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*Full Length Research Paper*

# Phenotypic characterization of goat type in Nuer Zone of Gambella People Regional State, South Western Ethiopia

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**This study was carried out to characterize goat type phenotypically under farmer's management practices in Lare and Jikawo districts of Nuer Zone, Southern western Ethiopia. Moreover qualitative and quantitative data were collected from a total of 600 adult (>1PPI) goats. Different statistical tests such as Chi-square test, general linear model, correlations and REG procedures were used for computed different statistical analysis. Goats in both districts were more explained by plain coat color pattern , white coat color type in female (85.53%) and (14.47%) male were observed in Lare district, while in Jikawo district white coat color type were observed with 42.53% for females and 43.59% for males. Absence of ruff was observed with 88.98 and 95.79% in Lare and Jikawo districts respectively. Smooth hair coat type, pendulous ear orientation, concave facial profile presence, straight horn shape and back ward horn orientation were frequent in male and female in both districts in a similar manner. Location had non-significant effect on linear body measurements in males and females. Males were significantly higher than females for the measurements of Chest Girth and Pelvic Width as well as Body Weight. Significant (P<0.05) difference was observed between age and body weight and all linear body measurements even ear length. Interaction effect of sex by age is significant except ear length. In males positive and highly strong association were found between body weight and Chest girth(r=0.86), wither height(r=0.763), body length(r=0.798), similarly, in females body weight had significant (P<0.05), strong and positive association between Chest Girth(r=0.91) and body length(r=0.82). Prediction equation to estimate body weight of Nuer goats for male and female was calculated. In all age groups of Nuer goat type, males had higher body weight (p<0.05) than females. Conducting molecular characterization and fully describes goat breed type existing in this study area is necessary.**

**Key words**: phenotypic, characterization, husbandry practice, Nuer goat, Gambella, Ethiopia

## INTRODUCTION

The demand for livestock products in the developing world will double over the next 20 years, because of population growth, urbanization and rising incomes (Ameha and Getachew, 2004).

The broad genetic variability of African small ruminant breeds enables them to survive under stressful environmental conditions, including high disease incidence, poor nutrition and high temperatures. Environmental pressure also maintains a wide range of genotypes, each adapted to a specific set of circumstances. This is clearly the species' genetic response to risk. Under on-station management, indigenous African sheep and goat breeds have shown good growth and reproduction performances, indicating their potential (Rege, 1994).

Goats are an integral part of economic and social life in especially developing countries. The best animal is one fitting breeding objectives to farm environments as confirmed by Bett *et al* (2009) and other authorities. But these vary as goats must be versatile and able to adapt to semi-tropical, humid, cold and mountain conditions, between and even within the same country (Arineitwe and Ndyomugyeni, 2013). The range of challenges is immense and is one reason for slowing positive progress. However, the steps to finding superior animals have been highlighted in several recent reviews by Ahuya *et al,* (2005), Berhanu et al (2012), Bett *et al,* (2012), Kosgey *et al,* (2005), and Kosgey (2012).

Goat production in Ethiopia contributes significantly to national export earnings and the livelihoods of producers, especially poor rural households. Across the whole country, goats provide meat, milk, cash, skins, manure and security (insurance), as well as banking and gifts (Adane and Girma, 2008).

Ethiopia is home, excluding some pastoral areas of Afar and Somali regions, to approximately 24 million goats (CSA, 2012). Though the population density of goats in mid- and low-altitude areas is high, they are produced across the country from the arid lowlands to the coolest highland areas.

Goats provide milk especially for children, for meat and skins for home consumption and sale income, as well as blood and manure. Goats also can have a role in tradition, social status, social payments, rituals and ceremonies, bride price, insurance, status display, dispute compensation and as a mobile bank (Berhanu *et al*., 2012; Arineitwe and Ndyomugyeni, 2013). Despite these various roles these multi-purpose animals are commonly referred to as meat goats.

A systematic description of the goat types and management systems should be considered a prerequisite for planning the rational use of indigenous goat resources. In addition, breed characterization is the first step in the urgent task of genetic resource conservation (Baker 1992; FAO, 2011). Breed characterization can be done through performance evaluation, phenotypic characterization and DNA molecular characterization (FAO, 2010).

