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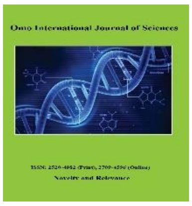

Research Article

Morphological characterization of Woyto-Guji goat under community-based breeding program in South Ethiopia

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Abstract

Indigenous Woyto-Guji goats are important for rural livelihoods in southern Ethiopia due to their adaptability and productivity under extensive management. However, their morphological and phenotypic diversity is not fully documented, which limits evidence-based breeding and management decisions. This study aimed to characterize Woyto-Guji goats and assess the effects of village, sex, and age on key qualitative and quantitative traits. A total of 362 goats from three villages (Baide, Arfayde, and Jarso) were sampled. Qualitative traits (coat color, color pattern, horn orientation, presence of wattles and ruffs) and quantitative traits (body weight, body length, chest girth, wither height, ear length, tail length, horn length, and scrotum circumference) were recorded. Age was determined by dentition, and statistical analyses were conducted using SPSS v20, including Chi-square tests for qualitative traits, GLM for quantitative traits, Pearson correlation, and stepwise regression for body weight prediction. Results showed significant variation ($p < 0.05$) among villages, sexes, and age classes. Jarso goats had higher body weight (26.38 ± 5.52 kg) and chest girth (72.71 ± 4.80 cm). Males had longer horns (9.21 ± 3.04 cm) and greater wither height (62.49 ± 5.29 cm), whereas females were slightly heavier (25.04 ± 5.01 kg vs. 24.75 ± 6.27 kg). Older goats (3PPI and 4PPI) exhibited larger body measurements compared to younger ones. Strong positive correlations were observed between body weight and chest girth ($r = 0.86$), body length ($r = 0.76$), and wither height ($r = 0.64$). A regression model using chest girth, body length, and wither height explained 80% of body weight variation ($R^2 = 0.80$, $p < 0.001$), providing a practical field-based estimation approach where scales are unavailable. These findings highlight the phenotypic diversity of Woyto-Guji goats across villages and age classes and offer data-driven insights for selective breeding and management.

Keywords: Body weight prediction; Morphological characterization; Woyto-Guji goat transfer

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1. Introduction

Goat production is a key component of rural livelihoods in Ethiopia, providing households with meat, milk, income, and socio-cultural benefits (Tesfaye et al., 2020). Indigenous goat breeds are particularly valuable due to their adaptability to harsh climates, resistance to endemic diseases, and ability to thrive under low-input production systems (Netsanet et al., 2016). Despite their importance, many local goat populations, including the Woyto-Guji goat of southern Ethiopia, remain poorly characterized, and their genetic and phenotypic diversity has not been systematically documented. This knowledge gap limits evidence-based breeding strategies and the design of sustainable management interventions (FAO, 2015).

Morphological characterization provides a practical approach to assess phenotypic variability within and between goat populations. It offers essential information for breed improvement, conservation, and the development of sustainable utilization strategies (FAO, 2012). Both qualitative and quantitative traits can be recorded directly in the field, making them particularly suitable for community-based breeding programs (CBBPs).

The Woyto-Guji goat is an indigenous breed widely kept in the dryland areas of southern Ethiopia, where it contributes significantly to the livelihoods of smallholder pastoral and agro-pastoral households. The breed has been included in a community-based breeding program (CBBP) initiated by the International Livestock Research Institute (ILRI) and the former Southern Ethiopia Agricultural Research Institute (SARI) since 2013. While prior studies have assessed the productive potential of this population, comprehensive documentation of its morphological traits within the current CBBP context is limited.

The objective of this study was to characterize Woyto-Guji goats using both qualitative and quantitative morphological traits. Specifically, it aimed to (i) assess phenotypic variation across villages, sex, and age, (ii) explore relationships among linear body measurements and live body weight, and (iii) develop regression models for predicting body weight from morphometric traits to support field-based selection and management decisions.

