# Phenotypic Characterization of Indigenous Sheep Types in Northern Ethiopia

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**Abstract**
This study was aimed to generate basic information on physical characteristics of indigenous sheep types under farmer's management condition in East Gojam zone. Multistage purposive sampling was employed based on the potential of sheep production. Linear body measurements were taken from 630 mature sheep (63 males and 567 females). Dentition was used to estimate the age of sheep as age group one (1pairs of permanent incisors), age group two (2pairs of permanent incisors) and age group three and above (≥3pairs of permanent incisors). Both qualitative and quantitative data were analyzed using SAS. Most East Gojam sheep populations were characterized by plain coat color pattern with reddish coat color, white color, smooth hair type and straight head profile. Moderate (0.57) relationship between chest girth and body weight was observed in female, while the moderate (0.7) relationship for male was observed between height at withers and body weight. Age by sex interaction had significant effect ($p<0.05$) on body weight. But the interaction effect ($p>0.05$) were not observed in most linear measurements (Body Length, Rump Length, Canon Bone Length, Canon Bone Circumference and Ear Length) implying that these parameters were not affected by the sex-age interaction effect in this particular study. The regression analysis was undertaken to predict body weight from linear body measurements indicates that body weight, in most of the cases, could be predicted with a higher level of accuracy from more than one independent variables (Chest girth, height at wither and body length) in combinations in this particular study.
**Keywords**: Characterization, live body weight, linear body measurements, East Gojam Zone

## Introduction

The livestock sector in Ethiopia play significant role in the national economy. It contributes 15-17% and 35-49% of the total and agricultural Gross Domestic Product (GDP), respectively and provides livelihood for 37-87% of the population (CSA, 2011). The sector also accounts for 12–15% of total export earnings, the second in order of importance. Hides, skins and leather products made up 7.5% of the total export value whereas live animals accounted for 3.4%. However, in recent years official export has been declining while illegal export has been increasing (CSA, 2011). Ethiopia's sheep population, estimated to be 25.5 million heads, is found widely distributed across the diverse agro-ecological zones of the country (CSA, 2013). It has been reported that about 75% of the total sheep population are kept in small scale mixed farms in the highlands, which cover regions of over 1500 meter above sea level and receive over 700 mm of annual rainfall, while the remaining 25% are found in the lowlands (Markos, 2006). Breed diversity is high in peripheral and remote areas of the country (Solomon, 2008). In order to make best use from sheep keeping operation, it is important and a prerequisite to have a comprehensive understanding of the whole situation through assessing the production environment, the production system, productive and adaptive characteristics of the sheep breeds (Sisay, 2010).

Genetic improvement is one way to increase the productivity of the sheep resource in the country. The essential procedure for genetic improvement of livestock involves identification of the breeds or strains of livestock and the type of environment in which they are kept, description of the breed characteristics, their adaptation as well as production potentials in those environments (Workneh Ayalew and J. Rowlands, 2004). Moreover, in current scenarios for successful improvement programs, compatibility of the genotypes with the farmers' breeding objectives and the production systems is crucial (Markos, 2006). Despite low level of productivity, which accounted for several factors such as genotype, institutional, environmental and infrastructural constraints, indigenous sheep breeds have a great potential to contribute more to the livelihood of people in low input, smallholder, and pastoral production systems (Kosgey and Okeyo, 2007). Thus, it is urgent to improve the low productivity to satisfy the increasing demand for animal protein, improve the livelihood of livestock keepers and economic development of the country at large.

East Gojam zone, where this study has been done, possess probably most diversified sheep populations. According to Sisay (2009) indigenous sheep breeds in the Amhara national regional state morphological characters measured showed considerable variations within the 11 locally known sheep populations.

Further more information is scanty to show sheep types, found in east Gojam zone. In line with these, updating of the previous sheep characterization result is vital since genetic resources and production systems are not static (Solkner *et al.,* 1998). Thus, the objective of this study was to phenotypically characterize sheep types of East Gojam Zone using linear body measurement and qualitative physical characteristics.

**Materials and method**

**Description of the Study Area**

The study was conducted in East Gojam zone. It is 298 km from Addis Ababa and 265 km from the capital city Bahir Dar. The farming system practiced in the study area was mixed crop-livestock production system. The area consists of different livestock composition. According to CSA (2013), the study site had 1,844,674 Cattle, 1,142,377 Sheep, 394,402 Goat, and 98,726 Horse, 358,934 Donkey, 14,239 Mules, 1,151,578 Poultry, 838 Camel and 125,354 Bee hives. The site was selected for morphological characterization of sheep types because it is mainly dominated by sheep production next to cattle and poultry production (CSA, 2013). The study area is mainly characterized by mixed farming system (crop-livestock) in which crop takes the first position while livestock production is secondary to crop farming practice.

The capital of East Gojjam zone is Debremarkos which is situated at an altitude of 2498 masl, longitude 37 $^{O}$ 43' 47.2'' E and latitude 10 $^{O}$ 20' 19.7'' N. Agro ecologically the area is traditionally divided into four climatic zones; 41.41% *Woinadega*, 35.55% *Dega*, 15.72% *Kolla* and 5.32% *Wurich* (RDOEGZ, 2011). The mean annual average temperature and rain ranges 7.5-25 $^{O}$C and 900-1800 mm, respectively.

**Sampling method**

The sampling method employed for this study was multistage purposive sampling technique, which was based on the potential of sheep production in the zone. Discussions were held with zonal and district agricultural experts and development agents to know about the distribution of East Gojam sheep types. Then distribution of East Gojam sheep types were used to select sample districts for morphological characterization. The actual survey included single visit to a sampling site during which qualitative and quantitative measurements were made on mature sheep.

East Gojam Zone has 18 districts from which 3 districts (Gozamen, Sinan and Hulet eju) were selected purposively based on distribution of Sheep population. From each districts, three Peasant Associations (total of 9 Peasant Association) were selected based on the sheep population potential. Body weight and linear measurements were taken from a total of 630 mature sheep (210 from each district and 70 per Peasant Association). Within each Peasant Association, measurements were made on individual sheep from randomly selected flocks until the target number of sample animals is reached. Linear body measurements were made using measuring tape while live body weight were taken using suspended spring balance having 50 kg capacity. For qualitative traits visual observations were made following breed morphological characteristics descriptor list of FAO (2011) and qualitative traits were recorded from total of 630 mature sheep (210 from each district and 70 per Peasant Association).

**Data collection procedures**

Visual observations of qualitative traits were made and morphological features were recorded based on breed morphological characteristics descriptor list of FAO (2011) for phenotypic characterization of sheep. Each animal were identified by its sex, dentition and sampling site. Dentition record was included, as this was the only reliable means to estimate the approximate age of an animal. Ages of the animals were estimated from dentition class following the procedure described by Wilson and Durkin (1984). Adult sheep was classified into three age groups as one pair of permanent incisors (1PPI), two pairs of permanent incisors (2PPI), and three and above pairs of permanent incisors (≥3PPI) following the description of African sheep (Wilson and Durkin, 1984). The data collected from each study site were checked for any error and corrected during the study period, coded and entered into computer for further analysis.

