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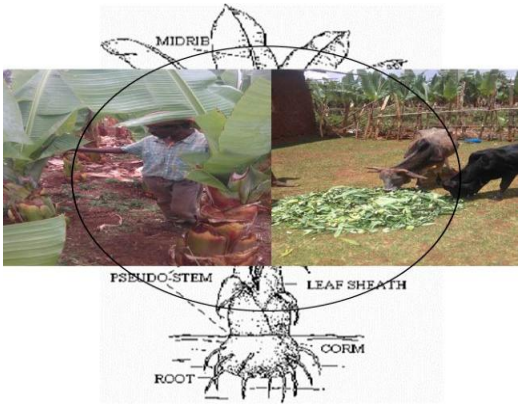
Volume 7 (5); 25 September 2017

Research Paper

Enset (*Enset ventricosum*) beyond human consumption: opportunities and constraints as livestock feed in Gurage Zone, S-W Ethiopia.

Tilahun M.

Online J. Anim. Feed Res., 7(5): 97-104, 2017; pii: S222877011700016-7



Abstract

The objective of this study was to assess Enset (*Enset ventricosum*) plant as livestock feed resource; the opportunities and challenges of using Enset as livestock feed. This study used a descriptive and explanatory study design. A multi sample purposive sampling technique was employed. Ninety households who own livestock above 2 Tropical Livestock Unit from the district i.e., 30 Household respondents from each agro ecology were selected. The collected data were analyzed using SPSS 20 software, and ranked data was analyzed using Microsoft Excel. In addition, logit model [α = 0.05] was used to analyze and predict the values of dependent variables (Enset plant with livestock). Enset plant production (86.67%), livestock farming (83.3%) and perennial crop production (81.1%) took the lion share as means agricultural practices of the study area. Though natural pasture (Hebir) was ranked third in the highland of the study area, it was ranked first in the overall data gathered for available feed resource in the study area. Only 30(33.3%) of the respondents tried Enset conservation practices. From different Enset parts, leaf (Bera and Kessa) was ranked first as majorly used as livestock feed; midrib (Chimbina) and pseudo stem (Enkurkina) took second and third rank, respectively. The agro ecological difference estimated coefficient 0.698 (P = 0.046) suggested that agro ecology difference decrease the respondents number by 69.8 % to say no for Enset and livestock relationship. Respondents land holding had an estimated coefficient of 2.09 (P = 0.01) which suggested an increase in land holding by a timad (quarter of hectare) was increased Enset part use by 8.05%. Similarly, land used for Enset cultivation has an estimated coefficient of -3.37 (P = 0.01) which suggested an increase in the proportion of land use for Enset plant cultivation was decreased the use of Enset plant parts by 0.03%. From the different identified constraints of Enset plant use as livestock feed, land shortage, climate change, market access ranked first, second and third, respectively. It can be concluded that Enset is major part of livestock feed; gradual land shortage and other factors are hindering farmers not to use Enset as livestock feed and trust up on other cash crops. Most Enset harvesting is done at main rain season so conservation techniques is must, and has to be scrutinized based on agro ecological difference.

Keywords: Feed resource, Enset, Livestock, Enset Parts, Gurage zone

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Research Paper

Productive and reproductive performances of local cows in Guraghe zone, South West Ethiopia.

Ayalew W and Feyisa T.

Online J. Anim. Feed Res., 7(5): 105-112, 2017; pii: S222877011700017-7

Abstract

In tropics the genetic diversity of indigenous livestock provides a range of options that are likely to be valuable in adaptation to poor-quality diets and tolerance of climatic extremes as well as resistance to specific diseases. The aim of this study was to assess productive and reproductive performance of local dairy cattle in Guraghe Zone. Formal survey was used to collect data from three district, which were selected from three agro-ecological zones namely, highland, midland and lowland. A total of 180 respondents (60 from each agro-ecology) that have at least one local milking cow were randomly selected. The data were analyzed by general linear model procedure of SPSS version 20 (SPSS, 2015). The breeding practices reported in the study area were mostly natural mating but AI also rarely practiced. In all agro-ecologies, farmers reported milk production as preferred trait, followed by reproduction, growth rate and longevity. In the follow up study, except agro-ecology all sources of variation had significant effect on morning and evening milk yields, however, the survey analysis revealed that agro-ecology was significant for all reproductive traits under this study. The average milk off-take of Guraghe highland cows was 1.7±0.02 liter/cow/day and on average cows gave a lactation yield of 379.14±12.11 liters/cow and an average lactation period of 7.90±0.08months. Overall mean of calving interval and days open were 22.03±0.37 and 12.70±0.37 months, while mean age at first service and age at first calving of cows in Guraghe Zone were quite late (33.51±0.70 and 42.85±0.70 months, respectively) even by local standard. In conclusion, this study has shown that performances of Guraghe highland cows less than the optimum values desirable for market-oriented dairy production. Therefore, there is a need for intervention to develop infrastructure, enhance input supply system and undertake appropriate breeding plan based on breeding objective and trait preferences of local farmers.

Keywords: Breeding objectives, Guraghe highland, Production and Reproductive traits

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Research Paper

On-farm phenotypic characterization of Holla sheep types in South Wollo Zone Eastern Amhara Ethiopia.

Kefale A, Awoke T, Getu A and Abegaz S.

Online J. Anim. Feed Res., 7(5): 113-123, 2017; pii: S222877011700018-7

Abstract

The study was conducted from purposively selected districts of Kalu and Worebabu districts in South Wollo administrative zone to describe the physical characteristics. Confirmatory and purposive sampling techniques were employed to select the target farmers. Following that semi-structured questionnaire, focused group discussions, secondary data source analysis and field observations were used to generate the required information. In addition, simple random sampling technique was used to select 450 sheep. The study was performed based on field measurements and body measurements were taken from 450 sheep of both sexes. Majority of the Holla sheep have brown, coat color (59.2%) female and (49.5%) male and white coat color type (27.4%) for females and (31.8%) for males were observed and they are short, smooth coat cover and polled type. Whereas, about 4.4% of ewes had wattle while the rams had no wattle which was strongly influenced ($P < 0.01$) by pelvic width, tail width and ear length. Similarly body weight and chest depth were also influenced ($P < 0.05$) by district. Age group had significant effect ($P < 0.05$) on body weight and other body measurements. Average ±SE body weight age at 0PPI, 1PPI, 2PPI, 3PPI and 4PPI was recorded as 18.21±0.23 kg, 20.34±0.26 kg, 22.14±0.25 kg, 23.41±0.56 kg and 26.33±0.65kg, respectively. Sex was strong and significant ($P < 0.01$) effect on wither height, tail length and tail width. The interaction of sex and age is significantly ($P < 0.05$) influenced the liner body measurements except ear length of sheep. The highest relationship ($r=0.74$) between heart girth and body weight were recorded in Worebabu and Kalu district of female age groups at 2PPI. So, chest girth is the first variable to enter in to stepwise regression model in both male and female sheep type. Present phenotypic information could be complemented with genetic analysis, and serve as a basis or designing appropriate conservation, breeding and selection strategies 'for Holla sheep.

Keywords: Body measurement, Characterization, Holla Sheep, On farm, Phenotypic Ethiopia

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Research Paper

Prevalence of bovine subclinical mastitis and its associated risk factors in Addis Ababa, Ethiopia.

Yilma M and Samuel D.

Online J. Anim. Feed Res., 7(5): 124-133, 2017; pii: S222877011700019-7

Abstract

A cross-sectional study was conducted with the objective of determining the prevalence of bovine Subclinical mastitis (SCM) in dairy cows and assessing its associated potential risk factors from November, 2016 to April, 2017 in Addis Ababa, Central Ethiopia using California mastitis test. A total of 390 lactating cows comprising different cattle breed from sixteen dairy farms were purposively sampled. The overall prevalence of SCM among the study animal was 49.23 % (192/390). Of this, the highest prevalence of SCM was observed in Holstein-Friesian (51.6%) followed by Jersey (50.0%) and cross (37.1%). The prevalence of SCM in <5 months, 5-8 months and >8 months stage of lactation was 73.9%, 38.5% and 47.5%, respectively. In terms of milk yield, the prevalence of SCM was higher in cows having more than 15 liters of milk production (61.5%) and 7-15 liters (45.8%) and lower in <7 liters (41.4%). The prevalence of SCM in parity group 1-3, 4-6 and >6 was 41.3%, 52.9%, and 78.7%, respectively. Regarding floor type, the highest prevalence was recorded in bad concrete floor (64.2%) than good concrete (43.7%). The prevalence of SCM was higher in cows having teat lesion (75.3%) than no teat lesion (42.4%). Breed, parity, stage of lactation, milk yield, teat lesion, floor type were found to have statistically significant difference ($P<0.05$). However, age, towel usage and body condition score showed non-significant difference ($P > 0.05$). In general, Subclinical mastitis was a major health problem of dairy cows in the study area. Therefore, more emphasis should be given on regular screening of cows, designing effective control and prevention strategies for subclinical mastitis.

Keywords: Addis Ababa Dairy cows, Prevalence and Risk factor, Subclinical mastitis

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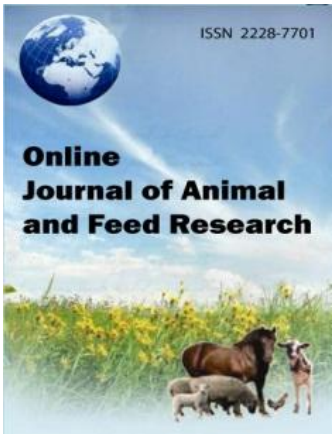

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ENSET (*Enset ventricosum*) BEYOND HUMAN CONSUMPTION: OPPORTUNITIES AND CONSTRAINTS AS LIVESTOCK FEED IN GURAGE ZONE, S-W ETHIOPIA

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ABSTRACT: The objective of this study was to assess Enset (*Enset ventricosum*) plant as livestock feed resource; the opportunities and challenges of using Enset as livestock feed. This study used a descriptive and explanatory study design. A multi sample purposive sampling technique was employed. Ninety households who own livestock above 2 Tropical Livestock Unit from the district i.e., 30 Household respondents from each agro ecology were selected. The collected data were analyzed using SPSS 20 software, and ranked data was analyzed using Microsoft Excel. In addition, logit model [$\alpha = 0.05$] was used to analyze and predict the values of dependent variables (Enset plant with livestock). Enset plant production (86.67%), livestock farming (83.3%) and perennial crop production (81.1%) took the lion share as means agricultural practices of the study area. Though natural pasture (Hebir) was ranked third in the highland of the study area, it was ranked first in the overall data gathered for available feed resource in the study area. Only 30(33.3%) of the respondents tried Enset conservation practices. From different Enset parts, leaf (Bera and Kessa) was ranked first as majorly used as livestock feed; midrib (Chimbina) and pseudo stem (Enkurkina) took second and third rank, respectively. The agro ecological difference estimated coefficient 0.698 (P=0.046) suggested that agro ecology difference decrease the respondents number by 69.8 % to say no for Enset and livestock relationship. Respondents land holding had an estimated coefficient of 2.09 (P=0.01) which suggested an increase in land holding by a timad (quarter of hectare) was increased Enset part use by 8.05%. Similarly, land used for Enset cultivation has an estimated coefficient of -3.37 (P=0.01) which suggested an increase in the proportion of land use for Enset plant cultivation was decreased the use of Enset plant parts by 0.03%. From the different identified constraints of Enset plant use as livestock feed, land shortage, climate change, market access ranked first, second and third, respectively. It can be concluded that Enset is major part of livestock feed; gradual land shortage and other factors are hindering farmers not to use Enset as livestock feed and trust up on other cash crops. Most Enset harvesting is done at main rain season so conservation techniques is must, and has to be scrutinized based on agro ecological difference.

Keywords: Feed resource, Enset, Livestock, Enset Parts, Gurage zone

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INTRODUCTION

Like most tropical countries, the major livestock feed resource in Ethiopia are natural pasture and crop residues. Contribution of agro industrial by products and manufactured feed has been much less (Berhanu et al., 2009). Due to livestock's attribute in most activities of farming, currently no one can insure a country like Ethiopia without livestock dependency. However, the significance of natural pasture is gradually declining from 89% in 1985 to 57% in 2013 (Alemayehu, 2017). This is majorly due to the expansion of crop production; population increase based redistribution of communal lands and land degradation (Berhanu et al., 2009). Gradual decline in the principal feed source (i.e., Natural pasture) force farmers and pastorals to focus merely on the amount of feed available rather than on the quality of the feed. The situation become worse on dry seasons hence, most farmers

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have not developed feed conservation techniques (Bereda et al., 2014; Tilahun et al., 2016). There are some plants which are adaptable to an area, and have immense importance in tackling feed scarcity in livestock production. Enset (Enset *ventricosum*) plant is the commonly known feed in the life of most Southern Nation Nationality of People Republic states (SNNPRs) peoples and neighboring regions. It is known for its ability to stand alone even in the acute forms of droughts. Lately, drought is common in all parts of Ethiopia with a varying degree between areas, altitudes and production systems (Helland, 2015). Dry time flounces major resources of farmers and pastoralists such as livestock, grown plants and even human beings. In contrast, most SNNPRs districts especially Gurage zone have little history in relation to drought. So, important trends should have to be assessed, strengthen and transfer to adoptable areas by evaluating its significance and correlation with different household characteristics.

Several studies have been conducted on fodder production and use in Ethiopia, both by national and international research organizations, however, the focus of those studies are limited to the agronomic and nutritional characteristics of feed resources, and animal responses to types of feeds and feeding practices Bediye et al. (2001), and most studies forgets Enset plant as livestock feed while assessing other feed resources in Enset based farming s systems (Menbere, 2014). Therefore, considering all these facts and the severity of feed shortage in livestock production in most sub system of the region, it is important to management important feed related problems and available feed resources of the area to develop a proper utilization strategy and to recommend path ways for future studies. However, no enough documentation is found to support this evidence so far. This study was initiated to generate significance evident with regard to contributions of Enset plant as livestock feed.

The objectives of this study were to assess the importance of Enset plant as livestock feed; to assess the relationship between Enset plant and different agro ecologies; to assess opportunities and constraints of Enset plant as livestock feed.

MATERIALS AND METHOD

Study area

Gurage zone is found 158 km from the capital city Addis Ababa, and located about 8^0 33' latitude and 37^0 59'longitudes.The average elevation of the district is 1870 meters. The mean annual Temperature range from 14-24^0c with an average of 20-25^0c and annual rain fall is 1294mm.The soil type of the area heavy vertical around 80% which in organic matter while capability to drain water (CSA, 2017).

Enset based agricultural production system is the identity of the study area with a minor proportion of integration with livestock production. The most important crop grown in this study area includes Maize, Teff, Sorghum, and Enset. The major livestock's keep by rural farmers are cattle, sheep and goat by the degree of proportion and importance, respectively (CSA, 2017).

Household survey

This study used a descriptive and explanatory study design. Those designs were appropriate to address the value of Enset as livestock feed and identifying the hindering constraints about Enset use as livestock. It helped us to describe and explain Enset use difference based agro ecology and household characteristics. In addition, the design also helped us to scrutinize and identify the salient variables that are relevant in deciding the cause for the difference in Enset plant use as livestock feed.

From the whole districts, three kebeles i.e., *Moche*, *Yeferez* and *Ewan* from Highland, Midland and low land were purposely selected, respectively. Based on the information gathered from the Focus Group Discussions (FGDs) we generalized that HHs who own above two TLU had not been selling and slaughtering their stock to cope up with feed shortage. So, for this study, HHs who own above 2 Total Livestock Unit (TLU) were selected. However, households who own less than 2 TLU was used selling or slaughtering as primary option to tackle feed shortage at the time of dry time (Tilahun et al., 2017). A sample of 30 respondents was selected from the three agro ecologies found in the study district. A total of 90 respondents were used for the purpose of this study. Selected household who deliberately refuse to participate in the survey was replaced by the next household. The data was collected in the month of May, 2017.

Both primary and secondary data were collected. Semi structured questionnaire majorly with qualitative questions was prepared and then translated in to the local language '*Guragigna*', and it was administered to selected HHs. In addition, personal observation, Key Informant Interview (KII) and Focus Group Discussions (FGDs) were held to triangulate the information gathered from the main data source (i.e., HH survey). Secondary data was gathered from different written documents, reports, and articles.

