

Morphological Characterization of Indigenous Hararghe Highland Goat Breed in Their Native Environment, West Hararghe, Ethiopia

¹Dereje Tsegaye, ²Berhanu Belay and ³Aynalem Haile

¹Adama Science and Technology University,

Institute of Animal Biotechnology, P.O. Box: 1077, Asella, Ethiopia

²Jimma University, College of Agriculture and Veterinary Medicine,

P.O. Box: 307, Jimma, Ethiopia

³International Center for Agricultural Research in the Dry Areas (ICARDA),

P.O. Box: 5466, Aleppo, Syria

Abstract: This study was designed to characterize morphologically Hararghe highland indigenous goat in their home tract and production system. About 930 goats in three agro ecological zones (Highland, midland and lowland) were considered with sex and age groups factor. Brown, white, black, grey and creamy white colors were the common coat color observed with proportions of 34.5%, 26.2%, 15.6%, 14% and 9.7%, respectively. Almost all (95.9%) of this goat breed has no wattle and 78.1% were without bear. Body weight of the goats' changes at increasing rate at 0PPI to 2PPI and gradual increase was observed at older ages. Sex, age and agro ecological zones had a significant ($p < 0.01$) effect on body weight and many of the linear body measurements. Average body weight of males at age of 0PPI, 1PPI, 2PPI, 3PPI and 4PPI were 15.5 ± 0.36 , 24.6 ± 0.66 , 29.5 ± 0.77 , 37.5 ± 0.86 and 40.7 ± 0.80 kg, respectively. The corresponding values for female goats were 14.6 ± 0.34 , 21.6 ± 0.50 , 25.2 ± 0.55 , 27.0 ± 0.53 and 30.3 ± 0.40 kg, respectively. The result indicated that phenotypic characterization, body weight and linear body measurement description could help as an input for efficient utilization, conservation and designing improvement strategy for this genetic resource in the community.

Key words: Age • Agro Ecology • Body Weight • Linear Body Measurements • Sex

INTRODUCTION

A large number of livestock genetic diversities were reported in Ethiopia. Studies estimated that about 15 breeds of goat, 13 breeds of sheep and 25 breeds of cattle exist in Ethiopia though the livestock characterization is not exhaustive [1]. Hararghe highland goat breed is one of the 15 recognized goat breed in Ethiopia but it has been longer time since it has been characterized nearly 25 years and nothing is known concerning the body weight change over time because of change in population, production system. In Ethiopia goat production has traditionally been an integral part of the farming systems in all agro-climatic conditions [2] where in the lowlands, the goats are kept in large flocks by pastoralists. Currently studies revealed that an increasing trend of goat all agro ecologies [3]. The broad genetic variability of African small ruminant breeds enables them to survive under

stressful environmental conditions like high disease incidence, poor nutrition and high temperature [4]. Environmental stress also maintains a wide range of genotypes, each adapted to a specific set of circumstances. The goat characterization in various forms has not been exhaustively undertaken in Ethiopia. Morphological characterization is one of the crucial means for describing the goat breeds. It is essential to characterize a breed for its conservation [5]. Body measurements in addition to weight estimate describe the individual or population than do the conventional methods of weighing and grading small ruminant [6]. Body dimensions have been used to indicate breed, origin and relationship through the medium of head measurements [7].

The information available regarding Hararghe highland goat is more of on station based, not sufficient to describe the breed and morphologically

characterization was undertaken before two decades. Indigenous livestock breeds are considered, for diverse reasons, as treasured genetic resources that tend to disappear as a result of new market demands, crossbreeding or breed replacement and mechanized agricultural operations [5]. Therefore, with these all scenarios and the current global animal genetic resource mix up through inbreeding, interbreeding and environmental change it is important to characterize over different agro-ecological zones. The objective of this study was to characterize morphologically the Hararghe highland goat breed in their home areas.