**Statistical Data Analysis**

Quantitative and qualitative data generated from on farm linear body measurement and observations were analyzed using statistical analysis system (SAS, release 9.2, 2008) and described using SAS software.

General linear model procedures (PROC GLM) of the Statistical Analysis System (SAS 9.2., version, 2008) were employed for quantitative variables to detect statistical differences among sample sheep populations. 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. Scrotum circumference was analyzed by fitting age group and district as fixed factor. Least square means with their corresponding standard errors were calculated for each body trait over district, sex, age and age by sex interaction. Chi-square ($\chi^2$) test was carried out as it is appropriate to assess the statistical significance among categorical variables.

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Model used for the least square mean analysis in females and males except scrotal circumference was:

$Y_{ijk} = \mu + A_i + B_j + S_k + (BxS)_{jk} + e_{ijk}$

Where: $Y_{ijk}$ = Observed body weight or linear measurements

$\mu$ = Overall mean

$A_i$ = the fixed effect of $i^{th}$ district (i = Gozamen, Sinan and Hulet eju

$B_j$ = the fixed effect of $j^{th}$ age classes (j = 1PPI, 2PPI, ≥3PPI)

$S_k$= the fixed effects of $k^{th}$ sex (k= male, female)

$E_{ijk}$= random residual error

Model used for the least square mean analysis in males for scrotal circumference was:

$Y_{ij} = \mu + A_i + S_j + e_{ij}$

Where: $Y_{ij}$ = Observed body weight

$\mu$ = Overall mean

$A_i$ = the fixed effect of $i^{th}$ district (i = Gozamen, Sinan and Hulet eju)

$S_j$ = the fixed effect of $j^{th}$ age classes (j = 1PPI, 2PPI, ≥3PPI)

$E_{ij}$= random residual error

Parameters considered for male were sheep live body weight and linear body measurements; Pelvic Width (PW), Body Length (BL), Chest Girth (CG), Height at Wither (HW), Rump Width (RW), Rump Length (RL), Canon Bone Length (CBL), Canon Bone Circumference (CBC), Ear Length (EL), Rump Height (RH), Scrotal Circumference (SC), whereas Scrotum Circumference (SC) was excluded for the analysis means of parameters measured on female sheep.

Correlations of live body weight with different body measurement under consideration were computed for each sex using Pearson correlation coefficient. Stepwise regression procedure of SAS was used to regress body weight for males in pooled age group using PROC REG procedure of SAS in order to determine the best fitted regression equation for the prediction of live body weight. Similarly, stepwise regression equation was also employed for females in pooled age group by excluding SC from the model. Best fitting models were selected based on higher coefficient of determination ($R^2$) and smaller mean square error, the Mallows C parameters C (p), Alkaike's Information Criteria (AIC) and Schwarz Bayesian Criteria (SBC). The following models were used for the estimation of body weight from linear body measurements.

For male:

$y \quad \beta \quad \beta_1X_1 \quad \beta_2X_2 \quad \ldots\ldots\ldots\ldots\ldots + \beta_{11}X_{11} + e_j$

y = the response variable (live body weight)

$\beta_0$= the intercept

$X_1 \ldots X_{11}$ are the explanatory variables (PW, BL, CG, HW, RW, RL, CBL, CBC, EL, RH, and SC)

$\beta_1 \ldots, \beta_{11}$ are regression coefficients of the variables $X_1 .., X_{11}$

ej = random error

For female:

$y \quad \beta \quad \beta_1X_1 \quad \beta_2X_2 \quad \ldots\ldots\ldots\ldots. \quad + \beta_{10}X_{10} + e_j$

Where:

y = the dependent variable body weight

$\beta$ = the intercept

$X_1 \ldots X_{10}$ are independent variables (PW, BL, CG, HW, RW, RL, CL, CC, EL, and RH).

$\beta_1 \ldots \beta_{10}$ are regression coefficients of the variable $X_1 .., X_{10}$

ej = random error

## Results and discussions

### Qualitative traits of the sample population

There is an increasing interest in the characterization of African small ruminant populations because of their major role in the maintenance of genetic resources as the basis of future improvement at both the production and the genetic levels (Nsoso et al., 2004). Details of some morphological traits of east Gojam zone sheep population are presented in Table 1. The overall observed coat color patterns for both sex were 57.14% plain, 28.73% patchy, 8.25% spotty and 5.87% pied and the most frequently observed predominant coat color were red 20.48%, white 20.16% and white and red 19.21%. The hair type of most of the sample populations of males and females were smooth hair type (50.79%) followed by coarse hair type (27.78%) and smooth and long straight hair type (8.41%) which is mainly observed in males. East Gojam zone sheep type was characterized by straight head profile (52.54%) followed by slightly convex (36.98%) which was mainly common in the case of male sheep. About 18.25% of sheep studied have curved horn shape while few numbers (1.27%) have straight horn shape. The tail length observed were medium with most commonly observed fat type of tail (15.87%) followed by short tail (11.59%) and rarely long tail (3.97%) were recorded.

Almost all of the sample populations of males (100%) and females (86.67%) did not possess toggle but few females in all the study districts had toggle. Males are mostly horned than females. The ear form of East Gojam sheep were lateral (96.03%) and rudimentary type (3.97%) while in all the study districts, the majority of males have lateral ear form.

The chi-square test for assumption of equal proportion of categorical variables in three (Gozamen, Sinan and Hulet eju) sample sheep population indicated that among the variables considered in this study coat pattern, coat color type, hair type, head profile, horn nature, horn orientation, horn shape, tail length and toggle were found to significantly ($P<0.05$) differ within the sample sheep population while ear form and basic temperament were found to be non-significantly ($p>0.05$) differ within the sample sheep population.

Similar to this study, Wossenie (2012) reported that Hararghe Highland sheep had coat color pattern (52.2%) plain and (47.8%) patchy with the most frequently observed predominant coat color being light brown (35.3%), light brown with white patch (29.1%) and white (23.9%) and in same year Bosenu (2012) reported that out of the sampled 155 ewes, 57.42% were plain, 38.71% patchy and 3.8% had spotted coat pattern which was almost similar with this study. The same author also reported that majority of female 71.61% and entire male 100% didn't have toggle which also agree with this study.

A multiple correspondence analysis was carried out on the nine qualitative traits recorded and a bi-dimensional graph representing the association among the different categories of qualitative traits is presented in figure 1. The interpretation is based on points found in approximately the same direction from the origin and in approximately the same region of the space.

