an index value of 0.23, 0.19, 0.17 and 0.16, respectively were considered as the most limiting factors of sheep production in the study area. This report of the current finding agree with the previous report of Helen *et al*., (2015) who mentioned that feed shortage, prevalence of disease and predators are the major sheep production constraint in mixed crop-livestock system. Drought, feed shortage, and disease are among the main constraints of sheep production in the

same study area (Mulata, 2013).

Table 9. Major constraints of sheep production in the study area

Major problem	N	1	2	3	4	Index
Disease	107	66	26	15	4	**0.23**
Parasite	68	4	48	16	7	**0.16**
Feed shortage	77	14	21	42	5	**0.17**
Water shortage	9	2	4	3	13	0.05
Labor shortage	6	2	0	4	6	0.03
Market problem	2	0	0	2	4	0.01
Predator	19	2	6	11	10	0.06
Poor genotype	13	0	7	6	13	0.05
Lack of input	3	1	2	0	6	0.02
Poor extension service	7	1	3	3	4	0.02
Drought	76	41	13	22	15	**0.19**

Index = Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] given for reasons of culling female sheep divided by Σ of [4 for rank 1 + 3 for rank 2 + 2 for rank 2+1 for rank 4] for all for reasons of culling female sheep.

Feed shortage in both quality and quantity is a series problem in the area. The increased livestock population and poor management of the grazing land in the study area cause the degradation of both private and communal grazing lands. The prolonged dry season leads to depletion of the potentiality of the grazing land and aggravates the effect of over grazing on their productivity (Fig.3). The study area is a potential for enhancing the productivity of degraded grazing lands through over and under sowing forage development strategies.

Figure 3. Poor productivity of the grazing land in the study area

Introduction and proper utilization of improved forages in the area especially tree lucern is essential. Growing improved forages such as *Lablab purpureus* and *Rhodes grass, Calliandra calthyrsus, Gliricidia sepium and* pigeon pea (*Cajanus cajan*) on both private and communal grazing lands is among the best feasible forage development strategies to increase feed production in the area. Utilization of locally available concentrated feed like Atella and wheat bran is also the other option for mitigating the effect of prolonged dry season. Sheep production in the area faced with many problems such as poor extension service, poor genotypes, lack of labor, water shortage and market problems are among the constraints that limit the production performance of sheep flock. This report of the current finding is similar with previous report work done in mixed crop livestock production system (Mulata, 2013; Helen *et al*., 2015; Solomon *et al*., 2010; Zelealem *et al*., (2012) and Edea *et al*., 2012). The study area is found in the highland agro ecological zone where barley and wheat are widely cropped. Sheep ruminant production is among the major economic activity with multipurpose socio cultural importance. To enhance the contribution of sheep production on socioeconomic aspect of the local community, improving the feed availability and utilization of improved forage species, enhancing the husbandry and health management of the flock, improving the genotypic productivity of the smallholder flock and market linkages are among the typical and possible solution for the problem of sheep production.

4. CONCLUSION

The study revealed that the average sheep flock size holding of the households is relatively small as compared to sheep flock size of the households in other part of Ethiopia. The result obtained from this study indicated that sheep production in the study area is one of the major economic activities under small farmers. It contributes a

significant source of income for households, source of meat for home consumption, provide skin and manure, and have sociocultural importance. Smallholder farmers considered sheep as a means of escaping from the effect of drought when crop failed to fulfil the subsistent livelihood of the smallholder farmers. The study able to identify the sheep breeding objectives such as fast growth rate, good body conformation, and good reproductive performance for male and lambing frequency, twining, lamb growth, and good milk production for female sheep. Uncontrolled mating with little level of culling unwanted male and female sheep and less intensive selection of breeding male and female sheep is the most important reproductive management under smallholder farmer. The indigenous sheep population named as the highland sheep adapted to the area with an altitude ranged 1800-3000 meter above sea level and has an adaptive mechanism through developing coarse wool. The highland sheep has good reproductive performance under harsh environment (dry and cool area) with substantial production performance. However, sheep production in Atsbiewonberat was constrained by the incidence of disease, drought, feed and water shortage specially January to June, poor management and husbandry (health care, nutrition and husbandry), improper breeding practice resulted poor genotype and lack of market linkage. To bring sustainable improvement on production performance of the highland sheep in the study area, developing disease control method through awareness creation, vaccination and proper diagnosis and treatment of the suspected disease is the first step in solving sheep production constraints. The adoption of improved forage species, proper utilization of locally available concentrated feed source, cultivation, and supplementation of cactus during the dry season and developing total mixed feed ration is second possible solution for sheep production constraints. Introduction of value adding management practices (market oriented fattening scheme) and market linkage is the fourth and most important aspect of enhancing the livelihood and source of income for smallholder farmers.