A particular breed reflects the cultural and historical identity of the communities that developed them, and have been an integral part of the livelihood and traditions of many societies. Loss of typical breeds, therefore, means a loss of cultural identity for the communities. Gambella goat type in general the Nuer goat in particular are not characterize yet. Therefore, the aim of characterization is to obtain better knowledge of animal genetic resource, of their present and potential future uses for food and agriculture in defined environment, and their current state as distinct breed population. With the above facts and truths the present study carried out to characterize phenotypically the indigenous goat populations under farmers' management condition in study area

## MATERIALS AND METHODS

### Description of the Study Area

The study was conducted in Lare and Jikawo districts of Gambella Regional State, south-western part of Ethiopia. These districts are believed to be the home tracts for Nuer goat population.

Gambella region is geographically located between 7'N to 8.17'N latitude and 33'E to 35.02'E longitude. The region borders with Oromiya region to the north, the southern Nations, Nationalities and Peoples' Regional State (SNNPRS) and the Sudan Republic to the South, Oromiya and SNNPRS to the east and the Sudan Republic to the west (Figure 1). The altitude ranges between 300-2300 m.a.s.l. The average annual rainfall ranges from 800-1200 mm and average annual temperature ranges from 30.7-43 $^{O}$C. The Region has wet season (May-Oct) and dry season (Nov-April) (GBOA, 1999). The total land area is about 34,063 km$^2$, which is equivalent to 2.78 % of the national land area and divided into three zones and twelve Woredas. The total human population of the region, according 2012 central statistics authority projection report, was 390, 593 people (CSA, 2012).

According to the 2012 Central statistics projection report of Ethiopia, Gambella People National Regional State has 276,246 cattle, 45,428 sheep, 89,860 goat, 683 horses, 301,735 poultry population and 58,402 beehives (CSA, 2012).

### Method of Sampling and Data Collection

### Sampling method

From the two districts three from each (total of 6 kebeles) were selected based on the goats population and infrastructure. Linear body measurements of 94 male and 506 female goats, of which the majorities were mature, selected and measurements were taken (Table 1).

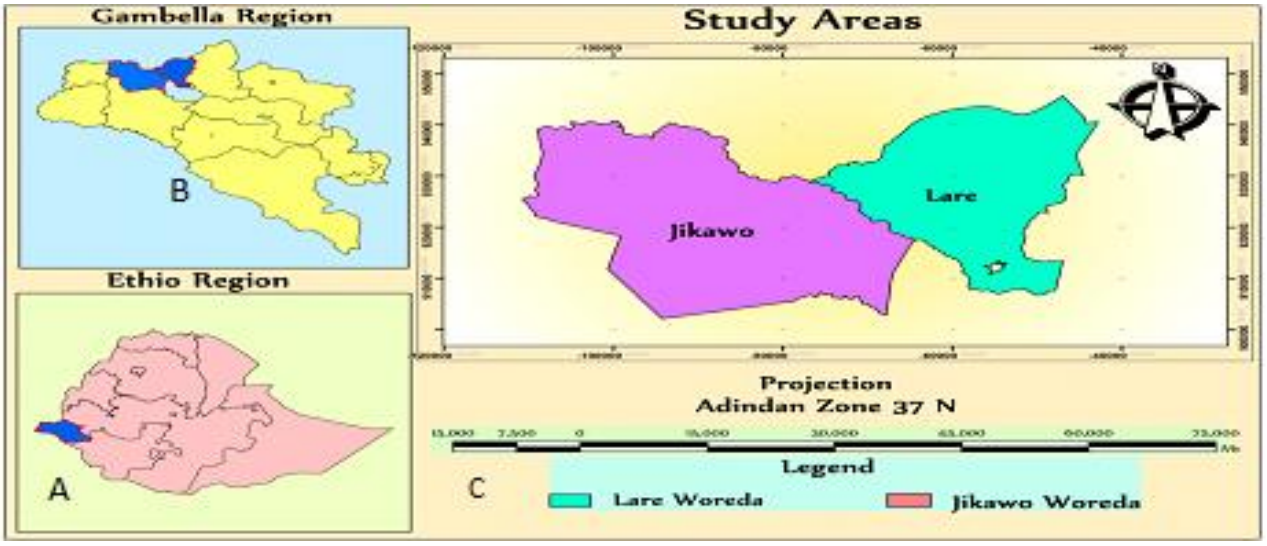



**Figure 1**: Location map of the study area (A: Map of Ethiopia, B= Map of Gambella National Regional State, C= Map of Study sites Jikawo & Lare)

**Table 1:** Summary of the total number of samples

| District | Peasant association | Linear. body measurement |
|---|---|---|
| Lare | Reick | 100 |
| | Mangog | 100 |
| | Nebneb | 100 |
| Jikawo | Lonjock | 100 |
| | Betokadeal | 100 |
| | Pakose | 100 |

## Data Collection

### Qualitative traits data collection

Visual observation was made and morphological features were recorded based on breed morphological characteristics descriptor list of FAO (2011) for phenotypic characterization of goat. Each animal were identified by its sex, dentition and sampling site. Dentition was used to estimate the approximate age of an animal. The table below shows the description of qualitative variables.