From the figure 1 it can be seen that 18.86% of the total variation is explained by the first two dimensions; 11.27% by the first and 7.59% by the second dimensions. On the identified dimensions, the sheep population in Gozamen district was clustered together with white and black color, black color, brown color, red color, long straight hair, modified tail shape, markedly concave head profile and with no horn.

In Hulet eju district the sheep population was closely associated with patchy coat color pattern with red and white coat color, coarse hair type, slightly concave head profile, absence of horn and characterized by presence of toggle but in Sinan district sheep population was closely associated with plain and spotty coat color pattern, white color, fawn, red coat color, white and black, smooth hair type, short, medium and long tail length, straight/flat and slightly convex head profile, smooth and long straight hair, and also characterized by absence of toggle. On the dimensions identified, sheep populations from the three districts share some common characteristics. This might be due to the geographic proximity of the three districts. The figure for typical east Gojam zone sheep ram and ewe is presented in figure 2, respectively.

Table 1. Morphological (physical) features of East Gojam zone sheep types.

| Morphological traits | descriptors | Districts | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Gozamen | | Sinan | | Hulet eju | | Overall N (%) |
| | | Female N (%) | Male N (%) | Female N (%) | Male N (%) | Female N (%) | Male N (%) | |
| Coat color pattern | Plain | 115(60.84) | 8(38.00) | 96(50.79) | 8(38.00) | 115(60.84) | 18(85.71) | 360(57.14) |
| | patchy | 55(29.10) | 12(57.14) | 69(36.5) | 3(14.28) | 40(21.16) | 2(9.52) | 181(28.73) |
| | Spotted | 15(7.94) | 1(4.76) | 15(7.94) | 9(42.86) | 11(5.82) | 1(4.76) | 52(8.25) |
| | Pied | 4(2.12) | - | 9(4.76) | 1(4.76) | 23(12.17) | - | 37(5.87) |
| | **$\chi^2$ Value** | | | | | | | **31.7852*** |
| Coat color type | white | 33(17.46) | 4(19.00) | 47(24.87) | 5(23.8) | 30(15.87) | 8(38.00) | 127(20.16) |
| | black | 6(3.17) | - | 7(3.70) | - | 13(6.88) | 1(4.76) | 27(4.29) |
| | brown | 47(24.87) | 1(4.76) | 11(5.82) | - | 14(7.40) | 1(4.76) | 74(11.75) |
| | fawn | - | - | 1(0.53) | - | 4(2.12) | - | 5(0.79) |
| | Grey | 4(2.12) | - | 9(4.76) | 1(4.76) | 23(12.17) | - | 37(5.87) |
| | Red | 27(14.29) | 3(14.29) | 31(16.40) | 3(14.29) | 57(30.16) | 8(38.00) | 129(20.48) |
| | red and white | 34(17.98) | 7(33.33) | 45(23.80) | 2(9.52) | 31(16.40) | 2(9.52) | 121(19.21) |
| | red, white and black | 15(7.94) | 1(4.76) | 15(7.94) | 9(42.86) | 6(3.17) | 1(4.76) | 47(7.46) |
| | white and black | 23(12.17) | 5(23.8) | 23(12.17) | 1(4.76) | 11(5.82) | - | 63(10.00) |
| | **$\chi^2$ Value** | | | | | | | **97.7487*** |
| Hair type | course | 80(42.33) | 3(14.29) | 48(25.39) | - | 41(21.69) | 3(14.29) | 175(27.78) |
| | smooth | 72(38.00) | 17(80.95) | 90(47.62) | 5(23.8) | 125(66.14) | 11(52.38) | 320(50.79) |
| | shinny/glossy | 6(3.17) | - | 5(2.64) | 1(4.76) | 5(2.64) | 1(4.76) | 18(2.86) |
| | long straight hair | 7(3.70) | - | 7(3.70) | - | 4(2.12) | 3(14.29) | 21(3.33) |
| | curly rough hair/dull | 5(2.65) | 1(4.76) | 6(3.17) | - | 6(3.17) | - | 18(2.86) |
| | course and lsh | 13(6.88) | - | 5(2.64) | 1(4.76) | 5(2.64) | 1(4.76) | 25(3.97) |
| | smooth and lsh | 6(3.17) | - | 28(14.82) | 14(66.67) | 3(1.58) | 2(9.52) | 53(8.41) |
| | **$\chi^2$ Value** | | | | | | | **82.2735*** |
| Head profile | slightly concave | 31(16.40) | 2(9.52) | 16(8.46) | 1(4.76) | 16(8.47) | - | 66(10.48) |
| | straight | 58(30.68) | 5(23.8) | 97(51.32) | 6(28.57) | 149(76.19) | 16(76.19) | 331(52.54) |
| | slightly convex | 100(52.9) | 14(66.67) | 76(40.2) | 14(66.67) | 24(12.70) | 5(23.80) | 233(36.98) |
| | **$\chi^2$ Value** | | | | | | | **105.6025*** |
| Horn shape | polled | - | - | 4(2.12) | 2(9.52) | - | - | 6(0.95) |
| | straight | 5(2.65) | 1(4.76) | 2(1.05) | - | - | - | 8(1.27) |
| | curved | 16(8.47) | 6(28.57) | 45(23.80) | 18(85.71) | 18(9.52) | 12(57.14) | 115(18.25) |
| | spiral | 1(0.52) | - | 1(0.52) | - | 4(2.11) | - | 6(0.95) |
| | no horn | 167(88.36) | 14(66.67) | 137(72.49) | 1(4.76) | 167(88.36) | 9(42.86) | 495(78.57) |
| | **$\chi^2$ Value** | | | | | | | **53.3465*** |
| Horn orientation | lateral | 7(3.70) | 1(4.76) | 3(1.59) | - | 7(3.70) | - | 18(2.86) |
| | forward | 7(3.70) | 3(14.20) | 29(15.34) | 5(23.8) | 6(3.17) | 6(28.57) | 56(8.89) |
| | upright | 1(0.52) | - | - | - | - | - | 1(0.16) |
| | Backward | 7(3.70) | 3(14.20) | 19(10.00) | 15(71.43) | 9(4.76) | 6(28.57) | 59(9.37) |
| | no horn | 167(88.36) | 14(66.67) | 138(73.00) | 1(4.76) | 167(88.36) | 9(42.86) | 496(78.73) |
| | **$\chi^2$ Value** | | | | | | | **46.0054*** |
| Horn nature | natural | 22(11.64) | 7(33.33) | 48(25.39) | 18(85.7) | 22(11.64) | 12(57.14) | 129(20.48) |
| | modified | - | - | 3(1.59) | 2(9.52) | - | - | 5(0.79) |
| | no horn | 167(88.36) | 14(66.67 | 138(73) | 1(4.76) | 167(88.36) | 9(42.86) | 496(78.73) |
| | **$\chi^2$ Value** | | | | | | | **35.1111*** |
| Tail length | short | 4(2.12) | 2(9.52) | 14(7.40) | 11(52.38) | 39(20.63) | 3(14.29) | 73(11.59) |
| | medium | 7(3.70) | 10(47.6) | 23(12.17) | 5(23.8) | 39 (20.63) | 16(76.19) | 100(15.87) |
| | Long | 4(2.12) | 3(14.29) | 5(2.65) | 3(14.29) | 8(4.23) | 2(9.52) | 25(3.97) |
| | modified | 174(92) | 6(28.57) | 147(77.78) | 2(9.52) | 103(54.49) | - | 432(68.58) |
| | **$\chi^2$ Value** | | | | | | | **71.0048*** |
| Ear form | Erect | - | - | - | - | - | - | - |
| | lateral | 183(96.83) | 20(95.24) | 183(96.83) | 19(90.48) | 181(95.77) | 19(90.48) | 605(96.03) |
| | Rudimentary | 6(3.17) | 1(4.76) | 6 (3.17) | 2(9.52) | 8(4.23) | 2(9.52) | 25(3.97) |
| | **$\chi^2$ Value** | | | | | | | **$0.5831^{NS}$** |
| Toggle | present | 45(23.80) | - | 22(11.65) | - | 17(8.99) | - | 84(13.33) |
| | absent | 144(76.20) | 21(100) | 167(88.36) | 21(100) | 172(91.0) | 21(100) | 546(86.67) |
| | **$\chi^2$ Value** | | | | | | | **18.3791*** |
| Basic temperament | Docile | 170(89.94) | 19(90.48) | 166(87.83) | 21(10.00) | 174(92.06) | 21(100) | 571(90.63) |
| | Moderately tractable | 10(5.29) | 2(9.52) | 15(7.94) | - | 7(3.70) | - | 34(5.40) |
| | wild | 9(4.76) | - | 8(4.23) | - | 8(4.23) | - | 25(3.97) |
| | **$\chi^2$ Value** | | | | | | | **$0.5339^{NS}$** |