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Reference

Abdi E., kemal k., Yassin E. and Muleta D. (2013). Cattle Production in West Hararghe: An Opportunity and Constraints Assessments in Darolabu, Odabultum, Gemechis and Chiro Districts, Oromia Regional State, Ethiopia. International Journal of Livestock Production Research. (Vol. 1:1) PP: 01- 15. http://acascipub.com/Journals.php. [October 10, 2015]

Abebe Y., Solomon M., Azage T. and Firew T. (2013). Assessment of sheep production system in burie district, north western Ethiopia. Global Journal of Agricultural Research Vo l.1, No.2, pp.29-47. Published by European Centre for Research Traning and Development UK September 2013. www.ea-journals.org. [October 10, 2015]

Aynalem H., Maria W., Joaquín M., Tadele M., Gemeda D., Okeyo M.,Johann S. and Barbara R. (2011). Guidelines for Setting up Community-based Sheep Breeding Programs in Ethiopia. ICARDA - tools and guidelines No.1. Aleppo, Syria, ICARDA.

Belete S. G. 2009. Production and Marketing System of Small Ruminant in Gomo district of Jima Zone, western Ethiopia. M.Sc Thesis, Department of Animal Science School of Graduate Studies, Hawassa University, Awassa, Ethiopia. Accessed on July 20, 2012. www.ipms-ethiopia.org [October 10, 2015]

Berhanu B. and Aynalem H. (2009a). Reproductive performance of traditionally managed sheep in the south western part of Ethiopia. *Livest. Res. Rural. Dev*. 21. Accessed 19 Sept. 2011. http://www.lrrd.org/lrrd21/9/bela21154.htm. [October 10, 2015]

Bosenu A., Kebede K., Gizaw S. 2014. Indigenous Breeding Practices and Selection Criteria of Sheep Breed in Selale Area, Central Ethiopia. International Journal of Livestock Research Vol 4(7) Oct'14,2014. Jigjiga University, Debre Berhan Agricultural Research Center, Ethiopia. Hosted@www.ijlr.org [October 10, 2015]

DAGRIS 2004. Domestic animal genetic resources information system (DAGRIS). (*eds. Rege, J.E.O., Workneh Ayalew and Ephraim Getahun*). International Livestock Research Institute, Addis Ababa, Ethiopia. http://dagris.ilri.cgiar.org.

DAGRIS, 2006. Domestic Animal Genetic Resources Information System (DAGRIS). (eds. J.E.O. Rege, W. Ayalew, E. Getahun, O. Hanotte and T. Dessie). International Livestock Research Institute, Addis Ababa, Ethiopia. http://dagris.ilri.cgiar.org/ [October 10, 2015]

Dhaba U., Belay D., Solomon D. and Taye T. (2012). Sheep and Goat Production Systems in Ilu Abba Bora Zone of Oromia Regional State, Ethiopia: Feeding and Management Strategies. Global Veterinarian 9 (4): 421-429, 2012. Jimma University, Ethiopia. 421 http://idosi.org/gv. [October 10, 2015]

Edea Z. Haile A., Tibbo M., Sharma A. K., Sölkner J and Wurzinger M. (2012). Sheep production systems and breeding practices of smallholders in western and southwestern Ethiopia. Implications for designing community-based breeding strategies. Yabello Pastoral and Dryland Agriculture Research Centre, Ethiopia.