2. Materials and Methods

2.1 Study area

The study was conducted in three purposively selected villages located in the Konso zone of southern Ethiopia. To represent the diverse ecological landscape Baide, Arfayde, and Jarso were selected based on their varying altitudes and environmental conditions. Baide, situated at an elevation of 1,202 m.a.s.l, is characterized by a semi-arid climate with sparse shrub and grass vegetation and an average annual rainfall ranging between 600 and 700 mm. In contrast, Arfayde sits at a higher mid-altitude of 1,565 m.a.s.l, receiving more substantial rainfall of 700 to 900 mm; its mixed shrub-grassland environment makes it particularly suitable for extensive goat grazing. Finally, Jarso represents the lowland regions at 890 m.a.s.l, where the climate is relatively warmer and the landscape is defined by scattered trees and natural pasturelands.

The variation in altitude, climate, and vegetation among these villages influences feed availability, growth performance, and overall productivity of Woyto-Guji goats. Although these villages do not cover the entire zone, they were selected to capture representative ecological and management variations typical of Woyto-Guji goat-rearing areas (FAO, 2012).

Table 1. Flock size used over location, sex and dentition.

Fixed factors	Alternatives	Frequency	%	Remarks
Village	Baide	125	34.5	1202 m.a.s.l
	Arfayde	134	37.0	1565 m.a.s.l
	Jarso	103	28.5	890 m.a.s.l
Sex	Male	134	37.0	
	Female	228	63.0	
Dentition	0PPI	56	15.5	0.5-1 year
	1PPI	54	14.9	1-1.5 years
	2PPI	99	27.3	1.5-2 years
	3PPI	77	21.3	2-3 years
	4PPI	76	21.0	3 years and above

2.2 Study animals and sampling

The 362 indigenous Konso goats sampled in this study were from smallholder flocks participating in the community-based breeding program (CBBP) across Baide, Arfayde, and Jarso villages. Flock sizes were small to medium, typically ranging from 10 to 25 animals per household, with a predominance of female goats retained for breeding and milk production, while males were sold or used for market purposes. Goats were managed under extensive, free-range systems, grazing on communal pastures, natural shrublands, and crop residues. Supplementary feeding was minimal, primarily consisting of crop by-products and seasonal forage during the dry period. Housing was generally simple, providing basic shelter during the night or rainy periods. Breeding was largely uncontrolled, with bucks allowed to mate freely within the village flocks, except for selected breeding bucks identified by the CBBP for genetic improvement.

As represented in Table 1, the sample included 134 males and 228 females, stratified by age using dentition as of 0 pair of permanent incisors (PPI): 0.5–1 year to estimate selection and/or yearling weight, 1 PPI: 1–1.5 years, 2 PPI: 1.5–2 years, 3 PPI: 2–3 years and 4 PPI: 3 years and above (Wilson, 1991). The minimum sample size per village was determined using the formula (Eq. 1) for population proportion with 95% confidence interval (Cochran, 1977):

$$n = \frac{Z^2 . P(1-P)}{d^2} \quad (1)$$

Where, n = sample size, Z = 1.96 (95% confidence level), P = expected proportion (0.5 for maximum variability), d = desired precision (0.05).

2.3 Data collection

Data were collected in accordance with FAO guidelines for phenotypic characterization of small ruminants, covering both qualitative and quantitative traits (FAO, 2012). Qualitative traits included five parameters: coat color, color pattern, horn orientation, presence of wattles and ruffs. Quantitative traits were comprised five linear measurements including body weight (BW), chest girth (CG), body length (BL), wither height (WH), ear length (EL), tail length (TL), horn length (HL) and scrotum circumference (SC, for males only).

Body weight was measured using a portable spring balance, while all other linear measurements were taken using a standard measuring tape. Age classification was based on dentition observation (Wilson, 1991). Measurements were conducted early in the morning before grazing, with animals standing on a flat surface in a natural upright position. The same trained enumerators performed all measurements using calibrated instruments.

Body weight (BW) was measured using a portable spring balance with goats gently restrained and lifted using a canvas sling. Chest girth (CG) was measured as the circumference of the chest immediately behind the front legs. Body length (BL) was measured from the point of the shoulder to the pin bone. Wither height (WH) was measured as the vertical distance from the ground to the highest point of the withers using a measuring stick. Ear length (EL) was measured from the base of the ear to its tip. Horn length (HL) was measured along the outer curvature from the base to the tip of the horn. Tail length (TL) was measured from the tail base to the tip. Scrotum circumference (SC) was measured at the widest point of the scrotum using a flexible measuring tape (for males only). Body condition score (BCS) was assessed using a 1–5 scale based on palpation of the lumbar region.