NB: N=number of households; Ns=non-significant;*P<0.05; Lsh= long straight hair

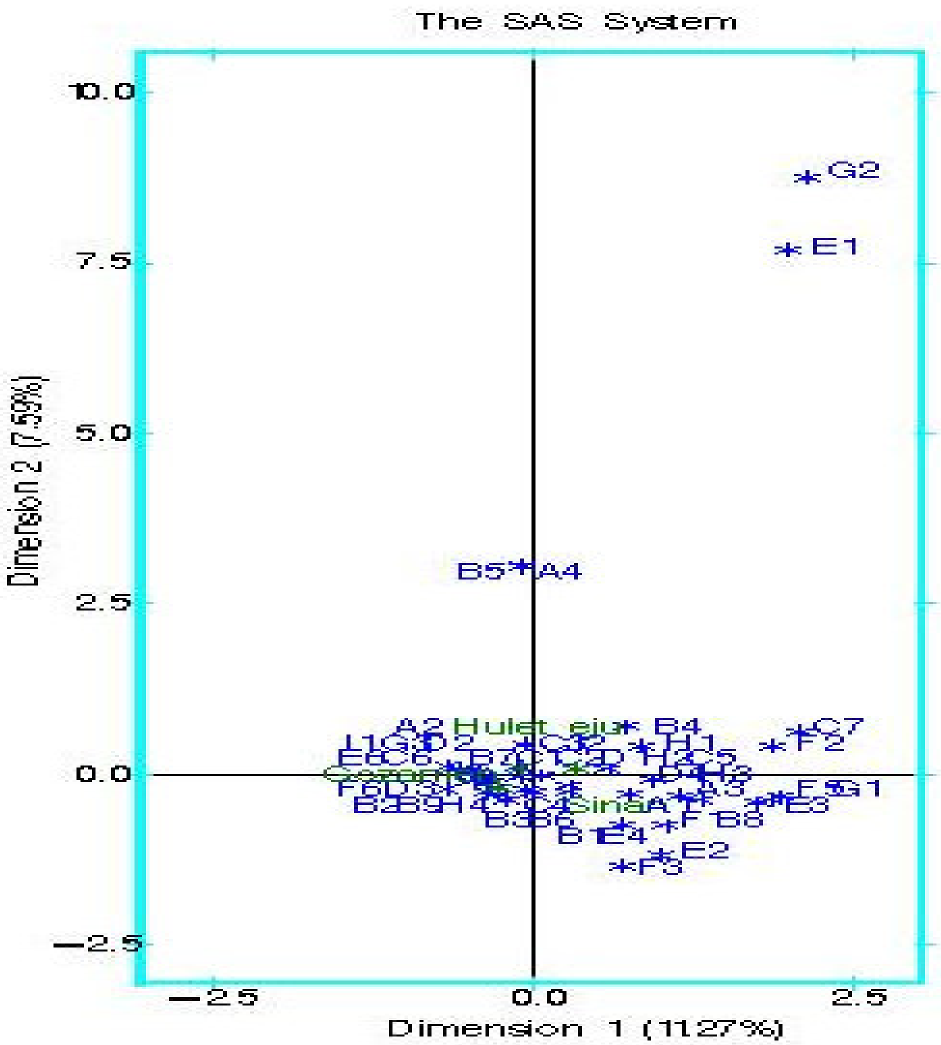


Figure 1. Bi-dimensional plot showing the associations among the categories of the different morphological variables considered

Legend for Figure 1

| Variable | Description |
|---|---|
| Coat color pattern | A1=Plain , A2=patchy, A3=spotty, A4=pied |
| Coat color type | B1=white, B2=black, B3=brown, B4= fawn, B5=Grey, B6=red, B7=roan(red and white), B8=red, white and black, B9=white and black |
| Hair type | C1=Coarse, C2=smooth, C3=glossy/shiny, C4=long straight hair, C5= curly rough hair and dull, C6=course and long straight hair C7=smooth and long straight hair |
| Head profile | D1= straight/flat, D2 = slightly concave, D3 = markedly concave, D4 = slightly convex, D5 = markedly convex |
| Horn shape | E1 = polled, E2 = straight, E3= curved, E4 = spiral, E5=No horn |
| Horn orientation | F1 = lateral, F2 = Forward, F3=upright, F4 = Drooping, F5 = Backward, F6=No horn |
| Horn nature | G1= Natural, G2 = Modified, G3=No horn |
| Tail length | H1 = short, H2=medium, H3=long, H4=tail modified |
| Toggle | I1=present, I2=absent |

Figure 2. Typical ram of Gozamen (left) and ewe of Sinan (right) districts

**Live body weight and linear body measurements**

Information on live body weight and linear measurements of the existing breed types has vital role in the selection program (Bosenu, 2012). Similarly, Tesfaye (2008) reported that information on body and testicle size of specific sheep breed at constant age has paramount importance in the selection of genetically superior animals for production and reproduction purpose. There for, it is not doubt that live body weight and linear body measurement is playing crucial role in genetic improvement and selection of specific breed. Most of live body weight and linear body measurements are presented in Table 2.