### Quantitative trait data collection

Morphometric measurements were made on the quantitative traits of breed using measuring tape. The measurements were taken on animals based on sex and age group. Animal's age classifications were made using dentition technique supplemented with owner's information. The table below shows the description of quantitative variables.

The linear measurements were made using plastic tape, while body weights of animals were measured using suspended spring or Slater weighing scale.

## Data Analysis

### Descriptive statistics

Observations on morphological characters were analyzed for male and female goat of the sample districts by using frequency procedure of Statistical Analysis System (SAS, 9.1). Univarate analysis were analyzed using the General Linear Model (GLM) procedures of the Statistical Analysis System (SAS, 9.1) by taking sex, dentition (Age) and district as fixed effects. Mean comparisons were made for variables showing significant differences between sample population using fisher test. Multiple linear regression models for estimation of body weight from the linear body measurements were estimated for male and females. Thus, regression was performed using the following model. Model to analyze adult (above 1PPI) body weight and Linear body measurements (LBMs) except scrotum circumference was:

$y_{ijk} = \mu + S_i + A_j + D_k + (AS)_{ij} + e_{ijk}$

Model used to analyze scrotum circumference was

$y_{ik} = \mu + A_i + D_k + e_{ik}$

Where:

$y_{ijk}$ = the observation of body weight and LBMs in the $i^{th}$ sex, $j^{th}$ age group and $k^{th}$ district