MATERIALS AND METHODS

Study Area: The study was conducted in Darolabu districts, located at an altitude that ranged from 1300 to 2450 masl in the eastern part of Ethiopia. The District was selected based on its potential for goat production, diversified agro ecological zone which encompasses lowland, midland and highland and its varied production system. The total surface area of the district is 434,280ha; with the mean annual rainfall of 963mm, with bimodal and erratic distribution and temperature ranges from 14°C to 26°C [8].

Data Collection: Before starting goat characterization, a rapid field survey was conducted by a team of researchers to assess the distribution, population and composition of the goat in different agro ecology of the study areas. Three agro ecologies (lowland, midland and highland) were identified based on altitude and production system of the district. Three peasant associations were considered in each agro-ecologies based on their goat production potential. About 12 qualitative characters(head profile, ear formation, ear type, coat color pattern, coat color type, horn shape, horn orientation, ages, presence of wattle, ruff, bear and horn) and 11 quantitative morphological characters like live body weight (BWT), body condition score (BCS), heart girth (HG), wither height (WH), chest width (CW), pelvic width (PW), rump height (RH), rump length (RL), ear length (EL), horn length (HL) and scrotal circumference (SC) were collected from a total of 930 goats based on the standard description list developed [9, 10]. Goats were purposively grouped into 5 age categories based on dentition. These age groups were goats with no pairs of permanent incisors (0PPI) at weaning age below 12-14 months, one pair of permanent incisors (1PPI) at age of 15- 23 months, two pairs of permanent incisor (2PPI) at age of 24-35 months, three pairs of permanent incisors (3PPI) at age of

36-48 months and four pairs of permanent incisors (4PPI) at age of over 48 months [11] and sex groups (male and female). Body condition score (BCS) was assessed subjectively and scored using the 5 point scale (1= very thin, 2=thin, 3= average, 4=fat and 5=very fat/obese) for both sexes [12].

Data Analysis: Statistical package for social Science (SPSS) computer software SPSS ver.16 was applied to analyze qualitative data like sex ratio, age proportions and physical description as descriptive statistics [13]. The General Linear Model (GLM) procedures of SAS ver.9.2 were employed to analyze quantitative data and ascertain the effect of sex, site (agro ecology) and age [14]. Mean separation was undertaken when it was significant to reveal the difference between means using LSD method.

$$\text{Model } Y_{ijkl} = \mu + A_i + S_j + D_k + e_{ijkl}$$

where:

Y_{ijkl} = The observation on body weight and linear body measurements;

μ = Overall mean;

A_i = Fixed effect of agro ecology (i= lowland, midland and highland)

D_k = Fixed effect of dentition (k= 0PPI, 1PPI, 2PPI, 3PPI and 4PPI);

S_j = Fixed effect of sex (j = male, female) and

e_{ijkl} = Random error

RESULTS AND DISCUSSION

Goat Population Characterization: The average age of different category of goats in terms of the eruption of permanent pairs of incisors (PPI) was assessed. The present study revealed that the average ages of goat with 0PPI, 1PPI, 2PPI, 3PPI and 4PPI were around 7 ± 2.12 , 16.4 ± 4.19 , 27.11 ± 5.98 and 38 ± 6.86 and 50.83 ± 14.55 months, respectively. The result in the current study was in agreement with previous reports [15] who reported 12-18 month for eruption of 1PPI, 18 to 24 month for 2PPI, 24 to 33 month for 3PPI and 33 to 38 months for 4PPI. Approximately same age of eruption with the current study was reported as 15.5 months for 1PPI; 22.5 months for 2PPI; 28 months for 3 PPI and 39 months for the eruption of 4PPI [16]. The variation of eruption of incisors and corresponding age could be caused due to variation in breed, environment, feeding habit and production system.