**District effect*:*** in this study body weight and most of the linear body measurements were significantly affected by the district ($p<0.05$) except body length, live body weight, and scrotal circumference. Similarly, Amelmal (2011) reported that most of the linear body measurements had significant ($p<0.05$) effect on live body weight and linear body measurements across the districts studied. In contrary to the current study, Wossenie (2012) indicated that district had no effect ($p>0.05$) except the body weight which was higher in Metta (29.4±0.2) than Deder (28.8±0.2) district in Haragehe highland sheep. The results of this study revealed that chest girth measurement was higher for Gozamen than Hulet eju and Sinan districts, but rump height and height at wither measurements were higher for Hulet eju than Gozamen and sinan districts.

**Age effect*:*** The variation among the different age classes for most quantitative linear body measurements and body weight were found to be significant ($p<0.05$) except ear length (Table 2). The trend in body weight and most linear body measurements except pelvic width and cannon bone circumference increased with increase in dentition class up to the third Dentition and then after it starts to decline or remains as it is. The size and shape of the animal increases until the animal reaches its optimum growth point or until maturity (Yoseph, 2007). Similar finding was reported by Fasae et al. (2006) who noted that body weight and body measurements increased with age of ewes for the first three years and then decreased slightly for ewes after four years.

**Sex effect:** Sex of animals had no significant effect ($P>0.05$) On most of the linear body measurements and live body weight; except for Body Weight, Rump Width, Rump Height and Cannon Bone Circumference which were larger ($P<0.05$) in ram (Table 2). Amelmal (2011) reported that except body condition score ($P<0.05$) the sex of the sheep had no significant effect ($P>0.05$) on the live body weight and other linear measurements. The body weight of rams (30.8 kg) and ewes (28.3 kg) in the current study was slightly greater than those reported for central highland sheep with 29.4 kg and 24.6 kg (Sisay, 2002), and Menz rams and ewes, with 22 kg and 19.3 kg, respectively (Tesfaye, 2008). Solomon (2008), reported average adult body weight of 28.6 kg for Arsi-Bale sheep which is similar to the present study, while the same author reported average body weight of 31 kg for Afar sheep. The weight of ewes (28.3 kg) obtained from this study was lower than the value (29.68 kg) reported for Dawro and Konta ewes (Amelmal, 2011) but slightly higher than the value for Horro ewe (27.65kg; Zewdu, 2008) and Haragehe highland sheep (26.5 kg; Wossenie, 2012).

**Age by sex effect:** Age by sex interaction had significant effect ($p<0.05$) on body weight. But the interaction effect ($p>0.05$) were not observed in most linear measurements (BL, RL, CBL, CBC and EL) implying that these parameters were not affected by the sex-age interaction effect in this particular study. Similarly, the interaction of sex and age group was significant ($p<0.05$) for all quantitative traits except for ear length for both Habru and Gubalafto sheep (Tasew, 2012). In contrary to this, Tesfaye (2008) reported that the interaction of sex and age group was significant ($p<0.05$) for BW, CG, BC and TC but not significant ($p>0.05$) for BL, WH, PW, TL and EL for Menz sheep. Similar to this result, Amelmal (2011) reported that the interaction between sex and age group significantly ($p<0.01$) affected only body weight of the sheep in Dawro zone and konta especial wordea.

Bamlaku (2012) also like the current result indicated that male sheep are appeared longer and heavier ($p<0.01$) than females at all age categories in Goncha Siso Enesie district.

Chest Girth (CG), Height at Wither (HW), Body Length (BL) and Body Weight (BW) of East Gojam Zone ram in age group 1PPI were 71.9±0.6 cm, 68.1±0.5 cm, 61.7±0.6 cm and 26.5±0.5 kg, respectively, and the values for females in the same age group were 75.5±0.4 cm, 69.3±0.3 cm, 61.7±0.3cm and 26.1±0.3kg, respectively. The measurements for the age group ≥3PPI were 83.6±1.6 cm, 73.9±1.4 cm, 64.9±1.5 cm and 33.3±1.6 kg for males and 79.7 ±0.2 cm, 70.9±0.4 cm, 63.7± 0.2 cm and 30.2±0.2 kg for females, respectively. In all age groups of East Gojam zone sheep, males had higher body weight ($p<0.05$) than females but body length and some of linear measurements were similar for the two sexes at all age group. Higher chest girth was recorded for female at age group 1PPI than same age group for males but in the other age group Chest girth was recorded higher for male sheep than female as shown in Table 2 this may be due to unequal number of sample proportion taken for analysis both for females and male of same age group.

Table 2. Live body weight and linear body measurements of sheep in the study area