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Enset plant uses

Enset plant use in different agro ecologies of the study area is presented in Figure 1. Enset is the significant plant which can be used in different activities of Gurage peoples. Enset can be used as food (*Kocho; Bulla;Amicho; Livestock*), as a plat to serve food, as a sheath (*Koba*) for "*chat*". The result indicated that all study area respondents use Enset plant (Corm; Psudo-stem) as household consumption. Eighty five and seventy three percent of households of the study area was used Enset (leaf; midrib; leftover from harvest) as livestock feed and indicated that Enset plant was used as livestock feed and as sheath (Leaf) for harvested chat plant. The use of Enset leaf can be extended to be used as a plate to serve food in different events (Weeding and Grief) of the society. The result indicated that about 53 % of households still use Enset leaf as a plate to serve food in different events of the community.

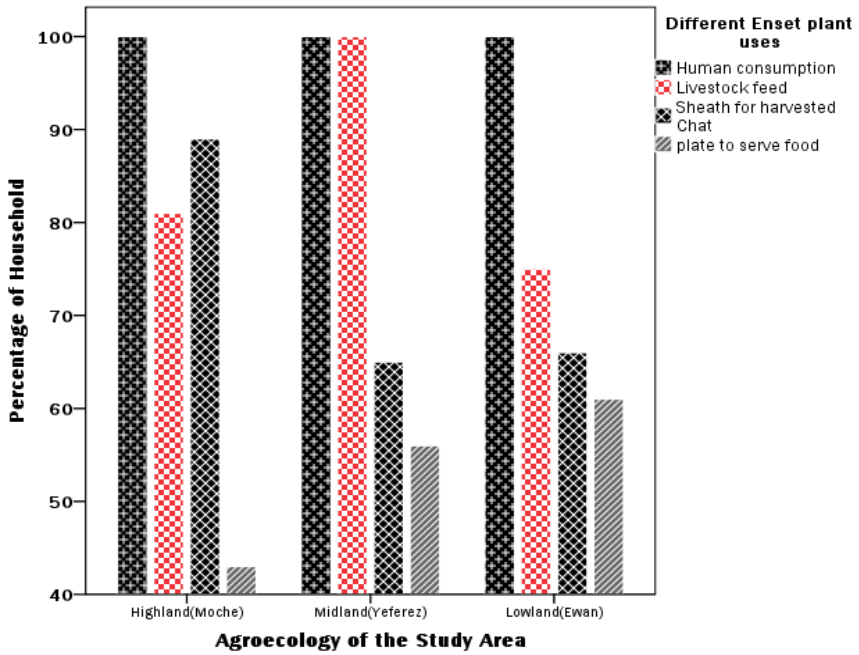

Figure 1 - Different Enset plant uses at different agro ecology of the study area

Data analysis

The raw data were analyzed using descriptive statistics and summarized into tabular and figure formats. In addition, multiple linear regression model [significance level of $\alpha = 0.05$] was used to analyze farmers perception towards Enset part use. The analysis was conducted using SPSS version 20.

$Index = R_n * C_1 + R_{n-1} * C_2 + \ldots + R_1 * C_n / \sum R_n * C_1 + R_{n-1} * C_2 + \ldots + R_1 * C_n$; Where R_n = Value given for the least ranked level (example, if the least rank is 6th, then R_n=6, R_{n-1}=5, and …, R_1=1); C_n= Count of the least ranked level (in the count of the 1st rank = C_1). The opposite matching for R and C value can be presented as follows;

R_1 *for* R_n, R_2 *for* R_{n-1}…, R_n *for* R_1 *and* C_1 *for* C_n, C_2 *for* C_{n-1},…, C_n *for* C_1.

The qualitative data were first organized and categorized and then interpreted with respect to basic research questions. Finally, both qualitative and quantitative data was integrated to reach in concrete result.

RESULTS AND DISCUSSION

Means of livelihood

Table 1 indicated that major agricultural practices of the study area. Livestock farming (100%), Enset plant production (86.67%), and perennial crop production (81.1%) took the lion share as means of livelihood on the study area. In addition, HHs was involved in others income generation sources such as livestock farming and off farm activities. About eighty three percent of the selected HHs was kept livestock as means of livestock and 76.67% of them involved in integration of livestock with crop production.

The different that were exhibited in the means of livelihood among the three agro ecologies might be attribute to the infrastructure majorly road availability and access to market and support from different Government Organization (GO) and Non-governmental organization (NGOs) in the selected kebeles, and Urbanization and being a neighbor to city made the different in the means of livelihood.

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Major Feed resource

Table 2 presented the major feed resource of the study district. Natural pasture was first ranked feed resource in two agro ecologies (midland; lowland) and in overall ranked data. The importance of natural pasture and crop residue in this study is in agreement with Tolera et al. (2012); Belay et al. (2012); Menbere (2014). However, crop residue, ENSET parts and residue and natural pasture ranked first, second and third in the highland of the study district. In addition, the recent national level share of natural grazing pasture as livestock feed resource reduced from 89 % in Alemayehu (1985) to 57% In CSA (2013). This might be attributed to expansion of crop production, population density, redistribution of land and land degradation. This is in line with the result of Berhanu et al. (2009).

Feed resources at different seasons

Available feed resource to an area is the best detector to show the relationship between livestock's and the environment. The result of this study showed that natural pasture (91% in sep- Dec; 85% Jan-Mar; 52% April-May; 89% June-Aug) is the primary feed source in most seasons of the study area. Enset plant is the second choice of respondents based on the average proportion (67%; 71%; 89%; 79%) responses from the study population. Enset plant use as livestock feed becoming highly significant in dry season this might be attributed to lack of natural pasture and crop residue conservation techniques makes Enset plant (especially leaf) to be the prior choice of farmers between the month of April and May. The study result is in line with the study by Bereda et al. (2014) in Gurage zone of Ethiopia which showed that Enset plant were the best feed resource choice in dry season

ENSET parts and their use as feed

Table 3 presented priority given to the different parts of Enset plant as livestock feed on different agro ecologies of the study area. There are different Enset parts leaf from this the commonly used once are pseudo-stem, corm, root, midrib and left over. The result of this study revealed that the leaf part of Enset plant was ranked first as prior Enset plant part; midrib second and pseudo-stem took the third rank. Corm, left over and Root part of Enset plant took fourth, fifth and sixth rank, respectively. No significance different in the choice of Enset parts among the different agro ecologies were revealed. One elder from Moche kebeles stated that Enset plant harvest (*Fike*) mostly done on main rain seasons (i.e., ample of feed choice) so this does not let animals to use Enset plant properly specially the collected left over during harvesting. This result is similar with the study of Fekadu (2009); Mohammed et al. (2013) which stated the drought tolerance of Enset, fresh leaves are a common fodder when other fodder is scarce during the dry season, which can extend for several months. They are especially fed to lactating cows at this time.

Relationship between household characteristics and ENSET parts use as livestock feed

Table 4 was presented the relationship between HH characteristics and Enset parts use. The Estimated coefficient (B) for land owned by farmers 2.09 (p=0.01) which suggest an increase by one timad (1/4 of hectares) of land holding was also increased households' Enset parts use by 8.05%. In contrast, the proportion of land used for Enset plant cultivation has an estimated coefficient of -3.37 (P=0.01) which suggested that an increase in the proportion of land used for Enset plant cultivation was decreased the use of Enset plant parts by 0.03%. Respondents sex difference has an estimated coefficient of 1.35 (P=0.05) which suggested that female headed Households was increased the use of different Enset parts by 3.85% than male headed HHs.

Constraints of ENSET plant use as livestock production

Different constraints towards using Enset plant as livestock feed is presented in Table 5. Land shortage was ranked first in all agro ecologies individually and overall sampled HHs from the selected area. Climate change got perceived from the selected HHs of the study area and ranked second in all agro ecologies. Market access of the agro ecologies ranked third as constraints which hinder the use of Enset part and residue as livestock feed. Household size increase through time results in shrinkage of land, and fragmentation of land so this might be the reason to take land shortage as constraint in use of Enset parts and residue as livestock feed.

The study indicated that highland Enset plant production constraint primarily goes to land shortage and climate change ranked second from the response collected from HH in the study area, and other constraints such as input, poor market, inequality taken the rest ranks, respectively. According to the respondent the first and the second constraints are similar in all agro ecology. One FGD participant from the High land agro ecology mentioned that "Gradual land shortage and fragmentation are letting farmers to convert their Enset land to other cash crop land, and also, farmers gradually decrease spending their time and effort on Enset from time to time. This is because most Enset varieties take above seven years to give yield."

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Table 1 - Means of livelihood in the study area.

Agricultural practices	Agro ecology						Overall (N=90)	
	Moche (n=30)		Yeferez (n=30)		Ewan (n=30)			
	Freq	%	Freq	%	Freq	%	Freq	%
ENSET plant production	27	96.67	22	73.3	29	96.67	78	86.67
Perennial Crop production	24	80	23	76.6	26	86.67	73	81.1
Irrigation based Crop production	9	14.4	19	63.3	23	76.67	51	56.67
Livestock Farming	30	100	30	100	30	100	90	100
Mixed farming	21	83.3	23	76.67	25	83.3.	69	76.67
Off-farm activities	12	40	23	76.67	20	66.67	55	61.1

Note that off farm activities represents casual labor, Trade, employment etc; the study purposely sampled HHs who own livestock above 2 TLU.

Table 2 - Major feed resource in the study district (N= 90; n=30)

Feed resources	Agro ecologies						Over all (N= 90)	
	Moche (n=30)		Yeferez (n=30)		Ewan (n=30)			
	N(index)	Rank	N(index)	Rank	N(index)	Rank	N(index)	Rank
Natural pasture (*Hibir*)	83(0.27)	3	110(0.36)	1	105(0.39)	1	299(0.33)	1
Crop residue	86(0.29)	1	86(0.29)	2	99(0.37)	2	271(0.30)	2
ENSET parts and residue	85(0.28)	2	65(0.21)	3	39(0.14)	3	200(0.22)	3
Formulated feed	46(0.15)	4	40(0.13)	4	27(0.10)	4	130(0.14)	4
Conservation Practice	5*	33.3**	3*	10**	7*	23.3**	15*	33.3**

Table 4 - Enset plant parts and its relationship with different household's characteristics

HH Characteristics	B(S.E.)	Wald	Sig.	Exp(B)
Agro ecology(1=highland)	0.27(0.36)	0.57	0.45	1.31
Age of respondent	-0.05(0.04)	1.16	0.28	.95
Sex of respondent(1=female)	1.35(0.70)	3.73	0.05	3.85
Marital status(1= married)	0.46(0.56)	0.67	0.41	1.58
Education(1=literate)	0.53(0.43)	1.50	0.22	1.70
Training	-0.49(0.54	0.83	0.36	.61
HH family size	0.05(0.29)	0.03	0.86	1.05
Land owned per HH	2.09(0.75)	7.70	0.01	8.05
Land used for Enset plant	-3.37(1.33)	6.40	0.01	0.03
Livestock owned	-0.16(0.26)	0.38	0.54	0.85
Cox and Snell R^2 = 0.20 Nagelkerke R^2 = 0.30				

Table 3 - Priority given to different Enset plant parts as livestock feed.

ENSET parts	Agro ecology						Overall	
	Moche (n=30)		Yeferez (n=30)		Ewan (n=30)			
	N(Index)	Rank	N (Index)	Rank	N (Index)	Rank	N(Index)	Rank
Leaf (*Bera/Kessa*)	173(0.27)	1	173(0.28)	1	168(0.26)	1	514(0.27)	1
Pseudo-stem(*Enkurkina*)	102(0.16)	3	102(0.17)	3	104(0.16)	3	308(0.16)	3
Corm(*Weheta*)	97(0.15)	4	97(0.16)	4	95(0.15)	4	289(0.15)	4
Root(*Heler*)	47(0.07)	6	47(0.10)	6	50(0.07)	6	144(0.07)	6
Midrib(*Chimbina*)	154(0.24)	2	154(0.24)	2	159(0.25)	2	467(0.24)	2
Left over(*Yerchiye*)	53(0.08)	5	53(0.11)	5	51(0.08)	5	157(0.08)	5

Leaf represents all leaf (Bera and Kessa) and leaf sheath (Weficho)

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Table 5 - Constraints faced in using ENSET as livestock feed

Constraints	Agro ecology						Total (N=90)	
	Lowland (n=30)		Midland (n=30)		Highland (n=30)			
	N(Index)	Rank	N(Index)	Rank	N(Index)	Rank	N(Index)	Rank
Land shortage	204(0.24)	1	208(0.25)	1	203(0.24)	1	615(0.24)	1
Poor market	113(0.14)	4	104(0.12)	3	122(0.14)	3	339(0.13)	4
Input	130(0.16)	3	141(0.17)	2	114(0.13)	4	385(0.15)	3
Information	80(0.10)	6	75(0.09)	6	79(0.09)	6	237(0.09)	7
In equality	88(0.11)	5	93(0.11)	4	75(0.08)	7	255(0.10)	6
Environmental degradation	68(0.08)	7	85(0.10)	5	96(0.11)	5	258(0.11)	5
Climate	154(0.18)	2	141(0.17)	2	150(0.17)	2	442(0.17)	2

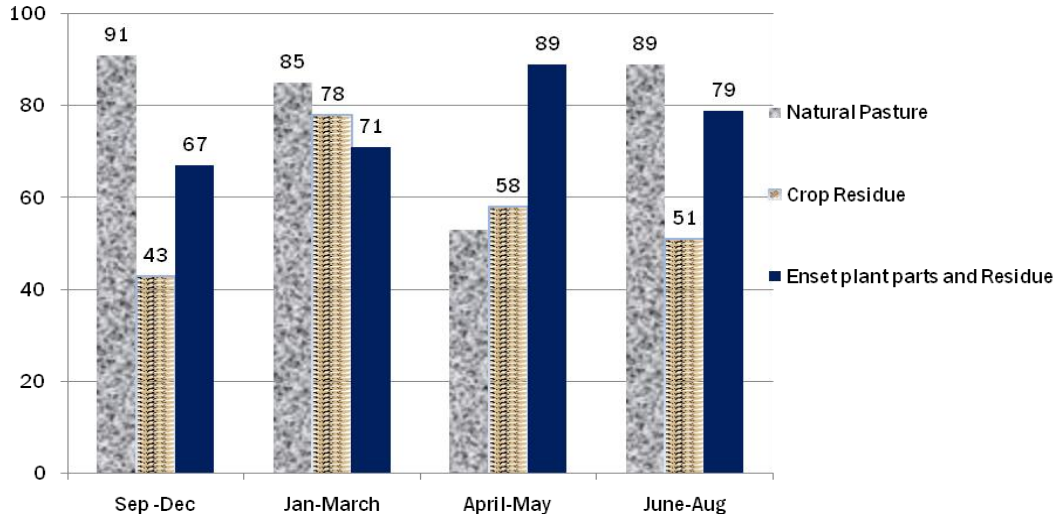

Figure 2 - Feed availability on different seasons of the study area

Table 6 - House hold characteristics of the study area.