2.3 Statistical analysis

All statistical analyses were conducted using All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 20.0 (IBM Corp., Armonk, NY, USA). Qualitative morphological traits were analyzed using the Chi-square (χ^2) test to evaluate differences in frequency distributions among villages, sexes, and dentition classes.

Quantitative traits were analyzed using the General Linear Model (GLM) procedure to assess the effects of village, sex, and dentition class. The statistical model applied was shown in Eq. 2.

$$Y_{ijkl}=\mu+V_i+S_j+D_k+e_{ijkl} \quad (2)$$

Where, Y_{ijkl}= observed value of the quantitative trait, μ = overall mean, V_i= fixed effect of the i^{th} village (Baide, Arfayde, Jarso), S_j = fixed effect of the j^{th} sex (male, female), D_k = fixed effect of the k^{th} dentition class (0PPI, 1PPI, 2PPI, 3PPI, 4PPI), e_{ijkl} = random residual error assumed to be normally and independently distributed with mean zero and constant variance.

Sex-specific analysis: Traits measured only in males (e.g., scrotal circumference) were analyzed separately. Least square means were compared using Duncan's Multiple Range Test at α = 0.05 and 0.001.

Pearson correlation coefficients were computed to determine the relationships among linear body measurements and their association with live body weight. To manage multicollinearity among highly correlated morphometric traits and identify independent predictors of body weight, stepwise multiple linear regression analysis was performed. The general regression model was expressed as shown in Eq. 3:

$$BW=\beta_0+\beta_1X_1+\beta_2X_2+\cdots+\beta_nX_n+\varepsilon \quad (3)$$

Where, BW = body weight, β_0 = intercept, β_n= regression coefficients of predictor variables (Xn: (BW), (CG), (BL), (WH), (EL), (TL), (HL) and (SC)), ε = random error term.

Models were evaluated based on the coefficient of determination (R^2) and standard error of estimate, and the model with the highest explanatory power and biological relevance was selected for field application.

3. Results and Discussion

3.1 Flock structure

As shown in Table 2, a total of 362 Konso goats were used for physical characterization across the three study villages: Baide (34.5%), Arfayde (37.0%), and Jarso (28.5%). The flock was predominantly female (63.0%), which aligns with the common smallholder practice of retaining does for breeding and milk production, while most males are often sold or culled earlier (Table 2).

Age classification based on dentition revealed the highest proportions in the 2PPI (27.3%) and 3PPI (21.3%) age groups, suggesting a young and reproductively active flock, ideal for selection and genetic improvement under community-based breeding programs (Table 2).

Table 2. Qualitative traits frequency for coat color, color pattern, wattle presence, ruff presence and horn orientation across villages

Qualitative traits	Village								Chi-square	Sig.
	Baide		Arfayde		Jarso		Total			
	N	%	N	%	N	%	N	%		
Coat color	**125**	**34.53**	**134**	**37.02**	**103**	**28.45**	**362**		**78.26**	**0.001**
Black	23	18.40	27	20.15	10	9.71	60	16.58		
Black dominant	31	24.80	17	12.69	13	12.62	61	16.85		
Brown	1	0.80	10	7.46	13	12.62	24	6.63		
Brown dominant	6	4.80	16	11.94	13	12.62	35	9.67		
Grey	6	4.80	5	3.73	4	3.88	15	4.14		
Grey dominant	9	7.20	1	0.75	0	0	10	2.76		
Red	2	1.60	8	5.97	9	8.74	19	5.25		
Red dominant	17	13.60	10	7.46	7	6.80	34	9.39		
Spot	4	3.20	0	0	6	5.83	10	2.76		
White	3	2.40	9	6.72	17	16.51	29	8.01		
White dominant	23	18.40	31	23.13	11	10.68	65	17.96		
Color pattern	**125**	**34.53**	**134**	**37.02**	**103**	**28.45**	**362**		**16.77**	**<0.001**
Plain	35	28.00	59	44.03	56	54.37	150	41.44		
Patchy	90	72.00	75	55.97	47	45.63	212	58.56		
Wattle	**125**	**34.53**	**134**	**37.02**	**103**	**28.45**	**362**		**9.33**	**0.001**
Present	3	2.40	2	1.49	9	8.74	14	3.87		
Absent	122	97.60	132	98.51	94	91.26	348	96.13		
Ruff	**125**	**34.53**	**134**	**37.02**	**103**	**28.45**	**362**		**13.74**	**0.001**
Present	50	40.00	56	41.79	21	20.39	127	35.08		
Absent	75	60.00	78	58.21	82	79.61	235	64.92		
Horn orientation	**118**	**33.24**	**134**	**37.75**	**103**	**29.01**	**355**		**258.01**	**<0.001**
Straight	56	47.46	3	2.24	0	0.00	59	16.62		
Backward	3	2.54	77	57.46	48	46.60	128	36.06		
Lateral	53	44.92	6	4.48	8	7.77	67	18.87		
Forward	6	5.09	48	35.82	47	45.63	101	28.45		