| **Effect and level** | **PW** | **BL** | **BW** | **CG** | **HW** | **RW** | **RL** | **CBL** | **CBC** | **EL** | **SC** | **RH** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LSM±SE | LSM±SE | LSM±SE | LSM±Se | LSM±SE | LSM±SE | LSM±SE | LSM±SE | LSM±SE | LSM±SE | LSM±SE | LSM±SE |
| Overall | 12.2±0.1 | 63.1±0.2 | 29.0±0.2 | 78.2±0.2 | 70.43±0.2 | 22.52±0.1 | 18.8±0.1 | 15.6±0.0 | 7.6±0.02 | 10.5±0.05 | 27.6±.7 | 71.7±0.1 |
| $R^2$ | 0.01 | 0.05 | 0.23 | 0.2 | 0.05 | 0.02 | 0.09 | 0.02 | 0.05 | 0.04 | 0.22 | 0.1 |
| CV% | 16.8 | 6.1 | 11.4 | 5.9 | 5.3 | 14.1 | 14 | 6.9 | 7.3 | 10 | 16.13 | 4.8 |
| **District** | * | **NS** | **NS** | * | * | * | * | * | * | * | **NS** | * |
| Gozamen | 13.3=±0.2$^{a}$ | 63.1±0.4 | 29.6±0.4 | 80±0.5$^{a}$ | 70.6±0.4$^{b}$ | 24.7±0.3$^{a}$ | 19.6±0.3$^{a}$ | 15.9±0.1$^{a}$ | 7.9±0.1$^{a}$ | 10.5±0.1$^{a}$ | 27.4±1 | 72±.4$^{b}$ |
| Sinan | 12.4±0.2$^{b}$ | 63.0±0.4 | 29.5±0.4 | 76±0.5$^{c}$ | 70.4±0.4$^{b}$ | 21.0±0.3$^{c}$ | 18.6±0.3$^{b}$ | 15.4±0.1$^{c}$ | 7.7±0.5$^{b}$ | 10.2±0.1$^{b}$ | 27.3±1 | 72.3±.4$^{b}$ |
| Hulet eju | 11.8±0.2$^{c}$ | 63.8±0.4 | 29.6±0.4 | 78.3±0.5$^{b}$ | 71.7±0.4$^{a}$ | 23.2±0.3$^{b}$ | 17.9±0.3$^{c}$ | 15.6±0.1$^{b}$ | 7.7±0.1$^{b}$ | 10.2±0.1$^{b}$ | 27.9±.9 | 73.2±.4$^{a}$ |
| **Age group** | * | * | * | * | * | * | * | * | * | **NS** | * | * |
| 1PPI | 11.9±0.2$^{b}$ | 61.7±0. 3$^{b}$ | 26.3±0.3$^{b}$ | 73.8±.4$^{b}$ | 68.7±.3$^{b}$ | 21.9±0.2$^{b}$ | 18.1±0.2$^{b}$ | 15.3±0.1$^{b}$ | 7.6±.04$^{b}$ | 10.2±0.1 | 24.4±.6$^{b}$ | 70.2±.3$^{b}$ |
| 2PPI | 13.0±0.4$^{a}$ | 63.8±0. 7$^{a}$ | 30.8±0.6$^{a}$ | 79.4±.8$^{a}$ | 71.5±0.7$^{a}$ | 23.0±0.5$^{a}$ | 18.5±0.5$^{ab}$ | 15.5±0.2$^{b}$ | 7.9±0.1$^{a}$ | 10.2±0.2 | 28.9±1$^{a}$ | 73.3±.6$^{a}$ |
| ≥ 3PPI | 12.5±0.4$^{ab}$ | 64.4±0.7$^{a}$ | 31.7±0.6$^{a}$ | 81.6±.8$^{a}$ | 72.4±0.7$^{a}$ | 24.0±0.5$^{a}$ | 19.6±0.5$^{a}$ | 16.1±0.2$^{a}$ | 7.8±0.1$^{a}$ | 10.5±0.2 | 29.3±1.6$^{a}$ | 74.0±.6$^{a}$ |
| **SEX** | **NS** | **NS** | * | **NS** | **NS** | * | **NS** | **NS** | * | **NS** | _ | * |
| Female | 12.3±0.1$^{a}$ | 62.7±0.2 | 28.3±0.2$^{b}$ | 77.8±.2 | 70.4±0.2 | 22.3±0.2$^{b}$ | 18.8±0.1 | 15.5±0.1 | 7.6±.03$^{b}$ | 10.4±0.1 | NA | 71.6±.2$^{b}$ |
| Male | 12.7±0.4$^{a}$ | 63.9±0.7 | 30.8±0.6$^{a}$ | 78.8±.8 | 71.4±0.7 | 23.7±0.5$^{a}$ | 18.6±0.5 | 15.8±0.2 | 7.9±0.1$^{a}$ | 10.2±0.2 | 27.6±.8 | 73.4±.6$^{a}$ |
| **Ageby sex** | * | **NS** | * | * | * | * | **NS** | **NS** | **NS** | **NS** | **NA** | * |
| Female 1PPI | 12.3±0.2$^{ab}$ | 61.7±0.3 | 26.1±0.3$^{d}$ | 75.5±.4$^{d}$ | 69.3±0.3$^{c}$ | 22.0±0.3$^{cd}$ | 18.6±0.2 | 15.3±0.1 | 7.4±0.1 | 10.5±.1 | NA | 71.1±.3$^{c}$ |
| Female 2PPI | 12.5±0.2$^{ab}$ | 62.6±0.4 | 28.8±0.4$^{c}$ | 78.1±.5$^{c}$ | 70.9±0.4$^{b}$ | 22.1±0.3$^{bcd}$ | 19.04±0.3 | 15.5±0.1 | 7.7±0.1 | 10.3±.1 | NA | 71.9±.4$^{bc}$ |
| Female ≥3PPI | 12.2±0.1$^{bc}$ | 63.7±0.2 | 30.2±0.2$^{b}$ | 79.7±.2$^{b}$ | 70.9±0.2$^{b}$ | 22.8±0.1$^{b}$ | 18.9±0.1 | 15.7±0.1 | 7.6±.03 | 10.6±0.1 | NA | 71.8±.2$^{b}$ |
| Male 1PP1 | 11.6±.3 $^{c}$ | 61.7±0.6 | 26.5±0.5$^{d}$ | 71.9±.6$^{e}$ | 68.1±0.5$^{c}$ | 21.7±0.4$^{d}$ | 17.5±0.4 | 15.3±0.2 | 7.7±0.1 | 9.9±0.2 | 24.4±.6$^{b}$ | 69.4±.5$^{d}$ |
| Male 2PPI | 13.6±0.7$^{a}$ | 65.1±1.4 | 32.8±1.2$^{a}$ | 80.8±1.5$^{abc}$ | 72.2±1.3$^{ab}$ | 23.9±0.9$^{abc}$ | 18.0±0.9 | 15.5±0.4 | 8.2±0.2 | 10.2±.4 | 28.9±1.5$^{a}$ | 74.6±1.7$^{a}$ |
| Male ≥3PPI | 12.7±0.7$^{abc}$ | 64.9±1.5 | 33.3±1.2$^{a}$ | 83.6±1.6$^{a}$ | 73.9±1.4$^{a}$ | 25.3±1.1$^{a}$ | 20.2±0.9 | 16.5±0.4 | 8.0±0.2 | 10.5±0.4 | 29.3±1.6$^{a}$ | 76.3±1.3$^{a}$ |

Means with different superscripts within the same column and class are statistically different. Ns = Non significant; NA= Not applicable *significant at 0.05; 1PPI = 1pair of permanent incisors; 2PPI = 2 pair of permanent incisors and ≥ 3 PPI = 3 or more pairs of permanent incisors; PW=Pelvic width; BL=Body length; BW=Body Weight; CG=Chest Girth; HW=Height Weather; RW=Rump Width; Rump Length; CBL=Canon Bone Length; Canon Bone Circumference; EL=Ear Length; SC=Scrotal Circumference; RH=Rump Height

**Correlation between Body Weight and Linear Body Measurements**

Determining animal live body weight, linear body measurements and their inter-relationship and correlation is imperative for determining genetic potential, breed standards and improved breeding programs for higher meat production (Younas et al., 2013). Linear body measurement traits such as chest girth and body length have been proposed as indirect selection criteria for prediction of live body weight in sheep (Mohammed and Amin, 1997). Besides their use as indirect selection criteria to improve live body weight, linear body measurement traits are important traits by themselves since they are positively correlated with subjectively scored body conformation characteristics of sheep (Janssens and Vepitte, 2004).