Table 1: Goat flock proportion/structure by age and sex groups in different agro ecologies in a sampled open population

Age	Lowland			Midland			Highland			Overall		
	Male (%)	Female (%)	Total (%)	Male (%)	Female (%)	Total (%)	Male (%)	Female (%)	Total (%)	Male (%)	Female (%)	N (%)
0PPI	41(42.7)	53(24.2)	94(29.8)	60(51.7)	61(31.8)	121(39.3)	55(46.2)	50(26.6)	105(34.2)	156(47.1)	164(27.4)	320 (34.4)
1PPI	22(22.9)	34(15.5)	56(17.8)	25(21.6)	39(20.3)	64(20.8)	26(21.8)	41(21.8)	67(21.8)	73(22.1)	114(19.0)	187(20.1)
2PPI	12(12.5)	18(8.2)	30(9.5)	10(8.6)	27(14.1)	37(12.0)	16(13.4)	31(16.5)	47(15.3)	38(11.5)	76(12.7)	114(12.3)
3PPI	8(8.3)	42(19.2)	50(15.9)	11(9.5)	18(9.4)	29(9.4)	11(9.2)	34(18.1)	45(14.7)	30(9.1)	94(15.7)	124(13.3)
4PPI	13(13.5)	72(32.9)	85(27.0)	10(8.6)	47(24.5)	57(18.5)	11(9.2)	32(17.0)	43(14.0)	34(10.3)	151(25.2)	185(20.0)
Total	96 (30.5%)	219 (69.5%)	315 (33.9%)	116 (37.7)	192 (62.3)	308 (33.1)	119 (38.8)	188 (61.2)	307 (33.0)	331 (35.6)	599 (64.4)	930 (100)

The figures indicate the number of goat of each age and sex category

Table 2: Summary of the qualitative traits in the female and male Hararghe High land goat

Character and factor level	Female		Male		Total	
	N	%	N	%	N	%
Head profile						
Straight	589	98.3	324	97.9	913	98.2
Slightly convex	10	1.7	7	2.1	17	1.8
Ear formation						
Rudimentary	1	0.3	1	0.3	2	0.2
Short ear	36	6.0	26	7.9	62	6.7
Long ear	562	93.8	304	91.8	866	93.1
Ear type						
Semi pendulous	95	15.9	73	22.1	168	18.1
Horizontal	504	84.1	258	77.9	762	81.9
Coat color pattern						
Plain	425	71.0	229	69.2	654	70.3
Patchy	156	26.0	94	28.4	250	26.9
Spotted	18	3.0	8	2.4	26	2.8
Coat color type						
White	150	25.0	94	28.4	244	26.2
Black	99	16.5	46	13.9	145	15.6
Grey	84	14.0	46	13.9	130	14.0
Mixture of black, grey white	62	10.4	28	8.5	90	9.7
brown	204	34.1	117	35.4	386	34.5
Horn shape						
Straight	256	42.7	164	49.5	420	45.2
spiral	105	17.5	23	6.9	128	13.8
polled	238	39.7	144	43.5	382	41
Horn Orientation						
Rudimentary	2	0.3	2	0.6	4	0.4
Front/Up ward	63	10.5	22	6.6	85	9.1
Backward	296	49.4	164	49.5	460	49.5
Absent	238	39.7	143	43.2	381	41.0
Presence of Wattle						
Present	23	3.8	15	4.5	38	4.1
Absent	576	96.2	316	95.5	892	95.9
Presence of Ruff						
Present	0	0	3	0.9	3	0.3
Absent	599	100.0	328	99.1	927	99.7
Presence of Bear						
Present	84	14.0	120	36.3	204	21.9
Absent	515	86.0	211	63.7	726	78.1

N= number of goat considered

The goat flock structure in a randomly sampled population over households by age and sex in different agro ecologies were presented in Table 1. Concerning the

goat population structure by age, younger age groups (0PPI and 1PPI) were dominating the flock structure with a proportion of 34.6% 0PPI and 20.3% 1PPI. The older age