HH characteristics		Agro ecology			Total (N=90)
		Moche (n=30)	Yeferez (n=30)	Ewan (n=30)	
		Mean± SD	Mean± SD	Mean± SD	Mean± SD
Age		40.56±12.41	42.43±12.60	43.93±11.88	42.3±12.24
Sex	Male	22(73*)	24(80*)	22(73*)	23(75*)
	Female	8(27*)	6(20*)	8(27*)	7(25*)
Marital status	Married	28(93.3*)	26(76.67*)	26(76.67*)	80(86.33*)
	Single	2(6.67*)	2(6.67*)	2(6.67*)	6(6.67*)
	Widowed	0*	1(3.33*)	1(3.33*)	2(2.2*)
	Divorced	0*	1(3.33*)	1(3.33*)	2(2.2*)
Education(illiterate)		93.3*	73.3*	90*	85.53
HH age distribution	Less than 10 years old	1.2±0.92	1.26±0.90	1.33±0.84	1.27±0.88
	Between10 and18	1.13±1.07	1.30±0.91	1.56±1.07	1.33±1.02
	Between18 and 65	2.06±0.78	2.26±0.78	1.97±0.61	2.10±0.73
	Above 65 years old	0.20±0.48	0.10±0.30	0.27±0.69	0.18±0.51
HH size		4.60±2.03	4.93±1.96	5.03±1.67	4.85±1.88
Livestock ownership		5.34±1.66	5.17±0.81	5.48±1.27	5.33±1.29
Land owned		2.04±0.91	2.50±0.67	2.50±0.63	2.31±0.77
Land for ENSET		0.68±0.44	0.70±0.33	0.73±0.38	0.70±0.39

*represents percentage

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CONCLUSION AND RECOMMENDATIONS

Livestock's are the major source of feed and power in different societies of the world. In the context of Ethiopia, we can say that the country does not exist without livestock due to their attribute in most activities of farming such as food source; source of insurance in the time of household crisis etc. Feed availability, management systems and conservation techniques are the prominent factor while considering livestock production. Currently, most highlands of Ethiopia are prone to the effect of climate change and drought. Conversely, areas like Gurage zone and most part of SNNPR which have been dependent on Enset (Enset *ventricosum)* plant as their staple food and as means of livestock feed has been resilience, and the damage to the population and animals on these areas have been quite few. This study tries to assess the opportunity and constraints of Enset plant use in relation to livestock survival. Most respondents of the study use perennial crop production (81.1%), Enset production (86.67%) and livestock farming (83.3%) as means of income generation. Respondents from Midland (*Yeferez)* and Lowland (*Ewan)* Kebeles ranked natural pasture first as major source of livestock feed, however, the Highland (*Moche*) respondents ranked crop residue as the prior feed resource. Our study revealed that all the agro ecologies prioritize leaf, midrib and pseudo-stem parts as first, second and third, respectively. Farmers land holding has a positive relationship 2.09(p=0.01), however, land use for Enset cultivation has negative -3.37 (p=0.01) relationship with Enset parts use. Households with female head has a positive relationship 1.35 (p=0.05) with Enset part use. Land shortage, climate change and lack of inputs are identified as major constraint, and the constraints show complete similarity in all agro ecologies.

Based on the findings of this study, we can recommend that Enset has immense significance in tackling feed shortage. Adopting different conservation technique will help farmers in filling the identified gaps which mostly farmers lack and become hindered in feed shortage at dry season. Government intervention in developing a training program might fill the gap in improving and sustaining a resilience society in the changing climate. The input used and the labor demand of the plant is higher in comparison to other cash crops is somewhat higher i.e., labor is demanded for seven continuous years till harvest. Different variables such as land availability, farmer's skill and education and agro ecological difference should be considered while planning to use Enset plant as livestock feed. Further studied which focus on nutritional difference between Enset parts should have to get emphasis and studied to come up with a solution to feed shortage.

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Author's contribution

The author conducted the field research, designed the research, analyzed the data, interpreted the results, and drafted the manuscript and write-up the manuscript. At last the author revised the manuscript, and read and approved the final version.

Conflict of interest

The author declare that he has no competing interests.

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PRODUCTIVE AND REPRODUCTIVE PERFORMANCES OF LOCAL COWS IN GURAGHE ZONE, SOUTH WEST ETHIOPIA

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ABSTRACT: In tropics the genetic diversity of indigenous livestock provides a range of options that are likely to be valuable in adaptation to poor-quality diets and tolerance of climatic extremes as well as resistance to specific diseases. The aim of this study was to assess productive and reproductive performance of local dairy cattle in Guraghe Zone. Formal survey was used to collect data from three district, which were selected from three agro-ecological zones namely, highland, midland and lowland. A total of 180 respondents (60 from each agro-ecology) that have at least one local milking cow were randomly selected. The data were analyzed by general linear model procedure of SPSS version 20 (SPSS, 2015). The breeding practices reported in the study area were mostly natural mating but AI also rarely practiced. In all agro-ecologies, farmers reported milk production as preferred trait, followed by reproduction, growth rate and longevity. In the follow up study, except agro-ecology all sources of variation had significant effect on morning and evening milk yields, however, the survey analysis revealed that agro-ecology was significant for all reproductive traits under this study. The average milk off-take of Guraghe highland cows was 1.7±0.02 liter/cow/day and on average cows gave a lactation yield of 379.14±12.11 liters/cow and an average lactation period of 7.90±0.08months. Overall mean of calving interval and days open were 22.03±0.37 and 12.70±0.37 months, while mean age at first service and age at first calving of cows in Guraghe Zone were quite late (33.51±0.70 and 42.85±0.70 months, respectively) even by local standard. In conclusion, this study has shown that performances of Guraghe highland cows less than the optimum values desirable for market-oriented dairy production. Therefore, there is a need for intervention to develop infrastructure, enhance input supply system and undertake appropriate breeding plan based on breeding objective and trait preferences of local farmers.

Keywords: Breeding objectives, Guraghe highland, Production and Reproductive traits

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INTRODUCTION

Livestock are an important component of nearly all farming systems in Ethiopia and provide of great socio-economic and cultural values. The diversified use of livestock on average contributing 45% of the total Agricultural Gross Domestic (GDP) of the country (IGAD, 2010). In Ethiopia dairy production is still in extensive system and depends mainly on indigenous livestock genetic resources; with animals having multipurpose use and as such no specialized and systematic breeding is used (Giday, 2001). To date local cattle are characterized by an average lactation length of 6 months and an average daily milk production of 1.37 liters per cow/day (CSA, 2017). To meet the ever-increasing demand for animal products and thus contribute to poverty alleviation in Ethiopia, genetic improvement of the indigenous cattle basically focusing on crossbreeding. About 99.19 percent of the dairy cattle are non-descriptive indigenous breeds, while the hybrids and pure exotic breeds were represented by 0.72 and 0.09 percent, respectively (Zelalem et al., 2011). This suggests that the total number of both exotic and hybrid female cattle produced through the crossbreeding work for many decades in the country is quite insignificant indicator of successful crossbreeding work (Aynalem et al., 2011).

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Although the indigenous Zebu cattle are poor in performance, the genetic improvement of Ethiopia also have a look at selection of the most promising breeds as the genetic diversity of Ethiopian's livestock provides a range of options that are likely to be valuable in climate change adaptation, including resistance and tolerance to specific diseases, adaptation to poor-quality diets and tolerance of climatic extremes. The Guraghe highland breed is Small East African Zebu type found in the Guraghe Zone in close proximity to the tsetse infested Ghibe valley, Ethiopia (Rege, 1999; DAGRIS, 2007). Accurate evaluation of the productive and reproductive performance of local cattle probably the most important factor that is a prerequisite for sustainable dairy production system. However, little research efforts have been made in Ethiopia in general and in Guraghe Zone in particular on productive and reproductive performances of local cows as most of the efforts are directed towards cross breed dairy animals. In addition, the dairy sector does not have specific institution or custodian which collects and analyses dairy related data that can be used to inform investors, policy makers and other industry stakeholders (SNV, 2008). Hence, in order to design relevant dairy development strategies and implement context specific interventions, understanding of the breeding objectives, trait preferences and productive and reproductive performances of local cows under existing management is indispensable. This study was therefore, carried-out to assess breeding practice, trait preferences and production and reproduction performances of Guraghe highland cattle in tropical highland environment of Guraghe Zone, Ethiopia.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Guraghe Zone, Southern Nation Nationalities and peoples of Ethiopia Regional State, located 155 km south west of Addis Ababa between 7.8^0 to 8.5^0 North latitude and 37.5^0C - 38.7^0 East longitude (CSA, 2017). The mean annual temperature of the zone ranges between 13-30^0c and the mean annual rain fall ranges 600-1600mm. The rainfall pattern in the Guraghe Zone is bimodal in which 80% of rain falls in the rainy period of June to August whereas 20% in the short rainy period of February to May.

Sampling technique and sample size

In the present study, multi-stage sampling method was used. In the first step, districts were stratified in to three groups based on agro-ecology (lowland, midland and highland). Accordingly, three Districts (Geta, from highland, Enmore from midland and Mareko from lowland were selected. In the second step, from each agro-ecology, two *kebeles* were selected by using randomizing sampling method; totally six *kebeles* were selected. In the same manner, 30 households were selected from each selected *kebeles* making a total of 180 households.

The questionnaire was pre-tested and modified as necessary. Finally, the formal survey was conducted by trained enumerators under close supervision and participation of the researchers. During the formal survey, all the required data were collected for the period 2015/16 using 180 respondents. A focus group discussion with eight to 10 farmers, who had previously participated in the household survey, was carried out in each of the six villages.

Animal management and Monitoring

The cows are managed in free grazing throughout the day and closed houses with ordinary floor structure is allowed during night. The feed on which the animals are fed include natural pasture, hay, *Enseteventricosum,* crop residue and rarely none-conventional feeds. Cows were hand milked with twice per day milking frequency, early in the morning (3:00-4:00 pm) and late in the afternoon (3:00 - 4:00 pm). There was no regular vaccination and spray for external parasite, but farmers took their animals for treatment whenever diseases occurred.

A follow-up study was conducted to evaluate milk yield of cows based on lactation stages, parity and lactation month. In this section, a diagnostic survey was undertaken to identify households that have lactating cows in all agro-ecologies. Lactating cows were stratified into early (1–2 months), mid (3–4 months), and late (5–6 months) lactation stages depending on their lactation length in order to see the production potential at different stages. In order to see the effects of parity lactations were classified into three parities as 1, 2, and 3^+. Party three and above were all pooled together as parity three due to very few number of observations in later lactations as well as due to the higher correlation between 3^{rd} and later lactations. In addition, lactation month during monitoring period (Jun, July and August) was considered. Finally, daily cow milk yield (morning and evening) was measured using a calibrated plastic jog for a period of three month.

Data Analysis

The data were analyzed with SPSS version 20 software (SPSS, 2015). This involved simple descriptive statistics. GLM (General Linear Model) procedure was used to test the effects of lactation phase, parity, agro-

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ecology and lactation month on morning milk yield (MMY) and evening milk yield (EMY). Similarly, daily milk yield, lactation milk yield, lactation length, age at fist service, age at first calving, calving interval and days open were compared under different agro-ecologies. The presence of any significant differences was checked by using Tukey Kramer multiple comparison tests at $\alpha < 0.05$. The model equation for MMY and EMY were:

$$Y_{ijklm} = \mu + A_i + P_j + L_k + S_l + e_{ijklm}$$

Where

Y_{ij} = the i^{th} observation of morning and evening milk yield

μ= the over all mean

A_i= the effect of agro-ecology

p_j= the effect of parity

L_k = the effect of lactation phase

S_m= the effect of lactation month

e_{ijkm} = random error, which is assumed to be normally and independently distributed with a mean of zero and constant variance

RESULTS AND DISCUSSION

Breeding objectives

Breeding objective is the reason (s) for which animals are specifically bred for, assuming that farmers have made a deliberate choice to genetically improve the next generation of animals in terms of their performance in relation to their parent generation. In Guraghe Zone, local farmers had a clear hierarchy for their production objectives, with high importance of livestock functions linked to crop production, such as milk production, draft power and a savings. Strong desire for milk production might be related with culture of Guraghe people which is known in consumption of traditional foods made from milk and milk products. Additionally, the importance of draught power, saving and manure functions, underline the strong integration of crop and cattle production in the study area. Similar to the current study, Tekleyohannes et al. (2012) noted that in the crop-cattle livestock production environment farmers will prefer hardy and docile animal. In general, our finding is comparable with the findings of similar studies conducted in Kenya and southern Mali (Mwacharo and Drucker, 2005; Traoré et al., 2016).

Trait preferences

A trait is any observable or measurable characteristic of an animal, and we usually characterize them either in terms of appearance or performance or some combination of both. Thus, for effective and sustainable breeding programs, breeding research should ensure that improved genotypes maintain the traits that are preferred by owners. In this study, milk production, fertility and growth rate rank between one to three in terms of importance (Tables 1,2). There was variation in the third rank preferential traits across agro-ecologies. Unlike the highland and lowland farmers, midland farmers give attention for draft power instead of growth rate. The preference for draft power traits might be unconnected to availability of irrigable farm land in the area. These results are in line with Wurzinger et al. (2006) who found that milk yield, fertility and body size were ranked highest by Ankole cattle breeders in different production systems in Burundi, Rwanda, Tanzania and Uganda. These traits were also scored higher by goat, sheep and cattle keepers as selection criterion in recent findings of Ejlertsen et al. (2013) in The Gambia. The significance of production and fertility traits emphasized by farmers might be related to the revenue from product sales related to a genetic change in the target trait. Contrary to our results, Tabbaa and Al-Atiyat, 2009 found that livestock farmers in general place more weight on morphological selection criteria (subjective selection) than production selection criteria. The discrepancy could be the selection criteria differ with breed, herd size, production system and marketing opportunities available in their area (Tabbaa and Al-Atiyat, 2009; Kebede et al., 2012).

Breeding practice

The breeding practices that reported in the study areas were mostly natural mating but AI also rarely practiced. Majority of the respondents 93.3%, 80%, 75% from lowland, midland and highland respectively; reported that natural mating is common breeding system of dairy animals, however, practice of AI service was very rare in all studied areas (Table 2). According to focus group discussion, the low adoption of AI was due to lack of efficiency of artificial insemination, the cost of artificial insemination is not affordable by small holder farmers and the absence of technological intervention to introduce foreign (improved) breed in the area affects the dissemination of AI

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technology in Guraghe Zone. In line with the current study, Desalegn (2008) reported similar constraints for the low adoption of AI in Ethiopia.

Table 1 - Breeding objectives of Guraghe highland cattle keepers in Guraghe Zone

Breeding objectives	Agro-ecology						Overall (n=180)	
	Highland		Midland		Lowland			
	N(Index)	Rank	N(Index)	Rank	N(Index)	Rank	N(Index)	Rank
Ceremonial & dowry	62(0.05)	6	103(0.08)	6	54(0.05)	6	219(0.06)	6
Draught power	250(0.2)	2	220(0.18)	2	206(0.17)	2	634(0.19)	2
Manure	133(0.11)	4	156(0.13)	5	158(0.13)	5	447(0.13)	5
Milk for home consumption	329(0.26)	1	378(0.31)	1	312(0.26)	1	1019(0.29)	1
Milk & product for sale	132(0.10)	5	195(0.16)	3	176(0.15)	3	503(0.14)	4
Prestige	14(0.01)	7	22(0.02)	7	19(0.02)	7	55(0.02)	7
Saving	221(0.18)	3	188(0.15)	4	164(0.14)	4	615(0.16)	3

N=number of observation (households); Index=the sum of (7 times first order + 6 times second order +5 times third order + 4 times fourth order + 3 times fifth order + 2 times sixth order + 1 times seventh order) for individual variables divided by the sum of (7 times first order + 6 times second order +5 times third order + 4 times fourth order + 3 times fifth order + 2 times sixth order + 1 times seventh order) for all variables.

Table 2 - Trait preference and breeding practice in Guraghe zone

Farmers trait Preferences	Agro ecology						Over all (n=180)	
	Highland (n=60)		Midland (n=60)		Lowland (n=60)			
	N(Index)	Rank	N(Index)	Rank	N(Index)	Rank	N(Index)	Rank
Longevity	138(0.12)	5	186(0.16)	3	128(0.11)	5	444(0.13)	5
Fast growing calves	220(0.18)	3	167(0.14)	5	222(0.19)	3	609(0.18)	3
Traction ability	219(0.18)	4	172(0.14)	4	217(0.18)	4	608(0.17)	4
Milk yield	271(0.23)	1	249(0.21)	1	252(0.21)	1	772(0.22)	1
Fertility	226(0.19)	2	210(0.17)	2	231(o.19)	2	667(0.19)	2
Temperament	126(0.11)	6	126(0.11)	6	120(0.10)	6	380(0.11)	6
Breeding practice	N=60	%	N=60	%	N=60	%	N=60	%
AI	15	25	12	20	4	6.67	31	17.22
Natural mating	45	75	48	80	56	93.3	149	82.78

AI= artificial insemination, N=number of observation (households), %= percentage; Index=the sum of (6 times first order + 5 times second order +4 times third order + 3 times fourth order + 2 times fifth order + 1 times sixth order) for individual variables divided by the sum of (6 times first order + 5 times second order +4 times third order + 3 times fourth order + 2 times fifth order + 1 times sixth order) for all variables.