Moderate correlation was observed between chest girth and body weight (0.57) in East Gojam female sheep but moderate relationship for male was observed between height at withers and body weight (0.7). The moderate correlation of chest girth with body weight in females than other body measurements was in harmony with other results of Thiruvenkadan (2005); Fasae *et al.* (2006); Tesfaye (2008) and Solomon *et al.* (2011) and it can indicate that chest girth is the appropriate variable for predicting live weight for female sheep in this study than other measurements at the farmers level when there is no other instruments like spring balances to measure exact live body weight of sheep. The strong correlation was observed between Rump height and Height at wither (0.82) but moderate correlation was seen between Rump height and Chest girth (0.77), and rump height and body weight (0.67) in males. But in females moderate correlation were observed between Rump height and Height at wither (0.72) and mild correlation between Chest girth and Rump width (0.45), Chest girth and Height at wither (0.38) as described in Table 3.

Table 3. Pearson correlation coefficient between body weight and different linear measurements for East Gojam zone sheep types (above the diagonal are for female sheep while below the diagonal for male sheep).

| Trait | PW | BL | BW | CG | HW | RW | RL | CL | CC | EL | RH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **PW** | | $0.05^{NS}$ | $0.17^{*}$ | $0.12^{*}$ | $-.05^{ns}$ | $0.15^{*}$ | $0.21^{*}$ | $-.1^{*}$ | $0.12^{*}$ | $0.1^{*}$ | $-.05^{ns}$ |
| **BL** | $0.07^{ns}$ | | $0.33^{*}$ | $0.4^{*}$ | $.04^{*}$ | $0.28^{*}$ | $0.11^{*}$ | $0.18^{*}$ | $0.22^{*}$ | $0.1^{*}$ | $0.36^{*}$ |
| **BW** | $0.19^{NS}$ | $0.58^{*}$ | | $0.57^{*}$ | $0.31^{*}$ | $0.18^{*}$ | $0.12^{*}$ | $0.12^{*}$ | $0.27^{*}$ | $0.12^{*}$ | $0.24^{*}$ |
| **CG** | 0.45* | $0.57^{*}$ | $0.65^{*}$ | | $0.38^{*}$ | $0.45^{*}$ | $0.23^{*}$ | $0.24^{*}$ | $0.36^{*}$ | $0.2^{*}$ | $0.28^{*}$ |
| **HW** | $0.2^{NS}$ | $0.64^{*}$ | $0.7^{*}$ | $0.61^{*}$ | | $0.17^{*}$ | $0.14^{*}$ | $0.25^{*}$ | $0.14^{*}$ | $0.14^{*}$ | $0.72^{*}$ |
| **RW** | 0.42* | $0.3^{*}$ | $0.47^{*}$ | $0.56^{*}$ | $0.36^{*}$ | | $0.21^{*}$ | $0.36^{*}$ | $0.16^{*}$ | $0.19^{*}$ | $0.15^{*}$ |
| **RL** | $0.4^{*}$ | $0.33^{*}$ | $0.33^{*}$ | $0.52^{*}$ | $0.37^{*}$ | $0.57^{*}$ | | $0.01^{NS}$ | $0.14^{*}$ | $0.16^{*}$ | $0.11^{*}$ |
| **CL** | $0.19^{NS}$ | $0.25^{NS}$ | $0.17^{NS}$ | $0.38^{*}$ | $0.26^{*}$ | $0.34^{*}$ | $0.38^{*}$ | | $0.22^{*}$ | $0.17^{*}$ | $0.23^{*}$ |
| **CC** | 0.46* | 0.29* | $0.26^{*}$ | $0.4^{*}$ | $0.37^{*}$ | $0.43^{*}$ | $0.44^{*}$ | $0.33^{*}$ | | $0.09^{*}$ | $0.04^{*}$ |
| **EL** | $0.09^{NS}$ | $-.07^{NS}$ | $0.01^{NS}$ | $-.01^{NS}$ | $0.07^{NS}$ | $-.14^{ns}$ | $-.3^{ns}$ | $0.15^{NS}$ | $-.1^{ns}$ | | $0.11^{*}$ |
| **RH** | 0.41* | $0.62^{*}$ | $0.67^{*}$ | $0.77^{*}$ | $0.82^{*}$ | $0.45^{*}$ | $0.56^{*}$ | $0.34^{*}$ | $0.47^{*}$ | $-.02^{ns}$ | |
| **SC** | 0.42* | $0.48^{*}$ | $0.49^{*}$ | $0.66^{*}$ | $0.53^{*}$ | $0.36^{*}$ | $0.46^{*}$ | $0.43^{*}$ | $0.45^{*}$ | $0.04^{ns}$ | $0.66^{*}$ |

NS= Non-significant (P<0.05); * significant at 0.05 level; PW=Pelvic Width; BL=Body Length; BW= Body Weight; CG= Chest Girth; HW= Height at wither; RW = Rump Width; RL= Rump length; CL=Canon bone length; CC=Canon bone circumference, EL=Ear length; RH=Rump height; SC = Scrotal circumference

**Multiple Regression Analysis**

Regression analysis is commonly used in animal research to describe quantitative relationships between response variable and one or more explanatory variables such as body weight and linear body measurements (chest girth, chest depth, body length, height at wither etc.) especially when there is no access to weighing equipment (Cankaya, 2008). Table 4 shows that the number of variables entered in the model to predict the best fitted variable to estimate body weight and their contribution in terms of adjusted coefficient of determination ($R^2$adj.), mallows Cp statistics, Akaike Information Criterion (AIC) and Schwarz Bayesian Criteria (SBC) sex . Stepwise multiple regressions were used to predict body weight from linear measurements which had positive correlation with body weight. Variables that best fitted the model were selected using C($p$) statistic, Alkaike's Information Criteria (AIC), Schwarz Bayesian Criteria (SBC), $R^2$ (R-square) and MSE (Mean square of error). One may define the "best model" as that which has a small value of C ($p$) which is also close to $p$ (the number of parameters in the model, including the intercept) and with "highest $R^2$ value.'' The small $C_p$ indicates precision and small variance in estimating the population regression coefficients while the coefficient of determination ($R^{2\ adj}$) represents the proportion of the total variability explained by the model.

The independent variables were Pelvic width, Body length (BL), Chest girth (HG), Height at Wither (HW), Rump width (RW), Rump length (RL), Canon bone length (CL), Canon bone Circumference (CC), Ear length (EL), and Rump height (RH). In addition to these variables scrotal circumference was considered for male population.