**Table 2**: Qualitative trait of Nuer goat in Lare and Jikawo

| Morphological character Attributes | District | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Lare | | Jikawo | | Over all | |
| | | Female | Male | Female | Male | Female | Male |
| | N (%) | N (%) | N (%) | N (%) | N(%) | N(%) | N(%) |
| Coat color Pattern | Plain /Pied | 130(53.06) | 22(40) | 111(42.5 | 17(43.59) | 241(47.78) | 39(41.79) |
| | Patchy | 81(33.06) | 21(38.18) | 86(32.95 | 11(28.21) | 167(33.0) | 33(33.19) |
| | Spotted | 34(13.88) | 12(21.82) | 64(24.52 | 11(28.21 | 98(19.20) | 23(25.01) |
| Coat color type | White | 75(30.61) | 7(12.73) | 63(24.14) | 10(25.64) | 138(27.37) | 16(19.18) |
| | Black | 38(15.51) | 12(21.82) | 42(16.09 | 6(15.38) | 80(15.80) | 18(18.18) |
| | Dark Red | 16(6.53) | 4(7.27) | 6(23 | 0 | 22(14.76) | 4(7.27) |
| | Light Red | 5(2.04) | 0 | 2(0.77 | 1(2.56 | 7(1.40) | 1(2.56) |
| | Fawn | 26(10.61) | 10(18.18) | 44(16.86) | 5(12.82) | 70(13.76) | 15(15.50) |
| | Grey | 14(5.17) | 5(9.09) | 27(10.34) | 5(12.82 | 41(7.76) | 10(10.96) |
| | White dominant | 30(12.24) | 7(12.73) | 21(8.05) | 0 | 51(10.15) | 7(6.37) |
| | Black dominant | 21(8.57) | 5(9.09) | 14(5.36) | 2(5.13) | 35(6.97) | 7(7.11) |
| | Red & white | 3(1.22) | 1(1.82) | 14(5.36) | 6(15.38) | 17(3.29) | 7(8.60) |
| | Brown | 17(6.94) | 4(7.27) | 27(10.34) | 2(5.13) | 44(8.64) | 6(6.20) |
| Ruff | Absent | 218(88.98) | 19(34.55) | 250(95.79) | 28(71.79)9 | 468(92.38) | 47(53.17) |
| | Present | 27(11.02) | 36(65.45) | 11(4.21) | 11(28.21) | 38(7.62) | 47(46.83) |
| Hair coat type | Glossy | 228.98) | 14(25.45) | 11(4.21) | 7(17.95) | 33(6.59) | 21(21.70) |
| | Smooth | 219(89.39) | 41(74.55) | 250(95.79)) | 32(82.05) | 469(92.59) | 73(78.30) |
| | Rough | 4(1.63) | 0 | 0 | 0 | 4(0.82) | 0(0) |
| Hair length | Medium | 221(90.20) | 41(74.55) | 250(95.79) | 32(82.05) | 471(92.99) | 73(78.30) |
| | Long | 24(9.80) | 14(25.45) | 11(4.21) | 7(17.95) | 35(&.01) | 21(21.70) |
| Rump profile | Flat | 93(37.96) | 32(58.18) | 142(54.41) | 18(46.15) | 235(46.18) | 50(52.16) |
| | Slopping | 77(31.43) | 14(25.45) | 66(25.29) | 8(20.51) | 143(28.36) | 22(22.98) |
| | Roofy | 75(30.61) | 9(16.36) | 53(20.31) | 13(33.33) | 125(25.46) | 22(24.86) |
| Ear Orientation | Erect | 38(15.51) | 9(16.36) | 11(4.21) | 1(2.56) | 49(9.86) | 10(9.46) |
| | semi-Pendulous | 40(16.33) | 16(29.09) | 67(25.67) | 8920.51) | 56(21) | 24(24.805) |
| | Pendulous | 145(59.18) | 23(41.82) | 174(66.47) | 29(74.36) | 319(62.83) | 52(58.09) |
| | Carried horizontal | 22(9.98 | 7(12.73) | 9(3.45) | 1(2.56) | 31(6.715) | 8(7.645) |
| Facial profile | Straight | 65(26.53) | 6(10.9) | 103(39.46) | 14(35.90) | 168(32.995) | 20(23.40) |
| | Concave | 87(35.5) | 38(69.09) | 137(52.49) | 20(51.28) | 224(43.995) | 58(60.185) |
| | Convex | 92(37.55) | 11(20) | 21(8.05) | 5(12.82) | 113(22.80) | 16932.82) |
| | Markedly convex | 1(0.41) | 0 | 0 | 0 | 1(0.205) | 0(0) |
| Horn presence | Present | 223(91.02) | 43(78.18) | 248(95.02) | 38(97.44) | 471(93.02) | 81(87.81) |
| | Absent | 22(9.98) | 12(21.82) | 13(4.98) | 1(2.56) | 35(7.48) | 13(12.19) |
| Back profile | Straight | 160(65.31) | 38(69.09) | 81(31.31) | 9(23.08) | 241(48.31) | 47(46.085) |
| | Slopes up to wards rump | 58(23.67) | 12(21.82) | 126(48.28) | 22(56.41) | 184(35.975) | 34(39.115) |
| | Slopes down from wither | 11(4.49) | 1(1.82) | 46(17.62) | 8(20.51) | 57(22.11) | 9(11.165) |
| | Dipped(curved | 16(6.53) | 4(7.27) | 8(3.07 | 0 | 14(4.80) | 4(3.635) |
| Horn Shape | Scurs | 1(0.41) | 0 | 0 | 0 | 1(0.205) | 0(0) |
| | Straight | 131(53.47) | 34(61.82) | 190(72.8) | 27(69.23) | 321(63.135) | 61(65.525) |
| | Curved | 83(33.88) | 9(16.36) | 54(20.69) | 10(25.64) | 137(27.285) | 19(20.960 |
| | Spiral | 8(3.27) | 1(1.82) | 4(1.53) | 1(2.56) | 12(2.40) | 2(2.19) |
| | Polled | 22(8.98) | 11(20) | 13(4.98) | 1(2.56) | 35(6.98) | 12(11.28) |
| Horn orientation | Lateral | 1(0.41) | 0 | 0 | 0 | 1(0.205) | 0 |
| | Obliquely up ward | 69(28.16) | 11(20) | 55(21.07) | 8(20.5) | 124(24.615) | 19(20.25 |
| | Back ward | 152(62.04) | 33(60) | 189(72.41) | 28(71.79) | 341(67.225) | 61(65.895) |
| | Polled | 22(8.98) | 11(20) | 17(6.51) | 3(7.69) | 39(7.745) | 14(13.8450 |
| | Loose | 1(0.41) | 0 | 0 | 0 | 1(0.205) | 0 |
| Beard | Absent | 178(72.65) | 18(32.73) | 230(88.12) | 10(25.64) | 408(80.385) | 28(29.185) |
| | Present | 67(27.35) | 37(67.27) | 31(11.88) | 29(74.36) | 98(19.615) | 66(70.815) |
| Toggle | Absent | 240(97.96) | 55(100) | 260(99.62) | 39(100) | 500(98.79) | 94(100) |
| | Present | 51(2.04) | 0 | 1(0.38) | 0 | 6(1.21) | 0 |