Milk Production Performance

Morning and evening daily milk yield. The overall least squares mean of morning and evening milk yield of Guraghe highland in the follow up study were 0.99±0.02 and 0.73±0.02, respectively. The mean value found in this study is lower than morning and evening milk yield reported for cross bred dairy cows in Jimma (Belay et al., 2012). Lactation phase, lactation month and parity had significant effect on MMY and EMY, while agro-ecology had no significant (P>0.05) effects on (Table 3). In all aspects the milk yield was observed significantly higher in the morning than in the evening for the three phases of lactations. The highest value of morning and evening daily milk yield was observed in the first phases of lactation than second and third phases of lactation, respectively. The lowest milk yield in the first lactation phase is due to the fact that cows that were anestrous during the first 63 days postpartum consumed less feed, produced less milk, and lost more body reserves than cows that resumed estrous activity prior to 63 days in milk (Staples et al., 1990). The subsequent rate of increase in the second stage of lactation is due to increase feed intake and cows experience a period of significant negative energy balance in early lactation and need to mobilize their tissue reserves to supply substrates and energy for milk production and nonmammary tissues needs (Bell and Bauman, 1997).

Similar to the present study significant effect of parity was reported for Holstein Friesian cows in Ethiopia (Destaw et al., 2016). The results of the current finding revealed that lactation milk yield look like linearly increasing from 1st to 3rd parity. This increasing trend might be due to the increase in body weight combined with advancing age at full development of secretary tissues of the udder.

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Morning and evening milk yield of monitored Guraghe highland cows were significantly influenced by the respective lactation months. The average morning and evening milk yields were gradually increased from Jun to August. The significant effect of lactation months could be related with availability of feed resource, since in June it is well known that cows reduce production with either acute or chronic exposure to feed shortage, whilst in wet season (July and August) the availability of green forages is better. Similar to current study significant effect of lactation month reported on morning and evening milk yield of Holstein Friesian cows in Ethiopia (Destaw et al., 2016).

Daily milk yield. The overall mean daily milk yield per cow from survey data was 1.7 liters (Table 4). The overall daily milk yield per cow in the present study was comparable with 1.8 liters/cow/day for Horro cattle in eastern Wollega reported by (Alganesh, 2002). A similar result was reported for local cows for pre urban production system central zone of Tigray, Ethiopia (1.87±0.79 liters/day) (Gebrekidan et al., 2012). Moreover, the value of daily milk yield per cow obtained in the current study is comparable with earlier report for national level (1.377 liters) (CSA, 2010). This low productivity Guraghe highland caws under smallholder management conditions could be due to lack of proper supplementary feeding for the dairy cattle, poor nutritive value of pastures and forages offered to the animals.

Table 3 - Lest square means and standard errors of Morning and evening milk yield of Guraghe highland cows under farmers management in Guraghe Zone

Factors	Milking time			
	MMY		EMY	
	N	LMS±SE	N	LSM±SE
Over all mean	90	0.99±0.02	90	0.73±0.02
CV (%)		14.9		19.6
Lactation phase		*		**
phase 1	44	0.95±0.04^{a}	44	0.71±0.03^{a}
phase 2	30	1.02±0.03^{b}	30	0.75±0.03^{b}
phase 3	16	0.81±0.05^{c}	16	0.74±0.04^{c}
Parity		**		**
1	18	0.92±0.04^{b}	18	0.41±0.05^{b}
2	24	0.99±0.04^{a}	24	0.72±0.03^{a}
3	48	1.00±0.02^{a}	48	0.81±0.02^{a}
Agro ecology		NS		NS
Highland	30	1.00±0.03	30	0.73±0.02
Midland	30	0.96±0.03	30	0.71±0.04
Lowland	30	1.02±0.03	30	0.70±0.03
Lactation Month		**		*
Jun	23	0.94±0.03^{b}	23	0.61±0.03^{b}
July	41	0.96±0.03^{ba}	41	0.78±0.03^{a}
August	26	1.04±0.03^{a}	26	0.79±0.03^{a}

**P< 0.01; *P<0.05; NS= Not Significant. Means with the same letter are not significantly different MMY= Morning milk yield, EMY= Evening milk yield

Table 4 - Production and reproductive performances of Guraghe highland cows in Guraghe Zone

Traits	Agro-ecology			Overall	*p* value
	Highland	Midland	Lowland		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
DMY	1.70±0.11^{a}	1.75±0.31^{a}	1.65±21^{a}	1.70±0.05	0.06
LMY	402.43±22.89^{a}	412.63±23.32^{a}	393.42±28.21^{a}	402.14±12.11	0.21
LL	7.90±0.12^{a}	7.86±0.17^{a}	7.80±0.13^{a}	7.90±0.08	0.13
AFS	33.20±1.21^{a}	31.40±1.59^{a}	37.38±1.46^{b}	33.51±0.70	0.01
AFC	42.53±1.21^{a}	40.73±1.59^{a}	46.71±1.46^{b}	42.85±0.70	0.01
CI	21.69±0.48^{a}	19.61±0.54^{b}	22.44±0.78^{a}	22.03±0.37	0.02
DO	12.36±0.48^{a}	10.28±0.54^{b}	13.11±0.78^{a}	12.70±0.37	0.04

LMY=lactation milk yield, LL=lactation length, AFS= age at first service, AFC= age at first calving, CI= calving interval, Do= days open, SE= Standard error

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Lactation milk yield. In this study the average lactation milk yield of Guraghe highland breed was 402.49±12.11kg. The value obtained in the current study is comparable with the average value reported by Ababu et al. (2004) for locals (399.5 liters/cow/lactation) in Degem district, Ethiopia. However, the result obtained in this study is lower than the mean of 947±42.3 litres in Boran and 1201±37.9 litres in Horro breeds in Ethiopia (Gebregziabher et al., 2013) and 550 litres in Horro breed and 645 litres in Begait breed (Rege et al., 2006). Such variability might be due to difference in genetic material (breed), availability of the feed resource and other husbandry practices. This result indicated that agro ecology could not be the factor of lactation milk yield of Guraghe highland cows (Table 3). In contrary to the current finding the significant effect of agro ecology was reported on lactation milk yield of Holstein cattle (Destaw et al., 2016).

Lactation length. The average lactation length of Guraghe highland cows was 7.90±0.08 months. This agrees with the report of Gebregziabher (2013) who indicated that an average lactation length of Horro cows 7.8 months. However, the current result is lower than the 9.5 months reported by Lemma et al. (2005) for local cows in the East Showa Zone and 9.13±2.63 months North Shoa Zone, Ethiopia (Mulugeta and Belayeneh, 2013). Moreover, the LL of the indigenous cows observed in this study was almost similar with the national average (7 months) (CSA, 2005). However, the estimate of average lactation length in Guraghe highland cows were shorter than the standard lactation period of 305 days.

Reproductive Performance

Age at first service. The overall estimated mean age of heifers at first service was 33.51±0.70 months. Our finding was slightly higher than what has been reported for Boran breeds in Southern Ethiopia (Adugna and Aster, 2007), but closer to those reported for Horro cattle in West Wallaga (Alganesh et al., 2004). The longer age at first service and calving in Ziway area might reflect later maturity. Nutrition and overall management of the cow can impact the circulating concentrations of hormones and metabolites, and these alterations can have positive and negative impacts on reproductive performance. Therefore, improved management levels such as good nutrition, housing and health care enhance growth rate of heifers to come on first heat at early age.

Age at first calving. The mean age at first calving was found to be 42.85±0.70 months. Our finding is comparable with 39.8±5.6 months of AFC for local caws (Tadele and Nibret, 2014). Lower mean AFC is recorded as 33.8 months reported in Arsi breed in Ethiopia (Gabriel et al., 1983). However, the mean age at first calving revealed in this study is shorter than the mean of 60 months in Begait breed, 53.4 months in Fogera breed and 53 months in Horro breed reported by Rege et al. (2006). Similarly, 1729.9±58.2 days reported in Boran cows at Tatesa cattle breeding center in Guraghe Zone, central Ethiopia Yifat et al. (2012) and 47.16±8.7 months in local cows in Chacha Town, North Shoa Zone, Ethiopia (Mulugeta and Belayeneh, 2013).

Calving interval. The average calving interval of Guraghe highland cow was 22.03±0.37 months. The mean calving interval observed in the present study was comparable with the reported values of 21.36±3.84 months (Belay et al., 2012), 666 days in Ginch watershed in Ethiopia (Getachew, 2002); 622.6±15.3 days in Boran cows at Tatesa cattle breeding center in Guraghe Zone, central Ethiopia (Yifat et al., 2012). On the other hand, it is significantly higher than the reported values of 527 days in Horro breed, 525 days in Fogera breed and 458 days in Begait breed (Rege et al., 2006) and 431.08±78.03 days for indigenous cows in and around Mekelle (Kumar et al., 2014). Our result indicates that CI is longer than the ideal value of 365 days (Khan et al., 1992). This might be due to poor oestrous detection, silent heats, poor feed quality and health care and poor management.

Days open. In this study the average days open till conception was 12.70±0.37 months. This finding was comparable with reports of Yifat et al. (2012) being 340.3±15.8. The present result indicates prolonged days open beyond ideal, of 90 days interval. Feed shortage, silent estrus, lack of proper heat detection and nutritional deficiencies coupled with heavy internal and external parasite load on the cows might have other contributory factors for long DO reported in this study. Similarly, Tadesse and Zelalem (2004) reported that increasing the level of protein supplementation from low (2 kg/day) to high (4 kg /day) reduced post partum interval from 159 to 100 days in Borana x Jersey crossbred cows.

CONCLUSION

Cattle production was found to be an important enterprise and significantly contribute to poverty alleviation, food security, improved family nutrition and income and youth employment. The assessment showed that the breeding practices of the study areas were mostly natural mating although also rarely practiced. Cattle production in Guraghe Zone is multipurpose of which Milk production, draft power and saving were the main breading objectives of small holder farmers. Similarly, farmers were give strong emphasize on milk production, fertility and growth performance traits. Productive and reproductive potential of Guraghe highland cow found to be less than the optimum values desirable for profitable milk production. Since the multipurpose use and as such no specialized

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and systematic breeding is used it may be wrong to say indigenous breeds as low potential simply putting them in a harsh condition as concept of genetic potential should be related to the condition in which the animals are expected to perform. Therefore, this calls for a planned technical and institutional intervention for improved support services for appropriate breeding programmes based on farmers trait preference and breeding objectives. Moreover, in line with this, a sustainable extension service to improve animal feed resources management and animal health care also deserve due attention.

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Authors' Contribution

WA and TF designed the research, analyzed the data, interpret the results, drafted the manuscript and writ up the manuscript. At last the authors revised the manuscript, read and approved the final version.

Conflict of interests

The authors have not declared any conflict of interests.

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ON-FARM PHENOTYPIC CHARACTERIZATION OF HOLLA SHEEP TYPES IN SOUTH WOLLO ZONE EASTERN AMHARA ETHIOPIA

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ABSTRACT: The study was conducted from purposively selected districts of Kalu and Worebabu districts in South Wollo administrative zone to describe the physical characteristics. Confirmatory and purposive sampling techniques were employed to select the target farmers. Following that semi-structured questionnaire, focused group discussions, secondary data source analysis and field observations were used to generate the required information. In addition, simple random sampling technique was used to select 450 sheep. The study was performed based on field measurements and body measurements were taken from 450 sheep of both sexes. Majority of the Holla sheep have brown, coat color (59.2%) female and (49.5%) male and white coat color type (27.4%) for females and (31.8%) for males were observed and they are short, smooth coat cover and polled type. Whereas, about 4.4% of ewes had wattle while the rams had no wattle which was strongly influenced ($P < 0.01$) by pelvic width, tail width and ear length. Similarly body weight and chest depth were also influenced ($P<0.05$) by district. Age group had significant effect ($P<0.05$) on body weight and other body measurements. Average ±SE body weight age at 0PPI, 1PPI, 2PPI, 3PPI and 4PPI was recorded as 18.21±0.23 kg, 20.34±0.26 kg, 22.14±0.25 kg, 23.41±0.56 kg and 26.33±0.65kg, respectively. Sex was strong and significant ($P<0.01$) effect on wither height, tail length and tail width. The interaction of sex and age is significantly ($P<0.05$) influenced the liner body measurements except ear length of sheep. The highest relationship ($r=0.74$) between heart girth and body weight were recorded in Worebabu and Kalu district of female age groups at 2PPI. So, chest girth is the first variable to enter in to stepwise regression model in both male and female sheep type. Present phenotypic information could be complemented with genetic analysis, and serve as a basis or designing appropriate conservation, breeding and selection strategies 'for Holla sheep.

Keywords: Body measurement, Characterization, Holla Sheep, On farm, Phenotypic Ethiopia

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INTRODUCTION

Ethiopia is endowed with huge livestock resources of varied and diversified genetic pools with specific adaptations to a wide range of agro-ecologies. Farm animals as a whole are an integral part of the country's agricultural system and are raised both in the highland and lowland areas. In developing countries, livestock production is mostly subsistence oriented and fulfills multiple functions that contribute more for food security (Roessler et al., 2008; Duguma et al., 2010). The demand for livestock products is increasing due to the growing urban population, while farm areas are shrinking considerably as a result of an increase in the rural population (Siegmund Schultze et al., 2009). Ethiopia's estimated livestock population is often said to be the largest in Africa. There were approximately 50.8 million cattle, 25.5 million sheep, 22.78 million goats, 2.0 million horses, 0.38 million mules, 6.2 million donkeys, 1.1 million camels and 49.3 million poultry excluding the Afar and Somali Regions (CSA, 2010). The Amhara National Regional State has 9 million heads of sheep which is about 35% of the national sheep population (CSA, 2010).

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So far, some attempts have been made to identify and characterize indigenous sheep breeds (Sisay, 2002; Kassahun and Solomon, 2008). Similarly, local names and general areas of distribution for few of the sheep types of Ethiopia have been mentioned by various authors in their effort to categorize and describe African sheep types (Epstein, 1971; Wilson, 1991). Sisay (2002) made the first comprehensive phenotypic characterization of sheep in the Amhara National Regional State. On farm characterization can serve as basis for the sustainable improvement and conservation of indigenous animal genetic resources, and has received increasing attention in determining the variation between and within pure breeds (Rege, 2003). Thus, more comprehensive information specific to on-farm phenotypic characterization of Holla sheep breeding should be made available. Hence, this study was attempted to phenotypic characterize Holla sheep types both Kalu and Worebabo districts in South Wollo zone, North Eastern Ethiopia.

MATERIALS AND METHODS

Study Areas

The study was conducted in two districts (Worebabo and Kalu) of South Wollo zone of the Amhara National Regional state. Worebabo is situated an altitude ranging from 1480-2900 m.a.s.l at 39^0.40 -41'E longitude and 11^{0}6'20'N latitude in the semi-arid tropical belt of north- eastern Ethiopia (Figure 1). Its average annual temperatures were 21°C, where as the mean annual rainfall of the district were 1040mm. Kalu is located an altitude range of 1400 to 1850 m.a.s.l at 37° 41' 48''E longitude and 11^0.58'44'' N latitude in north west highlands of Ethiopia. The mean annual maximum and minimum temperatures recorded in Kalu were 28°C and 12°C, respectively while the mean annual rainfall of the study areas varied from 500 to 1200 mm.