In most cases heart girth was found to be the most important in accounting sizeable proportion of the changes in the body weight in case of female sheep population in East Gojam Zone. Similarly, this measurement was reported for Afar, Menz, Bonga, Horro, Gumuz, Jarso, and Nedjo sheep (Tesfaye, 2008; Zewdu, 2008; Solomon, 2007; Kedjela, 2010). Chest girth was more reliable in predicting body weight than other linear body measurements at farmer's level when there are no facilities to take the whole measurements. But in case o f males, live body weight could be fairly estimated from Height at wither and Chest girth measurements in combinations because of higher mean square of error recorded if Height at Wither is used alone as described in Table 4. The better association of body weight with chest girth was possible due to relatively larger contribution to body weight of chest girth which consists of bones, muscles and viscera (Thiruvenkadan, 2005).

Parameter estimates in multiple linear regression model showed that higher $R^{2\ adj}$ was observed when more than one body dimensions were used in the multiple regression equation. The addition of other measurements to chest girth would result in significant improvements in accuracy of prediction even though the extra gain was little for females. This suggests that body weight could be more accurately predicted by combinations of two or more measurements than chest girth alone in East Gojam Zone sheep types. However, under farmers' conditions, live weight estimation using chest girth and Height at wither for females and males respectively, alone would be preferable use to combinations with other measurements because of difficulty of proper animal restraint during measurement and ease of measurements. This thus reduces the practical usefulness of using other body measurements in conjunction with chest girth and height at wither. Similar to the current result, Hamayun et.al. (2006) reported that the high and significant correlation coefficient between height at withers and heart girth and body weight 4 to 18 months of age suggests that either of these variables or their combination would provide good estimate for predicting live body weight in Beetle goats at early age.

Multiple linear regression equations were developed for predicting body weight (BW) from other linear body measurement: Pelvic Width (PW), Body Length (BL), Chest Girth (CG), and Height at Wither (HW), Rump Width (RW), Rump Length (RL), Canon Bone Length (CAL), Canon Bone Circumference (CBC), Ear Length (EL), Rump Height (RH) and Scrotum Circumference (SC) for East Gojam sheep population. The small sample size of rams in this study may decrease the accuracy of the result if separate age groups were used. Thus, instead of using separate equation for different age groups, it seems logical to pool age groups for the prediction of body weight for male and female East Gojam sheep types. Scientifically, CG, HW, and CC were found to have significant association with body weight when overall age groups were observed for males which explained total variability of 56% to the dependent variable body weight.

Similarly, six regresses (PW, BL, CG, HW, RAW, and CC) were found to have significant association with body weight when overall age groups were observed for females which explained total variability of 35% to the dependent variable body weight (Table 4). Stepwise multiple linear regression analysis was carried out for best regresses within each sex group by entering the linear body measurements one at a time for male and by excluding SC for females Table 4. Regression models for predicting body weight of males and females sheep types in East Gojam zone from some linear body measurements;

$Y = -13.685+0.1913CG+0.4963HW-0.905CC$ for males

Where Y= response variable (body weight) and CG, HW and CC are explanatory variables while

$Y=-15.803+0.1259PW+0.1014BL+0.3883CG+0.0854HW-0.1267RW+0.4323CC$ for females Where Y= response variable (body weight)

**(PW, BL, CG, HW, RW and CC are explanatory variables)**

Table 4. Multiple regression analysis of live weight body on different body measurements for ewe and ram separately in pooled age group

| | | | parameters | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sex | Model | Intercept | $\beta_1$ | $\beta_2$ | $\beta_3$ | $\beta_4$ | $\beta_5$ | $\beta_6$ | $R^2$ | $R^2_{adj.}$ | C(*p*) | AIC | Root MSE | SBC |
| Male | HW | -14.768 | 0.615 | | | | | | 0.51 | 0.50 | 6.23 | 128.73 | 2.77 | 132.99 |
| | HW +CG | -21.437 | 0.467 | 0.2309 | | | | | 0.56 | 0.55 | 1.21 | 123.56 | 2.64 | 129.94 |
| | HW+ CG +CC | -13.685 | 0.496 | 0.1913 | -0.905 | | | | 0.58 | 0.56 | 0.70 | 122.78 | 2.60 | 131.29 |
| Female | CG | -5.2018 | 0.437 | | | | | | 0.32 | 0.32 | 25.84 | 1241.57 | 2.98 | 1250.25 |
| | CG+ BL | -9.5062 | 0.399 | 0.115 | | | | | 0.33 | 0.33 | 16.55 | 1232.59 | 2.95 | 1245.61 |
| | CG +BL+ RW | -10.211 | 0.434 | 0.1277 | -0.126 | | | | 0.34 | 0.34 | 9.84 | 1225.97 | 2.93 | 1243.33 |
| | CG +BL+RW+HW | -12.919 | 0.418 | 0.1065 | -0.122 | 0.07 | | | 0.35 | 0.34 | 8.08 | 1224.22 | 2.93 | 1245.92 |
| | CG+BL +RW+HW +PW | -14.135 | 0.404 | 0.1072 | -0.13 | 0.09 | 0.1 | | 0.35 | 0.35 | 5.50 | 1221.61 | 2.92 | 1247.64 |
| | CG+BL+RW+HW+PW+CC | -15.803 | 0.388 | 0.1014 | -0.127 | 0.09 | 0.1259 | 0.4323 | 0.36 | 0.35 | 4.30 | 1220.36 | 2.91 | 1250.73 |

As observed in the figure 3 live body weight of sheep population in East Gojam increased slightly from youngest age group to oldest age group for both sexes to certain point of growth and decline then after. The interaction between sex and age group was higher for males in body weight and other linear measurements. The regression equation of sex by age group of East Gojam sheep population shows that both sex group increase in weight from youngest age group to the oldest age group and then weight becomes constant.

**The relationship of live body weight with age for the two sexes of sheep**


Sex=1=Female, 2=Male, BW=body weight, PPI=Permanent pairs of incisors

Figure 3. Relationship of live body weight with age and sex of sheep in east Gojam Zone.

**Conclusion**

Most of different linear body measurement and body weight were significantly affected by districts ($p<0.05$) except body length, live body weight, and scrotal circumference in this particular study area this might be due to the difference in management condition of farmers across the district compared.

The variation between the different age classes for most of linear body measurements and body weight were found to be significant ($p<0.05$) except Ear length, as detected by pair-wise comparisons for both sexes.

In all age groups of East Gojam zone sheep types, males had higher body weight ($p<0.05$) than females but body length and some of linear measurements were similar for the two sex at all age group. However, higher chest Girth was recorded for female age group (1PPI) than same age group for males this might be due to unequal number of observation for both sex at same age group.

**Recommendation**

Further information regarding to the genetic potential of East Gojam zone sheep types was not adequate in the literature. Therefore, well organized on-farm monitoring and on-station research should be under taken to evaluate the genetic potential of East Gojam sheep populations.

Genetic breed characterization (molecular characterization) is necessary to fully describe and identify sheep breed types existing in this study area.

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