Fig. 1: Young male Hararghe highland goat



Fig 2: Adult female Hararghe highland goat

groups of goat 2PPI, 3PPI and 4PPI accounted 12.3%, 13% and 19.9%, respectively. The female and male ratio in the flock was in favor of females (X:Y) as females were kept for breeding. The proportions of kids were higher in the population and followed by breeding does. Similar reports were reported in Ethiopia for both goat and sheep indicating that herders keep more proportion of females than males [17, 18]. The number of males in a flock gets smaller as age advances. This could be attributed to the producers' preference to retain females in the flock for breeding and selling and castration of males is practiced to reduce feeding competition and costs and to increase production efficiency in terms of weight gain. However, the selling, slaughtering and castration of males at early age leads into negative selection. A similar observation was made in Nigeria reported in the forest deciduous zone of South Western Nigeria that, goat farmers kept more females than male goats because, majority of the males are preferably castrated or fattened for sale as meat and source of income to the owners in time of financial crisis before celebrating their first or second birth day [19].

Physical Categorical Characters: The proportion of morphological characters of Hararghe highland goat breed for both buck and does is presented in Table 2. Majority (70.3%) of the goat were with plain coat color pattern while the rest 26.9% and 2.8% were patchy and spotted coat color pattern, respectively. The breed is mainly dominated by brown (34.5%) (Fig. 1) and white (26.2%) (Fig. 2) coat color type followed by black (15.6%), grey (14%) and mixtures of black, white and grey (9.7%) coat

color. Coat color pattern in this study was in agreement with the studies conducted in Hararghe [20] and in Eritrea and part of Ethiopia [21] who had reported a plain coat pattern which was a dominant one. The coat color was deviated from the previous studies on this goat breed and it was reported that Hararghe highland goat were dominated by white (41%) and followed by brown (23%) coat color. The present study revealed a decreasing trend of white color in goats, which might be attributed to the selection and preference of goat owners toward brown and hornless goats. The preference to some color might be attributed to market demand for some colors.

The majority (98.2%) of the goat had straight head profile and few goats were with slightly convex head profile (1.8%). Majority of the goat possess horizontally oriented ears (81.9%) and long eared (93.1%). Goats with semi pendulous ear type (18.1%) and short ears (6.7%) were less in proportions in the flock. There is also variability in horn possession where more than half of the goat had horn (56.8%) of which (45.2%) of goats were with straight and 13.8% of the goats shown a spiral horn shape and 41% goats were polled. The present study is in agreement with the earlier report 37% goats were polled [20]. Almost all (95.9 %) goats had no wattle and 99.7% of the goats had no ruff and 78.1% had no bear. The absence of ruff and the small proportion of wattle were also reported earlier [20]. The proportion of bearded male goat in this study was less than previous report which is 72% [20]. This might be attributed to preferential selection by the farmers toward a given trait, inbreeding and interbreeding.

Effect of Sex, Dentition Pattern and Agro-ecology on Live Body Weight and Morphological Measurements

Effect of Agro Ecology: Least squares means \pm standard errors of body weight (kg), body condition score and linear body measurements (cm) for agro ecology are presented in Table 3 and Table 4. Age and sex consistently showed a significant effect ($p < 0.01$) body weight, linear body measurements and body condition score (Table 3 and 4). Agro ecology has an effect ($p < 0.01$) on BWT, HG, BCS, RL, BL and CW and did not show a significant effect ($p < 0.01$) on WH, PW, RH, EL, HL and SC. The interaction effect of age with sex was significant for all traits ($p < 0.01$), except CW and HL.

Effect of Age: Live body weight of goats increased with increasing rate until the eruption of the first pairs of incisors (1PPI) which is at the age of about 16 months. The increase in body weight was small between 1PPI to

Table 3: LSM±SE body weight BWT(kg), body condition(BCS), body length(BL), heart girth(HG), wither height(HW) and chest width(CW) for agro ecology (AE), sex, age and sex by age interaction for Hararghe Highland Goat