**Table 3:** Quantitative traits of Nuer goats in Lare and Jikawo with respect of BW, BL, CG & WH

| Effect and level | BW LSM±SE | BL LSM±SE | CG LSM±SE | WH LSM±SE |
|---|---|---|---|---|
| **Overall** | 22.02±2.31 | 56.93±3.64 | 64.91±3.74 | 57.65±3.34 |
| **CV** | 10.49 | 6.40 | 5.76 | 5.79 |
| **$R^2$** | 0.78 | 0.59 | 0.67 | 0.50 |
| **Sex** | * | NS | * | NS |
| Male | 23.00±0.24$^{a}$ | 55.01±0.38 | 64.07±0.39$^{a}$ | 56.48±0.5 |
| Female | 19.86±0.11$^{b}$ | 55.45±0.17 | 62.81±0.18$^{b}$ | 56.59±0.6 |
| **Age** | * | * | * | * |
| 1PPI | 16.40$^{c}$±0.22 | 50.17$^{c}$±0.35 | 56.46$^{c}$±0.36 | 52.21 $^{c}$±0.32 |
| 2PPI | 21.05$^{b}$±0.24 | 54.23$^{b}$±0.39 | 63.39$^{b}$±0.40 | 55.88$^{b}$±0.35 |
| 3PPI | 26.98$^{a}$±0.22 | 61.29$^{a}$±0.35 | 70.48$^{a}$±0.36 | 61.53$^{a}$±0.32 |
| **District** | NS | NS | NS | NS |
| Jikawo | 21.48±0.16 | 55.28±0.26 | 63.70±0.27 | 56.38±0.24 |
| Lare | 21.46±0.16 | 55.18±0.25 | 63.18±0.26 | 56.69±0.23 |
| **Sex by Age** | * | * | * | * |
| Female,1PPI | 14.69$^{f}$±0.25 | 50.12$^{f}$±0.39 | 56.13$^{d}$±0.40 | 52.76$^{d}$±0.36 |
| Female,2PPI | 19.21$^{d}$±0.18 | 55.19$^{c}$±0.29 | 62.50$^{c}$±0.30 | 56.52$^{c}$±0.27 |
| Female,3PPI | 25.94$^{b}$±0.14 | 61.05$^{b}$±0.22 | 69.80$^{a}$±0.23 | 60.51$^{b}$±0.21 |
| Male,1PPI | 18.11$^{e}$±0.37 | 50.22$^{e}$±0.59 | 56.79$^{d}$±0.61 | 51.65$^{d}$±0.54 |
| Male2PPI | 22.89$^{c}$±0.45 | 53.28$^{d}$±0.71 | 64.27$^{b}$±0.73 | 55.24$^{c}$±0.65 |
| Male,3PPI | 28.03$^{a}$±0.42 | 61.54$^{a}$±0.66 | 71.17$^{a}$±0.31 | 62.55$^{a}$±0.61 |

a,b,c,d,e means on the same column with different superscripts within the specified dentition group are significantly different (P<0.05); *significant at 0.05; BW= Body weight, BL=Body length, CG=Chest Girth, WH=Wither height, NS=non significant; 1PPI= 1 Pair of Permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 4PPI = 4 pair of permanent incisors. Number of Male=94 and Females=506 total=600

μ = overall mean
$S_i$ = the effect of $i^{th}$ sex (i = female and male), $A_j$ = the effect of $j^{th}$ age group (j = 1, 2, > or=3)
$D_k$= the effect of $k^{th}$ district (k =Lare and Jikawo), $(SA)_{ij}$=the interaction effect of $i^{th}$ sex and $j^{th}$ age groupe $_{ijk}$ = random residual error

## RESULTS AND DISCUSION

### Phenotypic Characterization of Nuer Goat: Qualitative Traits

Qualitative trait of Nuer goat in Lare and Jikawo districts are presented in Table 2. The most frequent coat color pattern of Nuer goat female and male goats in Lare and Jikawo districts were plain, patchy and spotted, respectively. Predominantly plain coat color pattern were observed across all study districts.