3.2 Qualitative traits

3.2.1 Coat color and pattern

The present study revealed a highly significant difference ($p < 0.001$) in coat color distribution among indigenous goats across the surveyed villages, with White dominant (17.96%), Black dominant (16.85%), and Black (16.58%) being the most prevalent types. This observation is consistent with earlier studies in southern Ethiopia, including south Omo, Gamo, and Gofa regions, where multicolored coats were commonly reported and influenced by both natural and human-mediated selection pressures (Dereje et al., 2019; Mekete et al., 2020; Dereje et al., 2021). Coat color and pattern, as visual phenotypic traits, play a critical role in assessing phenotypic variability and are often used as primary selection criteria in community-based breeding programs. The significant variation observed across villages suggests potential underlying genetic diversity and/or adaptation to local environmental conditions, as well as cultural preferences that may drive selection. These findings underscore the importance of considering coat color and pattern in breeding strategies, both for conservation of indigenous genetic resources and for aligning production traits with farmer preferences, which may enhance acceptance and success of improvement programs.

The study also revealed a highly significant variation ($p < 0.001$) in coat color patterns, with patchy patterns accounting for 58.56% and plain patterns 41.44% of the goats. This considerable phenotypic diversity is advantageous for community-based breeding programs (CBBPs), as it provides visible traits that farmers can use for selection, alongside functional traits such as growth, milk production, or reproductive performance.

From the data collected across villages, it was observed that certain flocks exhibited predominance in one pattern over the other. Goats in Baide village predominantly showed patchy patterns, while goats in Jarso had a higher proportion of plain patterns. Such differences likely reflect both farmer selection preferences and underlying genetic variation between flocks in different CBBP villages.

Supporting evidence from previous studies indicates that coat color and pattern are often associated with specific communities or regions within indigenous goat populations. Dereje et al. (2019) and Mekete et al. (2020) reported that visual phenotypic traits, including coat color and pattern, vary significantly across CBBP villages in southern Ethiopia, and these traits are frequently used by farmers for selection due to cultural, aesthetic, or market preferences. This supports the observed association between color phenotype and CBBP villages in the current study, highlighting the importance of incorporating these traits into selective breeding strategies.

3.2.2 Wattle and ruff presence

Wattle presence was low overall, accounting for only 3.87% of the sampled goats, and differed significantly among villages ($p < 0.05$), with Jarso showing a slightly higher frequency than Baide and Arfayde.

Ruff presence varied highly significantly among villages ($p < 0.001$), with the highest frequencies observed in Baide and Arfayde, and the lowest in Jarso. Similar observations for minor qualitative traits have been reported in indigenous goat populations by Lorato et al. (2015). Although wattle and ruff traits may have limited direct economic or adaptive importance, they are useful phenotypic markers for breed characterization and differentiation among village populations in community-based breeding programs.

3.2.3 Horn orientation

Horn orientation (Figure 1) differed significantly among villages ($p < 0.001$). In Baide, straight horns were the most common (47.46%), followed by backward (3.54%) and forward (5.09%) orientations. In Arfayde, backward horns predominated (57.46%), with forward (35.82%) and lateral (4.48%) orientations being less frequent. In Jarso, backward (46.60%) and forward (45.63%) horns were most common, while straight horns were nearly absent (0%). Almost similar values were reported for goats in Male and Dawuro areas (Lorato et al., 2015; Mekete et al., 2020).