Effects and Level	BWt (N=930)	BCS (N=930)	BL (N=930)	HG (N=930)	WH (N=930)	CW (N=930)
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	23.9±4.66	2.72±0.59	55.9±5.03	65.2±5.14	59.0±4.76	14.8±3.95
CV	20.19	21.8	9.10	7.80	8.08	26.71
R ²	0.72	0.15	0.64	0.73	0.60	0.24
Age group	***	***	***	***	***	***
0PPI	15.1±0.24 ^a	2.8±0.03 ^a	48.5±0.27 ^a	56.1±0.27 ^a	52.6±0.25 ^a	12.8±0.21 ^a
1PPI	23.1±0.41 ^b	2.8±0.05 ^b	56.0±0.45 ^b	65.6±0.46 ^b	60.3±0.42 ^b	14.7±0.35 ^b
2PPI	27.4±0.47 ^c	2.85±0.06 ^b	60.9±0.51 ^c	70.4±0.52 ^c	63.0±0.48 ^c	15.9±0.40 ^c
3PPI	32.2±0.50 ^d	2.9±0.06 ^b	64.4±0.54 ^d	76.0±0.56 ^d	66.7±0.51 ^d	16.8±0.42 ^{cd}
4PPI	35.5±0.44 ^e	3.1±0.05 ^c	64.9±0.48 ^d	76.9±0.49 ^d	67.4±0.46 ^d	17.9±0.38 ^d
AE	**	**	**	**	ns	**
lowland	25.9±0.29 ^a	2.8±0.04 ^a	57.6±0.36 ^a	67.9±0.37 ^a	61.9±0.34	14.4±0.28 ^a
midland	26.9±0.29 ^b	2.9±0.04 ^b	59.2±0.37 ^b	69.5±0.37 ^b	61.6±0.35	14.7±0.28 ^a
Highland	27.1±0.28 ^b	2.87±0.04 ^b	59.9±0.35 ^b	69.7±0.35 ^b	62.5±0.33	17.9±0.27 ^b
Sex	***	***	***	***	***	***
Male (M)	29.6±0.31	3.04±0.04	60.7±0.34	71.4±0.35	64.4±0.33	16.3±0.26
Female (F)	23.7±0.21	2.68±0.03	57.2±0.23	66.6±0.23	59.6±0.21	15.02±0.18
AGE*Sex	***	***	***	***	***	ns
0PPI, M	15.5±0.36 ^a	2.6±0.05 ^a	48.7±0.38 ^a	56.4±0.39 ^a	52.9±0.36 ^a	13.2±0.3
0PPI, F	14.6±0.34 ^a	2.6±0.04 ^a	48.3±0.37 ^a	55.7±0.38 ^a	52.4±0.35 ^a	12.5±0.29
1PPI, M	24.6±0.66 ^b	2.9±0.08 ^{bc}	56.8±0.72 ^b	67.3±0.73 ^b	62.4±0.68 ^b	14.8±0.56
1PPI, F	21.6±0.50 ^c	2.8±0.06 ^{ab}	55.2±0.54 ^b	64.0±0.55 ^c	58.2±0.51 ^c	14.7±0.42
2PPI, M	29.5±0.77 ^d	3.0±0.10 ^{bc}	62.4±0.83 ^c	72.1±0.85 ^{df}	65.4±0.79 ^{de}	16.7±0.65
2PPI, F	25.2±0.55 ^b	2.7±0.07 ^{ab}	59.5±0.59 ^d	68.7±0.60 ^b	60.6±0.56 ^c	15.0±0.46
3PPI, M	37.5±0.86 ^e	3.1±0.11 ^c	67.9±0.93 ^e	80.7±0.95 ^e	70.4±0.88 ^f	17.5±0.72
3PPI, F	27.0±0.53 ^f	2.7±0.07 ^{ab}	60.8±0.57 ^{cd}	71.4±0.58 ^d	62.9±0.54 ^{bc}	16.1±0.44
4PPI, M	40.7±0.80 ^g	3.7±0.10 ^d	67.6±0.87 ^e	80.5±0.89 ^e	70.8±0.82 ^f	19.1±0.68
4PPI, F	30.3±0.40 ^d	2.6±0.05 ^a	62.2±0.43 ^c	73.4±0.44 ^f	64.0±0.40 ^g	16.7±0.33

Means with different superscripts (a-h,defg) in same column and class are statistically different (p<0.05).ns= non significant; 0PPI, 1PPI, 2PPI, 3PPI and 4PPI = 0,1,2,3 and 4 pair of permanent incisor, respectively.