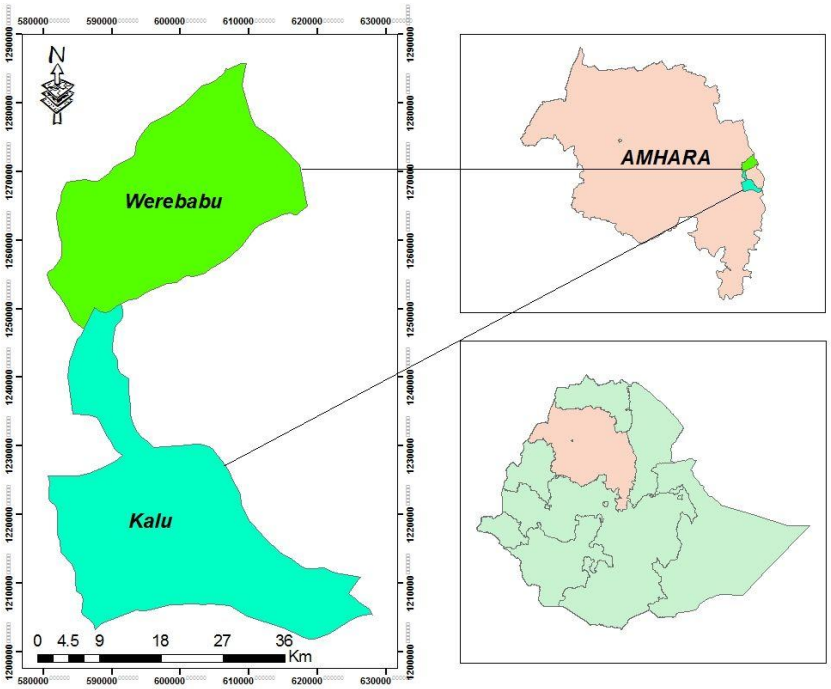

Figure 1 - Map of the Study area in South Wollo Zone

Sampling procedures

For body measurements and qualitative trait descriptions, a total of 450 sheep of both sexes which, were kept under natural pastures grazing conditions, were randomly taken from the surveyed households in four peasant associations. The Peasant Associations selected for this work were 01, 013 in Worebabo district, 04 and 08 in Kalu district. Since there was variation in sheep population among these peasant associations, different sample sizes of sheep of both sexes were taken. So, a total of 115 from 01, 110 from 013, 125 from 04 and 100 from 08 in Kalu district were randomly sampled.

Data collection procedures

The standard breed descriptor lists for sheep developed by FAO (2011) were closely followed to list both qualitative and quantitative morphological characteristics. Quantitative traits including; heart girth (HG), height at wither (WH), body length (BL), hair length (HL), ear length (EL), tail length (TL), rump height (RH)] and scrotal circumference (SC) were measured using measuring tape, while live body weight (LBW) was measured using portable weighing scale. All the measurements were made in the morning before the animals left for grazing and

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after restraining and holding the animals in an unforced position. The age of the animals were estimated by dentition and information taken from sheep owners. To assess effect of age on the parameters measured, the animals were grouped into five age groups: no pair of permanent incisor (0PPI), (1PPI), (2PPI), (3PPI), and (4PPI). The qualitative traits observed were coat color pattern, coat color type, head profile, rump profile, wattle, ruff, horn, horn orientation, horn shape, ear orientation, coat hair type, body skin color, hair length, tail type and shape.

Statistical data analysis

Both qualitative and quantitative data were analyzed using SPSS (Version 20). For adult animals, sex and age group of the sheep were fitted as independent variables while body weight and linear body measurements except scrotum circumference were fitted as dependent variables. A general linear model procedure (PROC GLM) of the SPSS was used for quantitative variables to detect statistical differences among sample sheep populations. Least square means with their corresponding standard errors were calculated for each body trait over location, sex, age and age by sex interaction.

RESULTS AND DISCUSSION

Phenotypic Characterization of *Holla* Sheep

The proportion of each level of the 15 qualitative traits recorded for each district is given in (Table 1). Out of 343 ewes and 107 rams of Holla sheep 59.2 % were plain, 27.1% patchy and 3.1% had spotted coat pattern. Plain brown (29.4%), brown and white (27.4%) coat color patterns were the dominant colors. Brown and red with red dominant (7.3%), black with white (7.0%), and Reddish brown and black (6.7%) coat were also observed in plain pattern and mixed in patchy or spotted patterns. Major colors like brown, brown and white and white and black were also frequently observed in samples population of Gumuz ewes (Solomon, 2007).The present study was similar from pervious reported for Bonga and Horro ewes coat color pattern (Zewdu, 2008) and indigenous sheep Tocha rams (Amelmal, 2011). Similarly the mixtures of red and white *('sendama')*, dark grey locally known as 'jibma'.This study results are in agreement with those of Mulata et al. (2014) reported that the sheep population found in Atsbiwonberta is characterized as dominant coat color of red brown. Coat color and presence of horn are among the qualitative body traits used as a criterion to select individual sheep for breeding purpose (Bosenu et al., 2014). Another author reported similar findings that coat color is among the qualitative body characteristics, the local community selects breeding rams and ewes based on the coat color (Dhaba et al., 2012).

The predominant hair types were short and coarse (71.4 %) and rest of short and smooth (28.6%). Coat pattern is more or less similar between the two sexes in *Holla* sheep type. The coat patterns of male sheep were 49.5% plain, 33.6% patchy and 16.9% were spotted. Plain brown (24.2%), brown and white (31.8%) coat color patterns were the dominant colors. Brown and red with red dominant (7.5%), black with white (8.4%), and Reddish brown and black (8.4%)) were the major colors frequently observed in the male sample population (Table 1). Other kinds of plain, patchy, and spotted coat patterns with different colors were also observed. The head profile was Straight (50.5%) or very slightly concave head profile (42.1%). Convex head profile was rarely observed (7.5%). They had short and rudimentary ears and all the sampled sheep are hornless. No wattle (Table 1).

Body weight and other linear body measurements

The least squares means and standard errors for the effect of sex, age group, location and their interaction on body weight and other body measurements are presented in Tables 2.

The overall least square means of body weight, body length, height at wither, heart girth, rump height, tail length, tail width, pelvic width, scrotal circumference, ear length and width of *Holla* sheep were 22.09 (kg), 52.4 , 58.4, 69.95, 61.31, 23.37, 15.54, 13.78, 23.52, 4.12, and 2.25 (cm), respectively.

Location (district) effect. Location was found to strongly influence ($P < 0.01$) on pelvic width, tail width and ear length. Similarly, body weight and chest depth were influenced ($p<0.05$) by location. However, body length, heart girth, height at wither, rump height, tail width and scrotal circumference were not significantly influenced ($p>0.05$) by location. Kalu sheep (22.45±0.20kg) were significantly ($p<0.05$) heavier than Worebabu sheep (21.72±0.23kg). The present study dis agreement with the pervious reported for Afar sheep (Tesfaye, 2008) and Nedjo sheep of west Wollega (Kedjela, 2010).

Age effect. Age group exerted strong significant effect ($p<0.01$) on body weight, body length, height at wither, heart girth, rump height, tail length, scrotal circumference, chest depth. Similarly, tail width and ear length were significantly ($p<0.05$) affected by age group. Body weight, body length, height at wither, heart girth rump height and scrotal circumference were in the current study body weight had significant difference in all age (dentition) groups and the same was true for all linear body measurements (Table 2). Where body weight and these linear body measurements increases when the animal gets older (increase in age).The above variables (BW, BL. HW, HG, RH, SC) are reached their maximum value in the oldest age (4PPI) of the sheep and dentition group 3 and 4 had higher

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values than those between 1 and 2 dentition groups. There was wide variability as the age of the animals increased for body measurements such as BW, BL, HG, and WH. This implies that these variables might be best explaining the growth pattern of the animals. The finding of this result of body weight and other body liner measurements is in agreement with the report of (Amelmal, 2011) who reported that matured body weight of the animal almost fully attains at older age. As age increased the size of un-castrated scrotal circumference also increased. The matured (age group 4) sheep had higher ($p<0.05$) scrotal circumference than the other age groups. The scrotal circumference of matured Kalu and Worebabu sheep (26.25± 1.86 cm) is greater than matured Menz (24.5±0.58cm) sheep and less than matured Afar (27.5±0.67cm) sheep (Tesfaye, 2008). Similar result was observed in Afar sheep (Tesfaye, 2008). Zewdu (2008) also reported that animals at older age group had larger scrotal circumference than animals at younger age groups. SC is a sex dependent character and it was affected by the age of the male sheep. Body weight of males in age group 0PPI (25.7 ± 0.3kg), age group 1PPI (31.9 ± 0.8kg) and age group 2PPI (38.2 ± 2.0kg) in the current study was higher than body weight of Menz males 18.0 ± 0.28kg, (22.9 ± 0.39kg) and 24.9 ± 0.67 in the same age group.

Sex effect. The least squares means and standard errors for the effect of sex, age group and their interaction on body weight and other body measurements are presented in Tables (2). Sex of the sheep had strong significant ($p<0.01$) effect on wither height, tail length and tail width. Similarly, rump height were significantly ($p<0.05$) affected by sex of the sheep. Scrotal circumference, ear length, chest depth, body weight, body length hart girth and pelvic width of Holla sheep were not affected ($p>0.05$) by sex. Holla sheep and its body weight (kg) 22.20±0.20 of males were higher 21.97±0.12 ($p<0.05$) than females in the study area. Differences in live weight and most of the body measurements between sexes observed in *Holla* sheep showed that these parameters are sex dependent. The effect of sex on body weight and other measurements obtained in this study is in agreement with previous results (Kassahun, 2000; Markos *et al.,* 2004: Tesfaye, 2008). The current report is in line to the previous findings of Mengistie *et al*. (2010) reported that a significant effect of sex on body weight, heart girth, body length and height at wither in Washera sheep. However; previous findings of Mulata et al. (2014) reported that sex has no significantly ($p>0.05$) effect on body weight, heart girth, body length and height at wither in highland sheep found in Atsbiwonberta.

Sex by age group. The interaction between sex and age group had a significant ($p<0.05$) effect on BW, BL, HW, HG, TL, TW, and SC. The interaction between sex and age group had no a significantly ($p>0.05$) effect on ear length of the sheep. Both females and males in age group (0PPI) had the same ($p>0.05$) body weight value but males in age group (0PPI) and up to 4PPI were heavier ($p<0.05$) than females in the same age group. Body weights of male and female sheep in the oldest age group (4PPI) were 27.45±1.28 kg and 25.21±0.28 kg, respectively Both females and males in age group (0PPI), age group (1PPI), age group (2PPI) and age group (3PPI) had almost the same ($p>0.05$) body weight value but males in age group 4(4PPI) were heavier ($p<0.05$) than females in age group 4(4pp) (Table 2). Differences in live weight and most of the body measurements between sexes observed in both Kalu and Worebabu showed that these parameters are sex dependent. Ewes have slower rate of growth and reach maturity at smaller size due to the effect of estrogen in restricting the growth of the long bones of the body (Sowande and Sobola, 2007).

Body weight and other linear body measurements

The correlation coefficient indicating the relationship between live weight and other body measurements in Holla sheep are shown in Table 3. Body weight most independent parameters depicted positive and highly significant ($P<0.01$) correlation. The highest relationship between chest girth and body weight were observed in female of dentition one ($r= 0.74$) and in male of the dentition two ($r=0.71$) the linear body measurements, chest girth with the highest correlation with body weight at various ages and in both sexes. The high, positive and significant correlation between body weight and chest girth suggest that this variables could provide a 'good estimate for predicting live weight of these breeds type (Table 3). This highest correlation of heart girth with body weight than other body measurements was in agreement with other results (Afolayan, et al., 2006; Fasae et al*.,* 2006; Solomon, 2008; Tesfaye, 2008) and would imply that hart girth was the best variable for predicting live weight than other measurements. Scrotum circumference (SC) had positive and strong correlation with body weight at most age groups with correlation coefficient of 0.34 to 0.96 for both rams. The strong correlation of SC with body weight is in agreement with previous reports of Horro sheep breed (Kedjela, 2010). Males with large SC tend to sire daughters that reach puberty at an earlier age and ovulate more ova during each estrus period (Söderquist and Hultén, 2006). Decrease in SC resulted in increase in morphologically abnormal sperm (Söderquist and Hultén, 2006) and SC strongly correlated with age at first puberty of females, semen traits and libido (Toe et al*.,* 2000). Higher heritability of SC was observed by (Toe et al*.,* 2000). Measurement of SC is thus an essential part of the breeding soundness evaluation (Yoseph, 2007) and selection could be based on testicular circumference (Toe et al., 2000).

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Table 1 - Descriptions of qualitative traits of Holla Sheep

Parameters		Kalu				Worebabu				Over all	
		Male	Female	X^2-value	P-value	Male	Female	X^2-value	P-value	Male	Female
		N (%)	N (%)			N (%)	N (%)			N (%)	N (%)
Coat Color Pattern	Plain	23(52.30)	105(58.0)	62.58	0.000	30(47.6)	98(60.5)	63.44	0.000	53(49.5)	203(59.2)
	Patchy	13(29.50)	23(28.2)			23(36.5)	42(25.9)			36(33.6)	93(27.1)
	Spotted	8(18.20)	25(13.8)			10(15.9)	22(13.6)			18(16.8)	47(13.7)
Coat Color Type	White	8 (18.20)	40(22.1)	76.25	0.000	13(20.6)	36(22.2)	75.45	0.000	21(19.7)	76(22.2)
	Brown	11(25.00)	53(29.3)			15(23.8)	48(29.6)			26(24.2)	101(29.4)
	Brown and white	14 (31.80)	50(27.6)			20(31.7)	44(27.2)			34(31.8)	94(27.4)
	Brown and red with red dominant	3 (6.8)	13(7.2)			5(7.9)	12(7.4)			8(7.5)	25(7.3)
	Black and white	6(13.6)	11(6.1)			3(4.8)	13(8.0)			9(8.4)	24(7.0)
	Reddish brown and black	2(4.5)	7(11.10)			7(11.10)	9(5.6)			9(8.4)	23(6.7)
Head Profile	Straight	23(52.3)	106(58.6)	85.62	0.000	31(49.2)	97(59.9)	84.34	0.000	54(50.5)	203(59.2)
	Concave	17(38.6)	63(34.8)			28(44.4	53(32.7)			45(42.1)	116(33.8)
	Convex	4(9.1)	12(6.6)			4(6.3)	12(7.4			8(7.5)	24(7.0)
Dewlap	Present	4(9.1)	13(7.2)	2.09	0.000	2(3.2)	8(4.9)	2.17	0.000	6(5.6)	21(6.1)
	Absent	40(90.9)	168(92.8)			61(96.8)	154(95.1)			101(94.4)	322(93.9)
Wattle	Present	-	12(6.6)	1.29	0.000	-	8(4.9)	1.94	0.000	0(0.0)	20(5.8)
	Absent	44(100.0)	169(93.4)			63(100)	154(95.1)			107(100)	323(94.2)
Ear formation	Rudimentary	13(29.5)	46(25.4	50.88	0.000	18(28.6)	41(25.3)	50.88	0.000	31(29)	87(25.4)
	Short	31(70.5)	135(74.6)			45(71.4)	121(74.7)			76(71.0)	256(74.6)
Tail type	Short fat tailed	28(63.6)	103(56.9)	6.08	0.014	35(55.6)	96(59.3)	6.08	0.014	63(58.9)	199(58.0)
	Long fat tailed	16(36.4)	78 (43.1)			28(44.4)	66(40.7)			44(41.1)	144(42.0)
Tail form	Curved tip	23(52.3)	84(46.4)	49.52	0.000	30(47.6)	77(47.5)	49.52	0.000	53(49.5)	161(46.9)
	Blunt	17(38.6)	75(41.4)			27(42.9)	65(40.1)			44(41.1)	140(40.8)
	Straight & tip down word	4(9.1)	22(12.2)			6(9.5)	20(12.3)			10(9.3)	42(12.2)
Hair type	Short and coarse	27(61.4)	130(72.2)	36.16	0.000	42(66.7)	115(71.4)	36.16	0.000	69(64.5)	245(71.4)
	Short and smooth	17(38.6)	50(27.8)			21(33.3)	46(28.6)			38(35.5)	98(28.6)

N=number of households; X^2 = *Pearson chi-square;* Ns = Non-significant (P > 0.05);*P < 0.05; **P < 0.01

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Table 2 - Least squares means ± standard errors of body weight(kg) and other body measurements (cm) for the effects of district, age, and sex and sex by age for *Holla* sheep