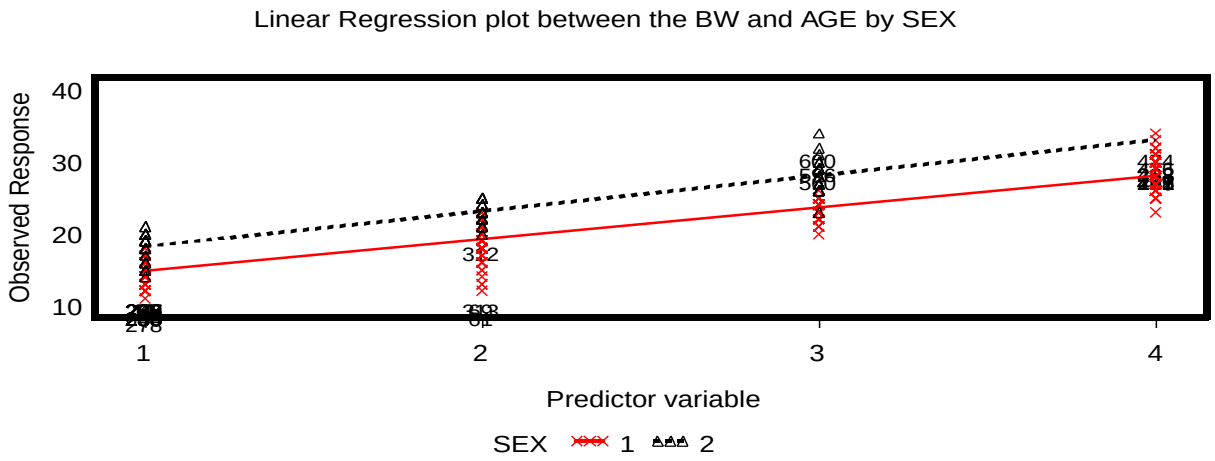
White coat color type in female (30.61%) and (12.73%) male were observed in Lare district, in Jikawo district white coat color type were observed with 24.14% for females and 25.64% for males. This agrees with the work of Kassahun and Solomon (2008) on Breeds of Sheep and Goats they state that dominant coat color is white for Western Lowland Goat breed.

From the finding, absences of ruff were observed with 88.98 % and 95.79% in female in Lare and Jikawo districts respectively. In addition smooth hair coat type, pendulous ear orientation, concave facial profile, presence of horn, straight horn shape and back ward horn orientation were frequent in male and female as well as in both districts in a similar manner.

### Live body weight and linear measurement

Body weight and linear body measurements of goat by sex, age and district are presented in Table 3.
**District Effect**: - there was no significant difference in linear body measurements between districts. Body weight, Ear Length, Height Wither, Chest Girth, Pelvic width, Rump Height, Scrotal Circumference and Body Length had no significant difference between districts. This result contradicts with the work of Biruh (2013) reported for Woyto Guji goats.
**Sex Effect**: Chest Girth, Pelvic width and ear length was significantly affected by sex (Table 2). Isaac *et al*. (2005) reported that sexual dimorphism in body size is clearly widespread among many mammalian taxa, with male-biased dimorphism being the more common, but certainly not the exclusive pattern. The same was true in this study where males were superior to females in body weight and chest girth.

Usually males have higher body weight than females and strong and positive association existed between important linear body measurements and body weight; males have higher values for linear body measurements because of positive correlation between body weight and liner body measurements. This sex influenced differences in body weight and linear measurements might be partly due to hormonal effect, that is, release of androgen (which is known to have growth and weight - stimulating




Regression Equation:
BW(SEX:1) = 10.25185 + 4.431339*AGE
BW(SEX:2) = 13.10177 + 4.957965*AGE

**Figure 2:** Graph of Body Weight by sex and age interaction

1 refers for female and 2 refer for male; Where Predictor variable is age (by dentations) and observed response is body weight.