FAO (Food and Agriculture Organization of the United Nations). 2004. Livestock sector brief: Ethiopia. Livestock information, sector analysis and policy branch (AGAL), FAO, Rome, Italy. Accessed on June 12, 2012. http://faostat.fao.org/ag/[October 10, 2015]

Galal, E.S.E. 1983. Sheep germplasm in Ethiopia. Animal Genetic Resources Information. Food and Agricultural Organization of the United Nations (FAO). 1/83, pp.4 –12

Gebreegziabher L. (2005). The role of Household on the expansion of Home gardens in Tigray, Ethiopia". A thesis Submitted in partial fulfillment for the degree of Masters of Science in Tropical Land Resource Management. Mekelle University, School of Graduate Studies. Faculty of Dryland Agriculture and Natural Resources.Galal, E.S.E. 1983. Sheep germplasm in Ethiopia. Animal Genetic Resources Information. Food and Agricultural Organization of the United Nations (FAO). 1/83, pp.4 –12

Helen N., Yoseph M., Solomon A., Kefelegn K and Sanjoy K. P (2015). Indigenous Sheep Production System in Eastern Ethiopia: Implications for Genetic Improvement and Sustainable Use. American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS) Volume 11, No 1, pp 136-152. Global Society of Scientific Research and Researchers http://asrjetsjournal.org/ [October 10, 2015]

Kassahun, A and Abegaz, S. 2008. Breeds of sheep and goats. In: Alemu Y and Merkel R.C. (eds.). Sheep and goat improvement hand book. Ethiopian Sheep and Goats Productivity Imporvement Program. Pp. 5-26.

Leta S. and Mesele F. (2014). Spatial analysis of cattle and shoat population in Ethiopia: growth trend, distribution, and market access. Springer Plus 2014 3:310. Adami-Tullu Agricultural Research Center, P. O. Box 35, Ziway, Ethiopia. Accessed on July 20, 2015 www.springerplus.com/content [October 10, 2015]

Mengistie T., Girma A., Solomon G., Sisay L., Abebe M and Markos T (2010). Traditional management systems and linear body measurements of Washera sheep in the western highlands of the Amhara National Regional State, Ethiopia. International Center for Agricultural Research in the Dry Areas, PO Box 5466, Aleppo, Syria http://www.lrrd.org/lrrd22/9/taye22169.htm[October 10, 2015]

Mulata H. (2013). Management practice and constraints of sheep production in southern, south eastern and eastern zones of Tigray, northern Ethiopia. World Journal of Animal Science Research Vol. 1, No. 1, December 2013, PP: 01 -17. http://www.wjasr.com [October 10, 2015]

Seare T., Gangwar S. K. & Kefelegn K (2011). Performance and physical body measurement of abergell sheep breed in traditional management system of Tigray regional state, northern Ethiopia. International Journal of science and Nature I.J.S.N., VOL. 2(2) 2011: 225 - 230. www.scienceandnature.org. [October 10, 2015]

Solomon G, Azage T, Berhanu G and Dirk H. (2010). *Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvemen*t. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 23. ILRI (International Livestock Research Institute), Nairobi, Kenya. 58 pp. Accessed on July 20, 2015. https://cgspace.cgiar.org. [October 10, 2015]

Solomon G., Abegaz, S., Rischkowsky, B., Haile, A., Mwai, A.O. and Dessie, T. (2013). Review of sheep research and development projects in Ethiopia. Nairobi, Kenya: International Livestock Research Institute (ILRI). https://cgspace.cgiar.org/ [October 10, 2015]

Solomon G., Getachew, T., Edea, Z., Mirkena, T., Duguma, G., Tibbo, M.,Rischkowsky, B., Mwai, O., Dessie, T., Wurzinger, M., Solkner, J. and Haile, A., 2013. Characterization of indigenous breeding strategies of the sheep farming communities of Ethiopia: A basis for designing community-based breeding programs. ICARDA working paper, Aleppo, Syria. 47pp.

Tsedeke K. K. 2007. Production and Marketing System of Sheep and Goat In Alaba, Southern Ethiopia. M.Sc Thesis. School of Graduate Studies, Hawassa University, Ethiopia.

Zelealem T. G, Anal A. K. & Gebrezgiher G (2012). Assessment of the sheep production system of northern Ethiopia in relation to sustainable productivity and Sheep meat quality. International Journal of Advaced Biological Research. VOL. 2(2) 2012: 302-313. http://scienceandnature.org [October 10, 2015]