3PPI and the increase was at decreasing rate until 4PPI at which at about 50 months age. The rate of increase in body weight was minimal as the goat advances in age and attributed to the attainment of mature weight at later age (3PPI and 4PPI). Literature stated that there is a cyclical change in does weight around the breeding cycle and the younger does are gaining faster than older one [22]. A sharp decline in body weight and other linear traits were recorded between age groups of 3-4 years and 4-5 years in West African Dwarf goat [19] which is in accordance with the current study.

Effect of Sex: The least squares means and standard errors for the effect of sex, on body weight, body condition and other body measurements are presented in Tables 3 and Table 4. The mean BWt, BCS, HG, BL, WH, CW, PW, RH, RL, EL and HL of females are 23.74±0.21kg, 2.68±0.03, 66.6±0.23cm, 57.2±0.23cm,

59.6±0.21cm, 15.02±0.18cm, 13.3±0.15cm, 63.7±0.19cm, 14.3±0.06 cm, 13.1±0.07cm and 8.47±0.15cm, respectively. The corresponding values for males were 29.6±0.31kg, 3.04±0.04, 71.4±0.35cm, 60.7±0.34cm, 64.4±0.33cm, 16.3±0.26cm, 13.6±0.22cm, 68.8±0.29cm, 14.9±0.09cm, 13.07±0.07cm and 10.25±0.27cm, respectively. The results in the current study for BWt, WH, HG, EL and HL for both sexes were lower than the previous work for same breed of goat [20]. This might be attributed to the consideration of all goat flock structures composed of all age groups from young to old, gradual decline in flock size which ultimately induce inbreeding, indiscriminate breeding practices, random selection of goat owners against some traits such horn and the apparent practices of farmers crossing blood related goat in a flock intended to multiply the breed type that they thought better. Body weight and all the body measurements were significantly affected by sex groups except PW and EL.

Table 4: LSM±SE pelvic width(PW), rump height(RH), rump length(RL), ear length(EL), horn length(HL), scrotal circumference(SC) for effects of agro ecology(AE), sex, age and interaction