**Table 4:** Quantitative traits of Nuer goats in Lare and Jikawo with respect of RH, PW, EL & SC

| Effect and level | RH LSM±SE | PW LSM±SE | EL LSM±SE | SC LSM±SE |
|---|---|---|---|---|
| **Overall** | 61.86±3.37 | 12.99±1.44 | 13.20±0.26 | 21.16±1.63 |
| **CV** | 5.46 | 11.13 | 19.60 | 7.73 |
| **$R^2$** | 0.47 | 0.54 | 0.071 | 0.06 |
| **Sex** | NS | * | * | NS |
| Male | 60.74±0.35 | 11.58±0.15$^{b}$ | 12.50±0.27$^{b}$ | 25.33±0.16 |
| Female | 60.75±0.16 | 12.59±0.07$^{a}$ | 13.04±0.13$^{a}$ | - |
| **Age** | * | * | NS | * |
| 1PPI | 56.83$^{c}$±0.33 | 10.59$^{c}$±0.14 | 12.44±0.25 | 20.75$^{b}$±0.27 |
| 2PPI | 60.18$^{b}$±0.36 | 11.86$^{b}$±0.15 | 12.83±0.27 | 21.67$^{a}$±0.32 |
| 3PPI | 65.24$^{a}$±0.32 | 13.81$^{a}$±0.14 | 13.03±0.25 | 21.23$^{ab}$±0.3 |
| **District** | NS | NS | NS | * |
| Jikawo | 60.58±0.24 | 12.06±0.10 | 12.93±0.19 | 21.24$^{a}$±0.26 |
| Lare | 60.91±0.23 | 12.11±0.10 | 12.61±0.18 | 21.19$^{a}$±0.22 |
| **Sex by Age** | * | * | * | NS |
| Female,1PPI | 56.74$^{d}$±0.36 | 10.69$^{c}$±0.15 | 12.27$^{b}$±0.28 | - |
| Female,2PPI | 60.88$^{b}$±0.27 | 12.54$^{b}$±0.11 | 12.90$^{b}$±0.21 | - |
| Female,3PPI | 64.64$^{a}$±0.21 | 14.56$^{a}$±0.09 | 13.95$^{a}$±0.16 | - |
| Male,1PPI | 56.91$^{d}$±0.55 | 10.49$^{c}$±0.23 | 12.61$^{b}$±0.42 | 20.75$^{b}$±0.27 |
| Male2PPI | 59.47$^{c}$±0.66 | 11.19$^{c}$±0.28 | 12.75$^{b}$±0.51 | 21.67$^{a}$±0.32 |
| Male,3PPI | 65.84$^{a}$±0.62 | 13.06$^{b}$±0.26 | 12.12$^{b}$±0.47 | 21.23$^{ab}$±0.3 |

a,b,c,d,e 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); *significant at 0.05; EL= Ear length; SC= Scrotal circumference; PW= Pelvic Width; RH= Rump height; 1PPI= 1 Pair of Permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 4PPI = 4 pair of permanent incisors. Number of Male=94 and Females=506 total=600

effects) in male animals after the testes are well developed (Frandson and Elmer, 1981).

**Age effect**: - age had significant effect on body weight and all linear body measurements (Table 2). Age was found to significantly influence body weight and linear body measurements up until age group 2 - 3 years in all the traits studied (Samuel and Salako, 2008). In the current study body weight (BW) had significant difference in all age (dentition) groups and the same was true for all linear body measurements. Where body weight and these linear body measurements increases when the animal gets older (increase in age). This implies that goats in this study area had higher body weight at latest age that is in agreement with the finding of Yoseph (2007); Arsi bale, Boran, and Woyto Guji goats attained their highest weights in the oldest age class.

**Sex by age interaction**: -The interaction effect of age by sex is significant for body weight and all linear body measurements except ear length in case of males. The mean body weight of males in age group 1PPI (18.11)

**Table 51**. Coefficient of correlations between body weight and linear body measurements in Nuer goat (Above diagonal for Female and below diagonal for Male)

| | HL | BW | CG | BL | HW | PW | EL | RH |
|---|---|---|---|---|---|---|---|---|
| HL | | 0.44* | 0.47* | 0.39* | 0.41* | 0.40* | 0.12* | 0.40* |
| BW | 0.35* | | 0.91* | 0.82* | 0.76* | 0.78* | 0.31* | 0.76* |
| CG | 0.39* | 0.86* | | 0.87* | 0.77* | 0.76* | 0.34* | 0.79* |
| BL | 0.42* | 0.81* | 0.83* | | 0.77* | 0.72* | 0.25* | 0.76* |
| HW | 0.51* | 0.76* | 0.75* | 0.85* | | 0.69* | 0.30* | 0.93* |
| PW | 0.38* | 0.55* | 0.57* | 0.62* | 0.57* | | 0.22* | 0.69* |
| EL | 0.01 NS | -0.11 NS | -0.05 NS | 0.02 NS | 0.08 NS | 0.12 NS | | 0.30* |
| RH | 0.37* | 0.68* | 0.72* | 0.83* | 0.75* | 0.54* | 0.04* | |

BW=Body weight, CG=Chest girth, HW= Height at whither; RH= Rump height; BL= Body length; EL= Ear length; PW= Pelvic width; * Correlation is significant at the 0.05, NS Correlation is not significant at the 0.05, N=number of animals