Effect & level	Body weight (kg)		Body length(cm)		Height at withers (cm)		Heart girth (cm)		Rump height (cm)	
	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE
Over all mean	414	22.09±0.19	420	52.40±0.34	445	58.43±0.33	426	69.95±0.38	429	61.31±0.34
C v	414	7.23	420	7.23	445	6.70	426	6.27	429	6.19
R^2	414	0.53	420	0.53	445	0.43	426	0.46	429	0.44
District	–	**		NS		NS		NS		NS
Kalu	207	22.45±0.22	210	52.15±0.40	231	58.56±0.39	210	70.06±0.45	210	61.55±0.40
Werebabu	207	21.72±0.22	210	52.64±0.38	214	58.31±0.38	216	69.85±0.43	219	61.06±0.38
Age group	–	***		***		***		***		***
0PPI	88	18.21±0.23^{a}	95	46.68±0.39	97	52.98±0.39	98	64.24±0.44^{a}	100	55.86±0.37
1PPI	78	20.34±0.26^{b}	81	50.11±0.45^{a}	81	55.27±0.47^{a}	78	66.02±0.54^{a}	80	59.45±0.46^{a}
2PPI	105	22.14±0.25^{c}	98	51.08±0.44^{a}	102	57.40±0.44^{a}	103	69.28±0.51	106	60.72±042^{a}
3PPI	76	23.41±0.56^{c}	74	56.13±1.11^{b}	75	61.28±0.98^{b}	76	73.14±1.11^{b}	74	64.18±1.10^{b}
4PPI	67	26.33±0.65^{d}	72	57.98±1.18^{b}	72	65.23±1.13^{b}	71	77.09±1.28^{b}	69	66.32±1.10^{b}
Sex		NS		NS		**		NS		*
Male	97	22.20±0.20	96	52.17±0.68	97	59.34±0.63	96	69.60±0.72	98	62.03±0.65
Female	317	21.97±0.12	324	52.62±0.21	330	57.53±0.21	330	70.31±0.24	331	60.58±0.20
Age by sex	–	*		***		***		***		NS
Male 0PPI	40	18.40±0.35a	42	47.24±0.58a	42	53.39±0.59a	42	63.82±0.67a	43	56.62±0.57a
Female 0PPI	48	18.03±0.44ab	53	46.12±0.51a	55	52.56±0.51a	56	64.66±0.58ab	57	55.11±0.49a
Male 1PPI	25	19.77±0.44b	24	48.83±0.76ab	23	54.29±0.8ab	23	62.85±0.90a	23	59.24±0.78b
Female 1PPI	53	20.91±0.30c	57	51.40±0.49b	58	56.25±0.50b	55	69.18±0.58c	57	59.65±0.49b
Male 2PPI	25	21.64±0.45d	24	49.00±0.77b	25	57.63±0.78b	24	67.39±0.91b	26	60.85±0.74b
Female 2PPI	80	22.63±0.24a	73	53.16±0.43b	77	57.17±0.43b	79	71.16±0.49cd	80	60.59±0.41b
Male 3PPI	4	23.75±0.26b	3	55.54±2.17cd	4	61.75±1.91c	4	74.25±2.17de	3	64.50±2.16c
Female 3PPI	72	23.07±0.26bc	71	56.72±0.44c	71	60.82±0.45c	72	72.04±0.4d	71	63.86±0.44c
Male 4PPI	3	27.45±1.28c	3	60.24±2.17d	3	69.63±0.22d	3	79.69±2.51	3	68.95±2.16c
Female 4PPI	64	25.21±0.28d	69	55.72±0.46c	69	60.83±0.47c	68	74.50±0.55	66	63.69±0.47c

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Table 2 - Least squares means ± standard errors of body weight(kg) and other body measurements (cm) for the effects of district, age, and sex and sex by age for *Holla* sheep

Effect & level	Tail length(cm)		Tail width(cm)		Pelvic width (cm)		Scrotal circumference		Ear length (cm)		Chest depth (cm)	
	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE
Over all mean	429	23.37±0.27	435	15.54±0.15	436	13.78±0.15	107	23.52±0.50	450	4.12±0.06	444	32.80
Cv	429	14.98	435	12.25±	436	13.75	107	13.63	450	19.02	444	5.49
R	429	0.28	435	0.24	436	0.25	107	25.75	450	0.14	444	0.28
district		***		NS		***		NS		***		**
Kalu	215	22.53±0.33	218	15.68±0.48	214	14.32±0.18	44	23.10±0.80	225	4.26±0.07	221	32.56±0.17
Werebabu	214	24.22±0.31	217	15.34±0.7	222	13.24±0.17	63	23.94±0.60	225	3.98±0.07	223	33.05±0.17
Age group		***		**		***		***		**		***
0PPI	96	20.92±0.34	101	15.00±0.18	98	12.32±0.19	45	20.66±0.45^{a}	104	3.81±0.07a	104	30.99±0.17
1PPI	82	22.78±0.39^{a}	80	15.83±0.21^{a}	8	13.39±0.22^{a}	26	22.74±0.59^{ab}	85	4.01±0.09^{a}	85	32.35±0.20^{a}
2PPI	106	23.75±0.36^{a}	108	15.11±0.20^{a}	106	14.11±0.20^{a}	28	23.45±0.61^{b}	109	4.24±0.08^{b}	108	32.75±0.20^{ab}
3PPI	71	24.10±0.76^{a}	74	15.05±0.46^{a}	78	14.28±0.48^{a}	5	24.50±1.38^{b}	78	4.30±0.17^{b}	78	33.62±0.41^{bc}
4PPI	74	25.33±0.96^{a}	72	16.56±0.53^{a}	73	14.80±0.54^{a}	3	26.25±1.86^{b}	74	4.22±0.22^{ab}	69	34.30±0.52^{c}
Sex		***		***		NS		NS		NS		NS
Male	103	25.52±0.52	103	16.72±0.29	103	13.96±0.29	107	23.52±0.50	107	4.15±0.12	106	32.75±0.28
Female	326	21.23±0.18	332	14.30±0.10	333	13.61±0.10			343	4.08±0.04	338	32.86±0.09
Age by sex		*		***		***		***		NS		NS
Male 0PPI	42	22.51±0.51^{c}	43	15.75±0.27^{b}	43	11.69±0.28	45	20.66±3.67^{a}	45	3.76±0.11^{a}	45	30.87±0.26^{a}
Female 0PPI	54	19.32±0.45^{a}	58	14.24±0.23^{a}	55	12.95±0.25^{a}			59	3.87±0.0.10^{a}	29	31.10±0.23^{a}
Male 1PPI	25	25.10±0.66^{c}	25	17.72±0.36^{c}	24	13.80±0.38^{a}	26	22.74±3.52^{ab}	26	4.06±0.0.15^{a}	26	31.88±0.34^{a}
Female 1PPI	57	20.47±0.43^{ab}	55	13.93±0.24^{a}	57	12.98±0.24^{a}			59	3.96±0.10^{a}	59	32.83±0.23^{b}
Male 2PPI	28	24.60±0.63^{c}	28	15.87±0.34^{b}	28	14.76±0.35^{b}	28	23.45±1.62^{b}	27	4.29±0.0.14^{b}	27	32.19±0.35^{ab}
Female 2PPI	78	22.89±0.37^{c}	80	14.36±0.20^{a}	78	13.70±0.21^{a}			81	4.19±0.08^{a}	81	33.31±.0.19^{bc}
Male 3PPI	5	26.24±1.48^{cd}	4	16.00±0.9^{bc}	5	14.70±0.0.83^{ab}	5	24.50±1.51^{b}	5	4.57±0.34^{b}	5	33.86±0.79^{c}
Female 3PPI	66	21.96±0.40^{b}	70	14.10±0.21^{a}	73	13.87±0.21^{b}			73	4.02±0.09^{a}	73	33.38±0.20^{c}
Male 4PPI	3	29.16±1.91^{d}	3	14.83±1.07^{c}	3	13.83±1.07^{b}	3	26.25±1.73^{b}	3	4.05±0.44^{a}	3	34.93±1.03^{c}
Female 4PPI	71	21.49±0.41^{b}	69	14.76±0.22a^{b}	70	14.76±0.23^{b}			71	4.38±0.09^{b}	66	33.67±0.22^{c}

^{a,b,c,d} means on the same column with different superscripts within the specified dentition group are significantly different (p <0.05); Ns = Non-significant (P>0.05); ** P< 0.01

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Table 3 - Coefficient of correlation between Body Weight and other body measurements with in age group and sex

Trait		Dentition class (Age group)									
		0PPI		1PPI		2PPI		3PPI		4PPI	
		M	F	M	F	M	F	M	F	M	F
BL	r	0.29*	0.54***	0.68***	0.62***	0.43*	0.64***	-	0.32***	-	0.22*
HW	r	0.35*	0.64***	0.36^{NS}	0.68***	0.09^{NS}	0.52***	-	0.37**	-	0.50***
HG	r	0.06^{NS}	0.65***	0.19^{NS}	0.74***	0.71***	0.69***	-	0.69***	-	0.54***
RH	r	0.41**	0.65*	0.53*	0.71***	0.21^{NS}	0.57**	-	0.31**	-	0.38***
TL	r	0.07^{NS}	0.08^{NS}	0.1^{NS}	0.07^{NS}	-	0.31**	-	0.63***	1.00***	0.15^{NS}
TW	r	-	0.36*	-	0.04^{NS}	0.46*	-0.01^{NS}	0.89^{NS}	0.27*		0.15^{NS}
PW	r	-	0.39**	-	0.56***	0.19^{NS}	-0.12^{NS}	0.81^{NS}	-0.08^{NS}		0.25*
EL	r	0.16^{NS}	0.39**	-	0.42**	0.03^{NS}	0.12^{NS}	1.0***	0.57***		0.05^{NS}
EW	r	0.09^{NS}	0.45**	0.26^{NS}	0.27*	-	0.23^{NS}	0.81^{NS}	0.56***		0.14^{NS}
CD	r	0.17^{NS}	0.33*	0.03^{NS}	0.16^{NS}	0.12^{NS}	0.29**	0.96*	0.46***		0.34**
SC	r	0.34*	-	0.27^{NS}	-	0.26^{NS}	-	0.96*	-		

N= number of observations. r = coefficient of correlation, 1PPI = 1 pair of permanent incisor and NS = non-significant;* < 0.05, ** < 0.01 PPI= pair of permanent incisor M=male, F=female, BL=body length, HG= hart girth, WH =wither at Height, RH= rump height, TL= Tail length, TW= Tail width, PW =pelvic width, CD=chest dept., SC=scrotal Circumference

Table 4 - Regression Models for Predicting Body Weight of Female *Holla* Sheep at Different age Groups

Age group	Model	B_0	B_1	B_2	B_3	B_4	B_5	B_6	R^2	MSE
0	HG	3.08	0.22						0.48	2.89
	HG+WH	-2.81	0.15	0.20					0.55	3.20
	HG+WH+EL	-1.75	0.10	0.19	0.66				0.62	3.02
1	WH	-10.87	0.56						0.65	3.65
	WH+HG	-18.05	0.41	0.22					0.72	3.97
	WH+HG+TW	-21.69	0.43	0.21	0.23				0.74	4.36
	WH+HG+TW+EW	-23.01	0.47	0.21	0.29	-0.84			0.76	4.32
	WH+HG+TW+EW+BL	-21.14	0.58	0.25	0.26	-1.07	-0.19		0.78	4.34
	WH+HG+TW+EW+BL+TL	-20.47	0.61	0.25	0.41	-1.26	0.21	-0.14	0.79	4.27
2	HG	-1.05	0.33						0.41	3.51
	HG+RH	-10.20	0.23	0.25					0.51	4.13
	HG+RH+CD	-19.14	0.21	0.29	0.25				0.55	5.53
	HG+RH+CD+EW	-24.38	0.14	0.36	0.33	1.56			0.60	5.5
	HG+RH+CD+EW+EL	-19.78	0.14	0.33	0.29	-1.53			0.66	5.34
	HG+RH+CD+EW+EL+TW	-13.36	0.12	0.34	0.27	4.85	-2.25	-0.28	0.69	5.94
	HG+RH+CD+EW+EL+TW+BL	-11.82	0.09	0.23	4.96	-2.50	-0.26	0.11	0.70	5.96

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Table 4 (Continued)

Age group	Model	B_0	B_1	B_2	B_3	B_4	B_5	B_6	R^2	MSE
3	HG	-5.29	0.39						0.46	4.01
	HG+TL	-3.10	0.29	0.20					0.51	4.02
	HG+TL+PW	-0.15	0.29	0.22	-0.23				0.53	4.37
	HG+TL+PW+EW	3.23	0.24	0.20	-0.30	0.91			0.55	4.77
	HG+TL+PW+EW+CD	10.75	0.28	0.23	-0.45	1.18	-0.28		0.57	6.47
4	CD	5.79	0.56						0.27	4.27
	CD+BL	1.98	0.47	0.12					0.34	4.36
	CD+BL+EW	0.09	0.39	0.17	0.63				0.42	4.22
	CD+BL+EW+PW	-6.08	0.39	0.21	0.66	0.25			0.48	4.77
	CD+BL+EW+PW+WH	-9.16	0.34	0.18	0.78	0.18	0.12		0.50	5.08
	CD+BL+EW+PW+WH+RH	-8.69	0.40	0.18	0.77	0.19	0.20	-0.12	0.53	5.01
over all	HG	10.28	0.45						0.51	1.98
	HG+WH	-15.26	0.28	0.29					0.62	1.84
	HG+WH+EW	-15.04	0.24	0.31	0.92				0.65	1.77
3	HG+WH+EW+BL	14.24	0.21	0.19	1.01	0.14			0.67	1.73
	HG+WH+EW+BL+TL	14.36	0.20	0.18	1.07	0.14	0.06		0.67	1.72
	HG+WH+EW+BL+TL+EL	-13.91	0.20	0.17	1.58	0.15	0.06	-0.46	0.68	1.73

Table 5 - Regression models for predicting body weight of male *Holla* sheep at different age groups

Age group	Model	B_0	B_1	B_2	B_3	B_4	B_5	B_6	R^2	MSE
0	RH	6.93	0.20						0.12	5.29
	RH+HG	16.04	0.26	-0.19					0.26	6.33
	RH+HG+SC	20.67	0.23	-0.31	-0.20				0.39	6.14
1	BL	0.18	0.38						0.37	6.17
	BL+RH	9.68	0.64	-0.38					0.51	7.34
2	HG	-12.23	0.49						0.64	6.46
	HG+PW	-19.35	0.72	-0.52					0.76	6.05
	HG+PW+TW	-19.10	0.56	-0.36	0.47				0.80	5.76
	HG+PW+TW+RH	-27.39	0.42	0.03	0.64	0.17			0.84	6.79
	HG+TW+RH	-27.55	0.40		0.66	0.18			0.84	6.41
	HG+TW+RH+SC	-24.08	0.56		0.49	0.27	-0.74		0.92	4.70
4	CD	4.0	0.66						1.00	0
over all	HG	-6.39	0.39						0.50	3.09
	HG+RH	-12.51	0.27	0.27					0.58	3.30

HG= Heart Girth; BL=Body Length; HW= Height at wither; CW=Chest Width; PW = Pelvic Width; TW = Tail Width; BCS= Body Condition Score; SC= Scrotal Circumference; 0PPI = 0 Pair of Permanent Incisors; 1PPI = 1Pairs of Permanent Incisors; 2 PPI = 2 Pairs of Permanent Incisors; 3 PPI = 3 Pair Permanent Incisors; 4 PPI = 4 Pairs of Permanent Incisors

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Multiple linear regression analysis

The regression analysis of live body weight on different body measurements for ewes and rams are presented in Tables 4 and 5, respectively. The result of Stepwise regressions procedure was carried out to predict the dependent variable body weight based on independent variables which had positive correlation with body Weight. Around ten body measurements for Body length, Height at wither; Heart girth, Rump height, Tail length, Tail width Ear length, Ear width and Chest depth were utilized in female for estimation of body weight. The male body weight also estimated using the above measurements and scrotal circumference. Six variables with significant contribution to the prediction model which included heart girth, body length, and height at wither, tail length, tail width and were fitted first to six steps where they accounted for 68 % of the total variability of the female sheep. Across all the 2 age groups of male sheep, heart girth, tail width, rump height and scrotal circumference alone accounted for about 92 % and polled data were heart girth and rump height for 58% of the variation in body weight, while step one procedure of stepwise regression of all sex and age category, for predication of body weight heart girth was consistently selected and entered into the model because of its higher coefficient of determination (R^2) value and its larger contribution to the model than other variables.