Factors and Level	PW (N=930)	RH (N=930)	RL (N=930)	EL (N=930)	HL (N=550)	SC (N=240)
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	12.8±3.27	63.0±4.27	14.0±1.31	12.8±1.12	8.33±2.59	18.82±4.97
CV	25.44	6.76	9.4	8.7	31.26	26.4
R ²	0.20	0.67	0.56	0.24	0.58	0.20
Age group	***	***	***	***	***	***
0PPI	11.1±0.17 ^a	56.4±0.23 ^a	12.4±0.07 ^a	12.1±0.05 ^a	5.1±0.18 ^a	17.26±0.39 ^a
1PPI	12.9±0.29 ^b	64.5±0.38 ^b	14.0±0.12 ^b	12.9±0.10 ^b	8.3±0.35 ^b	22.53±0.75 ^b
2PPI	13.9±0.33 ^c	67.7±0.43 ^c	14.9±0.13 ^c	13.0±0.11 ^b	10.2±0.38 ^c	28.88±1.04 ^b
3PPI	14.2±0.35 ^c	71.3±0.46 ^d	15.3±0.14 ^d	13.7±0.12 ^c	11.3±0.42 ^d	-
4PPI	15.1±0.31 ^d	71.3±0.41 ^d	16.5±0.13 ^c	13.6±0.11 ^c	12.0±0.38 ^d	-
AE	ns	ns	**	ns	ns	ns
Lowland	13.1±0.23	65.8±0.31	14.5±0.09 ^a	13.0±0.08	9.2±0.3	21.43±0.811
Midland	13.7±0.24	66.5±0.31	14.9±0.1 ^b	13.1±0.07	9.5±0.28	20.73±0.75
Highland	13.5±0.22	66.38±0.29	14.4±0.09 ^a	13.1±0.07	9.3±0.22	20.51±0.76
Sex	ns	***	***	ns	***	-
Male (M)	13.6±0.22	68.8±0.29	14.9±0.09	13.07±0.07	10.25±0.27	-
Female(F)	13.3±0.15	63.7±0.19	14.3±0.06	13.04±0.05	8.47±0.15	-
Age*Sex	***	***	***	**	ns	-
0PPI, M	10.6±0.25 ^a	56.6±0.33 ^a	12.4±0.1 ^a	12.1±0.08 ^a	6.4±0.25	-
0PPI, F	11.5±0.24 ^b	56.2±0.31 ^a	12.5±0.1 ^a	12.2±0.08 ^a	3.8±0.27	-
1PPI, M	13.0±0.47 ^{cef}	66.0±0.61 ^{bf}	14.2±0.19 ^b	12.9±0.16 ^b	9.2±0.59	-
1PPI, F	12.8±0.35 ^c	63.0±0.45 ^c	13.8±0.14 ^b	13.0±0.12 ^b	7.3±0.36	-
2PPI, M	14.2±0.54 ^{def}	70.3±0.71 ^d	15.2±0.22 ^{cd}	12.7±0.18 ^b	10.9±0.62	-
2PPI, F	13.7±0.38 ^{cd}	65.0±0.50 ^b	14.5±0.16 ^b	13.2±0.13 ^{bde}	9.4±0.44	-
3PPI, M	14.3±0.6 ^{gh}	76.0±0.79 ^e	15.6±0.24 ^c	13.9±0.21 ^c	12.5±0.76	-
3PPI, F	14.1±0.37 ^{efg}	66.6±0.48 ^{fg}	15.0±0.15 ^d	13.4±0.13 ^{df}	10.2±0.37	-
4PPI, M	15.7±0.56 ^h	74.9±0.74 ^e	17.3±0.23 ^e	13.7±0.19 ^{cf}	12.3±0.71	-
4PPI, F	14.5±0.28 ^{gh}	67.7±0.36 ^g	15.6±0.11 ^c	13.4±0.09 ^{ef}	11.7±0.27	-

Means with different superscripts (abcdefgh) within the same column and class are statistically different (p <0.05). Ns = non significant; 0 PPI = 0 pair of permanent incisors; 0PPI, 1PPI, 2PPI, 3PPI and 4PPI = 0,1,2,3 and 4 pair of permanent incisor.

All the body measurements in male goats were consistently higher (p<0.001) than females for all variables. The sex related differences might be partly a function of the sex differential hormonal effect on growth [23]. It was reported that, 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 [24].

Effect of Sex by Age Groups Interaction: The interaction effect of sex and age group was significant (p<0.01) for BWT, BC, BL, HG, WH, PW, RH, EL and RL; whereas CW and HL was not significant (p<0.05). The magnitude of least square mean and standard error of live body weight and other linear body measurement considered by this study for each combination of sex and age group interaction were given in Table 3 and Table 4. In all age groups males were heavier (p<0.001) than females except at the youngest age group (0PPI) which was the same for both male and female. BWT reported for Hararghe highland male goat in this study is similar with the one

reported for male goat around Metema district for all age group (i.e. 1PPI=27.5kg, 3PPI=39.0kg and 4PPI=39.2kg) except at age of 2PPI (35.22kg); but it is quite less for female in all age groups 1PPI, 2PPI, 3PPI and 4PPI with values of 26.83, 32.28, 34.6 and 33.96 kg [25].

CONCLUSION AND RECOMMENDATION

Hararghe highland goats are the predominant breeds in the study areas with high preference by the producers. Hararghe highland goats have shown inferior performance in body weight and other linear body measurements as compared to the previous study conducted before two decades on the same breeds of goat that might be because of environmental stress, feeding system, prevailing breeding practices and management. Therefore, attention should be given for their improvement, conservation, breeding management and for proper utilization to further explore the potential of this genetic material through improving genetic and husbandry management.

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