**Table 6.** Multiple regression analysis of live body weight on different body measurements of goats in all age groups

| Model | I (β0) | Parameters | | | | $R^2$ | Adj. $R^2$ | C(P) | AIC | Root MSE | SBC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | β1 | β2 | β3 | β4 | | | | | | |
| **Female** | | | | | | | | | | | |
| CG | -24.94 | 0.72 | | | | 0.8222 | 0.8218 | 102.15 | 714.9732 | 2.114 | 723.30 |
| CG+BL | -27.51 | 0.56 | 0.22 | | | 0.8444 | 0.843 | 6.34 | 628.0 | 1.980 | 665.92 |
| CG+BL+PW | -26.15 | 0.50 | 0.18 | 0.35 | | 0.8546 | 0.853 | 47.03 | 667.09 | 1.923 | 643.17 |
| CG+BL+HW+PW | -27.19 | 0.49 | 0.17 | 0.05 | 0.33 | 0.855 | 0.854 | 26.82 | 648.19 | 1.917 | 645.38 |
| **Male** | | | | | | | | | | | |
| CG | -11.08 | 0.53 | | | | 0.744 | 0.74 | 17.21 | 161.74 | 2.34 | 166.82 |
| CG+HW | -14.72 | 0.41 | 0.20 | | | 0.7755 | 0.77 | 6.35 | 151.72 | 2.21 | 159.35 |
| CG+HW+EL | -12.66 | 0.39 | 0.22 | -0.18 | | 0.786 | 0.778 | 3.91 | 149.19 | 2.16 | 159.36 |
| CG+HW+PW+EL | -12.64 | 0.38 | 0.21 | 0.144 | -0.19 | 0.79 | 0.78 | 3.95 | 132.700 | 2.18 | 144.74 |

BW=Body weight, CG=Chest girth, HW= Height at whither; RH= Rump height; BL= Body length; EL= Ear length; RL= Rump height; PW= Pelvic width and SC=scrotum circumference

and age group 2PPI (22.89) in this study were lower than Hararghe Highland goats 23.67 and 23.37, respectively for each age class as reported by Mahilet (2012) and the same true for Woyto Guji goats reported by Biruh (2013) with the result of 19.7 and 23.5 .

Bucks in each age category are higher in body weight than does in the respective age category and body weight increases with age in both sexes.

## Correlation between body weight and linear body measurements

The Pearson's correlation coefficient between body weight and linear body measurements for male and female are calculated and presented in the Table 5. Very weak to highly strong correlations were observed between body weight and linear body measurements. In males positive and highly strong association were found between body weight and Chest girth (r=0.86), wither height (r=7.63), body length (r=0.81), rump height (r=0.68). Horn length (r=0.355), and pelvic width (r=0.55) have moderate and positively correlated with body weight. These linear body measurements were highly affected by the change in body weight; hence, they are more important in prediction of live body weight of the animal. Reasonable skill in estimating weight is therefore necessary for the stockman as it will frequently be necessary to know weights where a weighbridge is not readily available or its use is not practically feasible (Singh and Mishra, 2004).

Moderate and significant positive associations were also observed between Horn length and all parameters except for ear length.

In case of females, chest girth had strong and significant correlations with body length (0.87), rump height (r=0.79), height at whither (r=0.76) and pelvic width (r=0.78) . Wither height was strongly and positively correlated with rump height (0.93), body length (r=0.77)

and moderately with horn length (r=0.41) and pelvic width (r= 0.69).Ear length had weak, negative, and non-significant correlations between body weight and other linear body measurements.

Body weight had strong correlation with chest girth, body length, pelvic width, whither height with (r=0.91), (0.82), (0.78), (0.76) respectively.

The correlation coefficient between body weight and all parameters for males and females in the current study were lower than Woyto guji goats which was reported by Biruh(2013).

### Prediction of body weight from linear body measurements

In order to predict body weight from linear measurements multiple regressions procedure was carried out for female and male based on independent variables which had positive correlation with body weight. In this study, regression equation was developed for estimation of body weight of females using 7 body measurements (BL, CG, RH, WH, EL, PW, and HL).Before prediction equations were developed checks for multicollinearity, departure from homogeneity of variance, and significant heteroscedasticity of data were tested.

The estimated regression model of male and females for predicting the mean body was given as follows.

LBW=-12.64+0.3779CG+0.214HW+0.1455PW-0.1937EL for male

LBW=-27.186+0.4912CG+0.1695BL+0.0503HW+0.334Pw for female

## CONCLUSION

All linear body measurement and body weight were not significantly affected by districts ($p<0.05$) .This may be the study was conduct within the same agro-ecological zone. In all age groups Nuer goat 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. Higher correlation was observed between chest girth and body weight in Nuer goat types. The authors recommend genetic breed characterization (molecular characterization) is necessary to fully describe and identify goat breed type existing in this study area.

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