Multiple linear Regression equation were developed for predicting body weight (LBW) from other LBMs female and male using the pooled data for all age groups due to the low proportion of animals at each dentition classes. The regression equations were developed for male and female by using chest girth, body length, height at wither, tail length, ear width and ear length of was independent variable and body weight as dependent (predicted) variable female sample population and chest girth and rump height was independent variables and body weight as dependent variable for male sample population. Parameter estimates in multiple linear regression model showed that ewes had higher R^2 (68%) value than rams (58%). This point out that those linear measurements could predict more accurately in females compared to males. Overall equation of the pooled age group using, height at wither, tail length, ear width, body length and ear length as important variable used for the prediction of body weight for female sheep and also heart girth and rump height used for prediction of body weight for male sheep. The prediction of body weight could be based on the following regression equation:

Y=-13.91+0.20 *HG*+0.17*HW+1.58EW+0.15BL+0.06TL+ (-0.46) EL* for ewes and

Y= -12.51+0.27 *HG*+0.27 *RH* for rams.

CONCLUSION AND RECOMMENDATION

Majority of the female Holla sheep in the study area have plain patch and spotted coat color pattern. Similarly male Holla sheep were plain, brown and brown and white. Generally, positive and significant ($P<0.05$) correlations were observed between body weight and most of the body measurements. Live body weight estimation using chest girth alone would be preferable to combinations with other measurements because of difficulty of the proper animal restraint during measurement and the low proportion of animals at each dentition classes. The high correlation coefficients between body weight and body measurements for all age groups suggest that either of these variables or their combination could provide a good estimate for predicting live weight of sheep from body measurements. More emphasis needs to be placed on the improvement of Holla sheep breeds due to their significant contribution to the family food and income and their ability to survive and reproduce in the extreme environments in which crop production as well as maintaining large ruminants is difficult. The present Morphometric information could aid future decision on the management, conservation and improvement of the Holla sheep genetic resources. It is suggested that it is important to undertake well planned on station study to predict further genetic potential of sheep type in the study areas.

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Competing Interests

The authors declare that they have no conflict of interest with respect to the research, authorship or publications of this article.

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PREVALENCE OF BOVINE SUBCLINICAL MASTITIS AND ASSOCIATED RISK FACTORS IN ADDIS ABABA, CENTRAL ETHIOPIA

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ABSTRACT: A cross-sectional study was conducted with the objective of determining the prevalence of bovine Subclinical mastitis (SCM) in dairy cows and assessing its associated potential risk factors from November, 2016 to April, 2017 in Addis Ababa, Central Ethiopia using California mastitis test. A total of 390 lactating cows comprising different cattle breed from sixteen dairy farms were purposively sampled. The overall prevalence of SCM among the study animal was 49.23 % (192/390). Of this, the highest prevalence of SCM was observed in Holstein-Friesian (51.6%) followed by Jersey (50.0%) and cross (37.1%). The prevalence of SCM in <5 months, 5-8 months and >8 months stage of lactation was 73.9%, 38.5% and 47.5%, respectively. In terms of milk yield, the prevalence of SCM was higher in cows having more than 15 liters of milk production (61.5%) and 7-15 liters (45.8%) and lower in <7 liters (41.4%). The prevalence of SCM in parity group 1-3, 4-6 and >6 was 41.3%, 52.9%, and 78.7%, respectively. Regarding floor type, the highest prevalence was recorded in bad concrete floor (64.2%) than good concrete (43.7%). The prevalence of SCM was higher in cows having teat lesion (75.3%) than no teat lesion (42.4%). Breed, parity, stage of lactation, milk yield, teat lesion, floor type were found to have statistically significant difference (P<0.05). However, age, towel usage and body condition score showed non-significant difference (P>0.05). In general, Subclinical mastitis was a major health problem of dairy cows in the study area. Therefore, more emphasis should be given on regular screening of cows, designing effective control and prevention strategies for subclinical mastitis.

Keywords: Addis Ababa Dairy cows, Prevalence and Risk factor, Subclinical mastitis

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INTRODUCTION

World have about 1,287,520,000 head cattle out of these dairy consists of 225,502,000 heads. In Africa there are 192,180,000 total populations of cattle, among these diary consists of 34,057,000 in number (ILRI, 2008). Ethiopia has the largest cattle population in Africa with an estimated population of 56.71 million. Cow represents the biggest portion of cattle population of the country, around 20.7% of the total cattle heads are milking cows (CSA, 2014). Even though Ethiopia is the most populous country in cattle than any African country; the per capita milk consumption was lower than other countries in the region. This is partly due to the low genetic milk production potential of the indigenous zebu cattle or by several types of diseases which potentially infect and affect the wellbeing of livestock population among which mastitis is the common and costly disease causing loss in milk yield, treatment cost for dairy farmers and culling of animals at unacceptable age (Vaarst and Envoldsen, 1997). Bovine mastitis is one of the threatening production diseases of dairy animals which directly or indirectly affect the economy of the farmers and ultimately affect the economy of the country. Mastitis is a globally economically warming diseases which affects animals health, quality of milk, milk yield which suffer enormous economically losses. It is well recognized that subclinical mastitis (SCM) is the major form of bovine mastitis which caused an extensive problem and economically losses in the dairy industry worldwide (Sharma et al., 2012). Huge loss in milk yield the sub-clinically affected animals remain a continuous source of infection to other herd mates. If the infection

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persists for longer periods, then it may form a fibrous tissue barrier between the organisms and the antibiotic preparations, thus, limiting their efficacy (Kader et al., 2002). It is characterized by having no visible signs either in the udder or in the milk, but the milk yield decreases and the Somatic cell count (SCC) increases, having greater impact in older lactating animals than in first lactation heifers (Erskine, 2001).

In Ethiopia, subclinical mastitis has received little attention; even, it is often surprising to producers, moreover, sub-clinically infected udder quarters can developed clinical mastitis and the rate of new infections can be high (Zdunczyk et al*.,* 2003). But, focused should be on the treatment line of cases. Subclinical mastitis causes more than three times losses as compared to clinical mastitis (Kayesh et al., 2014; Singh, 1994). The subclinical mastitis is more serious and causes much greater loss to the dairy industry (Abrahmsen et al*.,* 2014). This is explained by the fact that subclinical mastitis is more difficult to diagnose and therefore usually persists longer in the herds, causing production losses. According to Getahun et al. (2008) economic losses are due to loss in milk production, discarding abnormal milk and milk withheld from cows treated with antibiotics, degrading of milk quality and price due to high bacterial or somatic cell count (SCC), costs of drugs, veterinary services and increased labor costs, increased risk of subsequent mastitis, herd replacement, and problems related to antibiotics residues in milk and its products. There might also be potential food safety risks indirectly associated with high somatic cell count. The lower quality and the diminished sustainability of milk with a high somatic cell count both constitute a potential health risk and also affect the possibility of producing other dairy products, e.g., cheese and yoghurt (Andersson et al*.,* 2011).

Various researchers revealed subclinical mastitis as grievous and frequently encountered diseases in the dairy industry of different parts of Ethiopia. Among these most studies were carried out in Addis Ababa and its surroundings, which are not representative of other regions of the country (Almaw et al*.,* 2009), but others were studied in some part of different agro-ecological zone of the country. (Kerro and Tareke, 2003; Mungube et al*.,* 2004; Demelash et al*.,* 2005; Sori et al*.,* 2005; Matios et al*.,*2009; Girma, 2010; Nesru, 1999; Mekonnen and Tesfaye, 2010 and Nibret et al*.,* 2011).

According to Hussein et al. (1997) the prevalence of subclinical mastitis in the central regions of Ethiopia are found to be 19% on cow basis. Current experimental survey was conducted at two major Ethiopian dairy farms (Repi and Debre-Zeit), out of 186 lactating cows, 71 (38%) were sub-clinically infected (Workineh et al., 2002). Abera et al. (2012) also noted that, out of 245 examined lactating cows 70 (28.6%) cows were with subclinical mastitis reported in shashemene, southern Ethiopia.

Generally, as with most infectious disease, mastitis risk factors depends on exposure to the microbes, Immune system and environment or management factors (Suriyasathaporn et al., 2000). Host factors include breed, anatomy of teat canal, sphincter tone and presence of teat lesion. Agent factor includes the ability to colonize the teat duct, the ability to adhere to the mammary epithelium and not to be flushed out with milk flow. Environmental factor includes milking practice, housing system and bedding (Quinn et al*.,* 1994). Thus, it is necessary to have epidemiological information about subclinical mastitis and factors associated with udder infection so as to improve dairy production and uphold quality of milk for consumers. Hence this study was initiated with the objectives of to determine the prevalence of bovine Subclinical mastitis in apparently healthy dairy cows in Addis Ababa, Central Ethiopia and to assess associated risk factors of bovine subclinical mastitis in the study area.

MATERIAL AND METHOD

Selection of site

The study was conducted in Addis Ababa, which is the capital city and administration centre for the Federal Democratic Republic of Ethiopia starting from November, 2016 to April, 2017. The city covers an area of 530.14 km2 and is sub divided into ten sub-cites namely, Arada, Bole, Addis Ketema, Nefas Silk Lafto, Kolfe Keranio, Akaki Kality, Yeka, Lideta, Kirkos and Gulele sub-cites (CSA, 2007). Addis Ababa lies at 9.030 North latitude and 38.80 East longitudes with an average altitude of 2400 meters above sea level. It has an average annual temperature of 15.9^{0}C. It also receives an annual rain fall of 1089 mm or 91 mm per month with 60.1% annual relative humidity which ranges from 49% in February to 82% in July (NMSA, 2007).

Study animal

The study was conducted on a total of 390 Holstein Friesian (HF), Jersey and Cross (HF x Local) lactating cows from Sixteen dairy farms in Addis Ababa. The study populations were lactating cows of different age, lactation stage, parity, milk production and body condition. According to Ortegon (2013) cows were classified their age as 3 to 5 years, 5 to 7 years, and >7 years based on their dental eruption patterns. Concerning body condition score, the sampled animals were classified as poor, moderate and good based on the classification by Webster (1989). As parity is concerned, it was categorized as 1-3 calves, 4- 6 calves and greater than six calves. Lactation period was

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also classified as <5months, 5-8 months and >8 months (Demelash, 2005). Similarly, floor type was categorized as, good and bad concrete type and milk yield recorded by amount of litter as less than 7, between 8-15 and greater than 15 liters (Mureithi et al., 2016). All the farms examined were practiced intensive husbandry management and there milking system was manual (by hand).

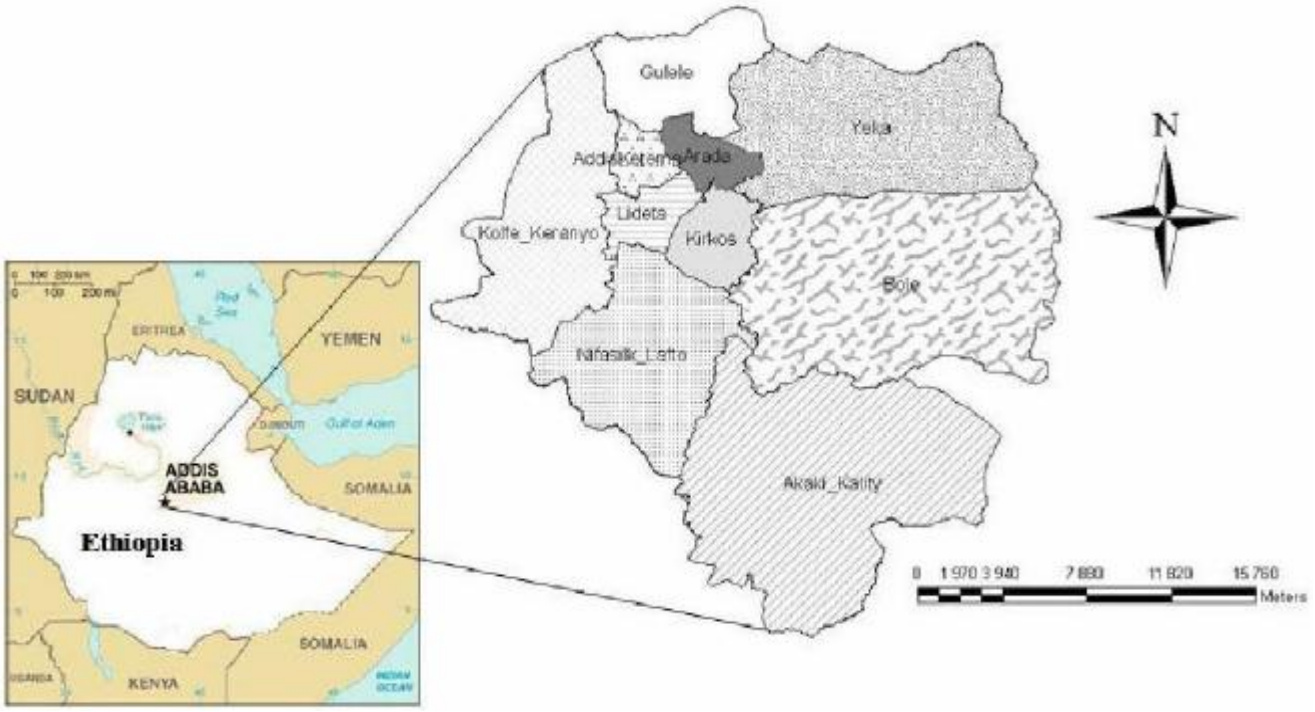

Figure 1 - Map of the study area

Study design

A Cross sectional study was conducted from November, 2016 to April, 2017 to determine the prevalence of bovine subclinical mastitis and its associated risk factor in Addis Ababa, central Ethiopia based on CMT.

Sample size and sampling method

Sixteen dairy farms were purposively selected based on their ease of accessibility, availability of lactating cows within the farm and the owners' willingness. Simple random sampling technique was applied for the selection of individual animals (lactating cows) in the farms. Milking practice during sampling was done with careful hygiene. To reduce contamination of the teat ends during sample collection, the near teats were sampled first followed by the far once. The milk is collected from each quarter into labeled sterile screwed test tube after discarding the first three milking streams. The sample size was determined according to (Thrusfield, 2005). Previous study conducted by Alebachew and Alemu, (2015) on the prevalence of bovine subclinical mastitis in the same area showed 46.8%. Therefore, using 46.8% as expected prevalence and 5% absolute precision at 95% confidence level, the number of animals needed in the study was 383. However, to increase the precision in this study 390 lactating dairy cows were sampled.

$$n = \frac{1.96^2 \, Pexp \, (1-Pexp)}{d^2}$$

where:

n = sample size

Pexp = expected prevalence

d = desired absolute precision

Data Collection

Farm inspection was practiced to assess the housing conditions, feeding practices and milking practices. The housing condition was qualified as bad when there is bad smell and the animals flank, udder and belly were soiled. The housing condition was qualified as good when none of the above indicated. Milking practice was investigated through close observation at the time of milking. Data concerning floor, body condition score, and teat lesion were collected by observation, while age, parity, lactation stage, and milk yield were determined by asking owner and

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farm attendant using a properly designed format and from the farm records where available. An apparently normal milk that was negative on the California mastitis test were considered to be normal milk (with no precipitation), while those that were CMT positive were considered to have subclinical mastitis. The reaction involved in the CMT is the disintegration of leukocytes when milk is mixed with the CMT reagent (Babaei et al., 2007). The CMT was carried out as described by Quinn et al. (2004). A squirt of milk, about 3 ml from each quarter was placed on shallow cups in the CMT paddle. An equal amount of the commercial CMT reagent was added to each cup. A gentle circular motion was applied to the mixtures in a horizontal plane for 15 seconds. The result of the test was indicated on the basis of gel formation. . The result was scored from 0-4. Finally cows with CMT score of 1 or above were judged as positive for sub clinical mastitis; otherwise negative (Quinn et al., 1999).

Data management and analysis

The collected data was entered in to Microsoft excel work sheet 2007. The data were thoroughly screened for errors and properly coded before subjecting to statistical analysis. The data were imported from Microsoft excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version 20. Descriptive statistics was used to quantify the prevalence of subclinical mastitis in relation to different explanatory variables. The associations of the Subclinical mastitis with the different risk factors such as breed, age, lactation period, parity, towel usage, milk yield, floor, body condition and teat lesion were assessed by using logistic regression. Univariable and multivariable logistic regression models were fitted containing the appropriate independent variables with 95% confident interval and less than 0.05 level of precision.

RESULTS

Out of 390 lactating cows examined 192 representing 49.23% were CMT positive for subclinical mastitis in the study area. Among the different potential risk factors considered for a univariate logistic regression, most risk factors except breed and towel usage other factors like, age, parity, body condition, floor, lactation stage, milk yield and teat lesion were found statistically significant ($P<0.05$). The highest prevalence of subclinical mastitis was occurred in Holstein Friesian animal (51.6%), followed by Jersey (50.0%) than in cross (37.1%). The odd of having subclinical mastitis was 2 times more likely to occur in Holstein Friesian cows than cross (OR=2. 012, CI= 0.989-4.094). Concerning age categories, cows at age group of 3-5, 5-7 and greater than seven years had an infection rate of 40.2%, 53.6% and 62.6%, respectively. According to lactation stage, the highest prevalence of subclinical mastitis was recorded in less than 5 months (73.9%) followed by greater than 8 months (47.5%) and 5-8 months (38.5%) of lactation stage. The risk of acquiring subclinical mastitis in lactation stage less than 5 months was almost 2 times more likely than those greater than 8 months of lactation stage (OR=1.987, CI= 1.001-3.944). Regarding parity, the highest prevalence of subclinical mastitis were observed in cows having parity number greater than six (78.7%) followed by 4-6 parity (52.9%) and 1-3 parity (41.3%). The odds of having subclinical mastitis were 5.9 times more likely in greater than six parity than 1-3 parity (OR=5.847, CI= 2.062-16.58). The risk of acquiring subclinical mastitis was 1.12 times more likely in 4-6 parity than 1-3 parity (OR=1.108, CI= 0.535-2.294). The prevalence of subclinical mastitis related to towel usage showed that cows, which were washed and dried their teat with towel had high subclinical mastitis prevalence (51.4%) than that of not washed and dried by towel (43.8%). Based on milk yield, the prevalence of SCM was highest (61.5%) in cows having more than 15 liters of milk production and lowest (41.4%) in cows producing <7 liters of milk production. The odds of having SCM was 8 times more likely in cows producing more than 15 liters of milk than cows producing less than 7 liters (OR= 8.1, CI= 3.343-19.87). The risk of having subclinical mastitis in animals giving seven to fifteen liters was 3 times more likely than 7 liters (OR=3.059, CI: 1.385-6.758). The prevalence of subclinical mastitis associated with good concrete floor was 43.7% and with bad concrete floor was 64.2%. The risk of having SCM is 3.7 time more likely in floors made of bad concrete than good concrete floor (OR= 3.685, CI= 1.767-7.685). Concerning body condition, the prevalence was high in poor body condition (81.8%) followed by moderate body condition (56.6%) and good body condition (44.4%). Cows having teat lesion were more prone to subclinical mastitis (75.5%) than cows with no teat lesion (42.4%). Accordingly, the likelihood of the subclinical mastitis was 4.8 times more in cows having a teat lesion (OR = 4.8; 95% CI = 2.336-9.748) than cows that have no teat lesion.

Breed, lactation stage, parity, milk yield, floor type and teat lesion were found to be statistically significant ($P<0.05$) association with the occurrence of subclinical mastitis in lactating dairy cows. On the other hand, body condition, age and towel usage did not significantly ($P>0.05$) influence the occurrences of Subclinical mastitis in the current study using multivariate logistic regression (Table 1).

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Table 1 - Analysis of the risk factors for the prevalence of bovine subclinical mastitis

Variables	Category	Number examined	Number Positive (%)	COR (CI: 95%)	AOR (CI: 95%)	P-value
Breed	Cross	62	23(37.1)	1	1	0.026
	Jersey	24	12(50.0)	1.696(0.655-4.392)	0.63(0.186-2.129)	
	Holstein-Friesian	304	157(51.6)	1.8(1.032-3.178)	2.012(0.989-4.094)	
Age	>7 years	107	67(62.6)	1	1	0.481
	5-7 years	84	45(53.6)	0.689(0.385-1.231)	1.615(0.687-3.792)	
	3-5 years	199	80(40.2)	0.4(0.248-0.651)	1.168(0.511-2.67)	
Lactation stage	>8months	120	57(47.5)	1	1	0.0001
	5-8months	182	70(38.5)	0.691(0.433-1.101)	0.481(0.274-0.843)	
	<5 months	88	65(73.9)	3.124(1.722-5.665)	1.987(1.001-3.944)	
Parity	1-3 calves	259	107(41.3)	1	1	0.002
	4-6 calves	70	37(52.9)	1.593(0.937-2.707)	1.108(0.535-2.294)	
	>6 calves	61	48(78.7)	5.245(2.709-10.16)	5.847(2.062-16.58)	
Use towel	Yes	278	143(51.4)	1	1	0.249
	No	112	49(43.8)	0.734(0.472-1.142)	0.731(0.429-1.246)	
Milk yield per day	<7 liters	70	29(41.4)	1	1	0.000
	7-15 liters	216	99(45.8)	1.196(0.693-2.065)	3.059(1.385-6.758)	
	>15 liters	104	64(61.5)	2.309(1.456-3.661)	8.149(3.343-19.87)	
Floor type	Good	284	124(43.7)	1	1	0.001
	Bad	106	68(64.2)	0.433(0.273-0.687)	3.685(1.767-7.685)	
Body condition	Poor	11	9(81.8)	1	1	0.154
	Moderate	122	69(56.6)	0.289(0.06-1.395)	0.202(0.32-1.272)	
	Good	257	114(44.4)	0.177(0.038-0.836)	0.163(0.25-1.048)	
Teat lesion	Absent	309	131(42.4)	1	1	0.000
	present	81	61(75.3)	4.144(2.384-7.206)	4.772(2.336-9.748)	

*COR= Crude odds ratio, AOR= Adjusted odds ratio, P<0.05= Statistically significant

DISCUSSION

This study showed the overall prevalence of subclinical mastitis at cow level was found to be 49.23%, which is in close agreement with the report of Alebachew and Alemu (2015), Mekibib et al. (2010) and Yien (2014), who found the prevalence rate of 46.8%, 48.6% and 48.76% in dairy farms of Addis Ababa, Holeta and Gambella, Ethiopia, respectively. However, it was higher than the findings of other authors in different regions of Ethiopia like: 36.67% by Hundera Sori et al. (2005) in Sebeta, 36.86% by Fufa (2013) in Addis Ababa, 41.02% by Ayano et al. (2013) in Holeta, 13.6% by Getahun et al. (2008) in Selalle, 28.6% by Abera et al. (2012) in Shashemene, Southern Ethiopia, 44.6% by Mekonnen and Tesfaye (2010) in Adama, 23.0% by Biffa et al. (2005) in Southern Ethiopia and 25.2% by Almaw (2009) in and surrounding of Gondar town. But, lower than the findings of Tadesse (2014) who indicated that 85.4% were positive for subclinical mastitis at cows' level reported in Addis Ababa, 54.5% in Asella by Birhanu (2013), 55.1% in Addis Ababa by Zeryehun et al. (2013). The variability in the prevalence of bovine subclinical mastitis between findings could be suggested the complexity of the disease which involves interaction of several factors, mainly the difference in husbandry system, breeds considered, environment, management of the farms, factors related to causative agent, variation in veterinary service coverage and awareness of the owner toward the disease, and technical know-how of the researchers (Radostits et al., 2007).

In current study, the highest prevalence of SCM was observed in HF breed (51.6%) followed by Jersey (50.0%) and cross breed (37.1%) and there was statistically significant association with SCM (P<0.05). This finding is comparable with report of other studies such as Almaw et al. (2009) in and surrounding of Gondar town, G/Michael et al. (2013) in and around areka, Southern Ethiopia, Sori et al. (2005) in and around Sebeta, Ethiopia and Junaidu et al. (2011) at Sokoto metropolis. Biffa et al. (2005) also reported that Holstein-Friesian cows are more frequently affected (56.5%) than local zebu (30.9%) and Jersey cows (28.9%). Sharma and Maiti (2010) also found that Holstein and Jersey cows are at higher risk (94.54%) for subclinical mastitis than Holstein Friesian-local zebu cross

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cows (31.25%). This variation of subclinical mastitis prevalence in breeds level could be that the disease influence the animals by some inheritable characteristic such as capacity of milk production (high yielding cows are more susceptible to mastitis than low-yielding ones), teat characteristic and udder conformation (Abaineh, 1997).

The current study showed, the prevalence rate of subclinical mastitis at cow level was higher as the age advances; 40.2% in 3-5 years, 53.6% in 5-7 years and 62.6% in >7 years. This study showed that, there were no statistically significant among the age. This finding is in agreement with the finding of Belachew (2016) around Debrezeit, Ethiopia which report insignificant upon age. In this finding, the prevalence of SCM in <5 months, 5-8 months and >8 months stage of lactation was 73.9%, 38.5% and 47.5%, respectively and there was statistically significant association between SCM and stages of lactation ($p<0.05$). This study is in agreement with Demelash et al. (2005), Nesru et al. (1999), Kerro and Tareke (2003), Hughes (1960), Kehrli and Shuster (1994), Radostits and Blood (1994) who reported subclinical mastitis prevalence was higher in early lactation and lower in mid stage lactation. In contrary different reports reflected prevalence of subclinical mastitis was higher in late stage of lactation than early (Getahun et al., 2008; Gizat et al., 2008, GebreMichael et al., 2013 and Biffa et al., 2005). On the other hand authors like; Kayesh et al. (2014), Mureithi (2016) and Rahman et al. (1997) reported higher prevalence (34.00%) of subclinical mastitis during the mid of lactation. The occurrence of high prevalence during earlier lactation stage may be due to absence of dry cow therapy and birth related influences (Quinn *et al*., 2005). The amount of milk ejected is also higher during earlier lactation periods and this cause increased in patency of the teats and decreased local defense factors. Similarly, the mammary gland is more susceptible to new infection during early lactation and late dry period, which may be due to the absence of udder washing and teat dipping, which may in turn increase the number of potential pathogens on the skin of the teat (Islam et al., 2011).

In the present study, the prevalence of SCM in parity group 1-3, 4-6 and >6 was 41.3%, 52.9%, and 78.7%, respectively and there was statistically significant association between SCM and parity number ($P<0.05$). This finding is in agreement with Mungube et al. (2004), Demelash et al. (2005), Matios et al. (2009), Gizat et al. (2008), Girma (2010) and Molalegn et al. (2010) who identified parity as risk factor to mastitis and Rasool et al. (1985) and Devi et al. (1997) both of them reported an increasing prevalence of subclinical mastitis with advancing parity. This might be due to cows with advanced parity become more productive, so it can be assumed that as the parity of cows advance and the age increases cows become prone to mastitis. In addition, to this active mononuclear leukocyte functioned better in primiparous cows than the multiparous cows (Jha et al., 2010).

Towel usage was found to be associated with the occurrence of subclinical mastitis, higher in animals/farms where towels were used for drying teats (51.4%) than not used (43.8%). This is because of using common source of water (bucket) for washing many towels and using of common a single towel for different lactating cows. This observation is in agreement with the reports of Fufa (2013) who report 54.28% prevalence in farms where towel was used and 43.55% in farms in which towel not used.

Milk yield considering as a risk factor for sub clinical mastitis revealed that the highest prevalence of subclinical mastitis in cows with a milk production of more than 15 liters was 61.5% and 45.8% in 7-15 liters and lowest in <7 liters (41.4%). It has a significant value ($P<0.05$), which is consistent with the report of Islam et al. (2011) who reported increased prevalence of SCM (42.85%) with the increased milk production and Siddiquee et al. (2013) who reports the prevalence of SCM was higher (73.7%) in cows producing more than 15 liters of milk. According to Grohn et al. (2004) high producing cows were susceptible for subclinical mastitis than low milk producing cows. This is due to the reason that higher milk production has affected the capacity of the immune system of dairy cows to combat infections, and the associated bacteria have adapted to changes in their hosts and environment (Tripura et al., 2014). This finding showed that, cows with poor body condition had more prevalence rate (81.8%) than those with moderate (56.6%) good body condition (44.4%) though the difference was not statistically significant.

The higher prevalence of subclinical mastitis reported in cows maintained in crackled (bad) concrete floor (64.2%) and low prevalence was observed in good concrete (43.7%). It was actually found to be statistically significant with a P-value of 0.001. This result is coincided with Mekibib et al. (2010) and Seid et al., (2015) who reports higher prevalence in good concrete than bad concrete floor type. Dirty floor would be a potential source that favors the proliferation and transmission of mastitis causing organism. This substantiates the importance of sanitation in the epidemiology of subclinical mastitis (Mureithi et al., 2016).

The present study showed that teat lesion was found to be the risk factor for subclinical mastitis with the prevalence of 75.3% in cows with teat lesion and 42.4% in cows with no lesion. It was found statistically highly significant. This is in consistent with the finding by Seykora and McDaniel (1995) that identified a positive association between teat-end lesion score and subclinical mastitis. However, Farnsworth (1995) in contradicted it with the findings. Thus, whenever teat lesions are present, it shown to be readily colonized by bacterial organisms and sever as reservoirs of infection (Mulei, 1999).

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CONCLUSION

The result of the present study (49.2%) indicated a relatively high prevalence of subclinical mastitis in dairy cattle of the study area. This high prevalence rate of subclinical mastitis in this study implied that it is the most serious health problem of the dairy cows in farm, which can interfere with efficiency of milk production and has high economic importance. The most important risk factor affecting the prevalence of sub clinical mastitis in cow were stage of lactation, parity number, floor type, breed and teat lesion. The highest prevalence was observed in cows with advanced age groups, Holstein Friesian breed, multiple parity, poor body condition score, high milk producers, early lactation stage and cows having teat lesion. Since subclinical mastitis is an economically important disease, hygienic milking practice, use of effective antibiotics, strategic mastitis control programs should be of paramount importance.

Recommendation

- Proper milking procedure with post milking teat disinfection, prompt treating of subclinical mastitis positive cows, segregation of positive cows and culling incurable cows should be encouraged in the study area to reduce the prevalence of bovine subclinical mastitis.
- Milkers should be trained on proper hygienic milking methods.
- Dry cow therapy should be applied to reduce the occurrence of new infection after parturition.
- Milkers should avoid using of common source of water (bucket) and common towel.
- Regular investigation and screening of subclinical mastitis for early detection and treatment, and culling of chronically infected cows should be practiced.

Author's contribution

Yilma M performed the data collection, laboratory works and write up of the manuscript. S Derso and Atsedemariam N analyzed the data and revised the manuscript. All authors read and approved the final manuscript.

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Conflict of interests

No conflict of interest

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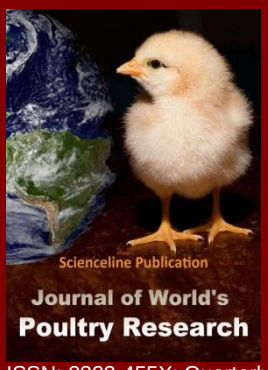

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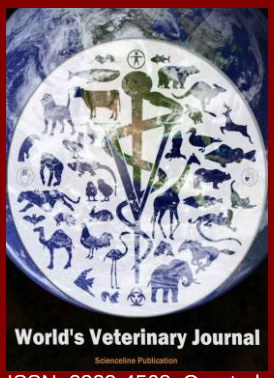

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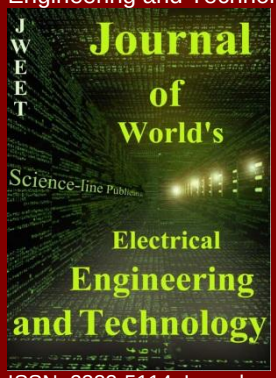

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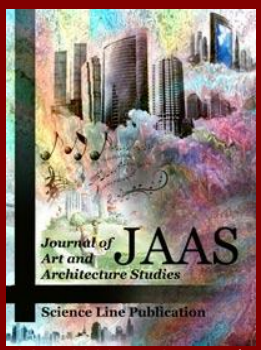

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