These village-specific variations likely reflect underlying genetic differences as well as local selection preferences, emphasizing the importance of considering horn orientation in breeding design and breed standardization. Similar patterns have been reported in indigenous goat populations in southern Ethiopia and other East African production systems, where horn traits are largely genetically determined but may also be influenced by farmer preferences related to handling ease and cultural practices (Dereje et al., 2019; Kitila et al., 2025).

Figure 1. Typical horn shape of Woyto-Guji goat bucks

3.3 Quantitative traits

The overall mean ± SD of body weight (BW), body condition score (BCS), tail length (TL), horn length (HL), body length (BL), scrotum circumference (SC), ear length (EL), chest girth (CG), and wither height (WH) of the Woyto-Guji goats are presented in Table 3. The average body weight was 24.93 ± 5.52 kg, with a body condition score of 2.71 ± 0.53, tail length of 12.22 ± 1.64 cm, and chest girth of 69.91 ± 5.89 cm. The coefficient of variation (CV) ranged from 8.09% for body length to 34.77% for horn length, reflecting moderate to high variability among traits.

3.3.1 Village effect

Goats from Jarso village exhibited significantly higher body weight (26.38 ± 5.52 kg) and chest girth (72.71 ± 4.80 cm), which may be associated with relatively better feed availability, wider browsing areas, and more favorable environmental conditions compared to the other villages. Similar trends were reported by Tesfaye et al. (2020) for mature Konso goats from Jarso and Mesoya. Differences in reported body weight between studies may also reflect seasonal effects, sampling structure, and management differences at the time of data collection.

Tail length showed significant variation among villages, with Baide goats having the longest tails (13.01 ± 1.61 cm), suggesting possible micro-environmental or genetic influences. Conversely, horn length, body length, and ear length did not differ significantly, indicating relative morphological uniformity for these traits across villages.

3.3.2 Sex effect

Significant sex-based differences ($p < 0.05$) were observed for most traits. Females had slightly higher body weight (25.04 ± 5.01 kg) than males (24.75 ± 6.27 kg), potentially due to preferential retention of productive females. Males had significantly longer horns (9.21 cm vs. 7.55 cm) and greater wither height (62.49 cm vs. 61.06 cm), reflecting sexual dimorphism (ALPHONSUS et.al, 2024).

3.3.3 Age by dentition effect

All traits except ear length were significantly influenced by age class ($p < 0.05$). As expected, older animals (3PPI and 4PPI) displayed higher values for body weight, body length, chest girth, and wither height, consistent with growth and physiological development. The highest average body weight at 3PPI (28.62 kg) and the lowest average body weight at 0PPI (19.07 kg) were revealed (Aliyu et.al, 2021).

Figure 2. Scrotum measurement

Table 3. Linear body measurements for body weight, body condition score, tail length, horn length, body length, scrotum circumference, ear length, chest girth and wither height determined by sex, village and age by dentition as a fixed factors

Traits	**BW (351)**	**BCS (362)**	**TL (362)**	**HL (354)**	**BL (362)**	**SC (110)**	**EL (355)**	**CG (362)**	**WH (362)**
Mean ± SD	**24.93±5.52**	**2.71±0.53**	**12.22±1.64**	**8.16±2.84**	**61.02±4.94**	**22.92±2.68**	**12.70±1.83**	**69.91±5.89**	**61.58±4.99**
CV (%)	**22.14**	**19.49**	**13.40**	**34.77**	**8.09**	**11.69**	**14.40**	**8.42**	**8.10**
R^2	**0.81**								
Sex	*	*	NS	*	*		*	NS	*
Male	24.75±6.27[b]	2.78±0.62[a]	12.54±1.62	9.21±3.04[a]	60.88±5.74[b]	22.92±2.68	12.83±2.40[a]	69.43±6.27	62.49±5.29[b]
Female	25.04±5.01[a]	2.66±0.46[b]	12.03±1.62	7.55±2.53[b]	61.10±4.40[a]	-	12.61±1.37[b]	70.20±5.64	61.06±4.74[a]
Village	*	*	*	NS	NS	NS	NS	*	NS
Baide	24.12±6.16[b]	2.87±0.52[a]	13.01±1.61[a]	7.79±2.99	61.29±5.15	23.16±3.04	12.52±1.58	69.02±5.97[b]	61.44±5.02
Arfayde	24.68±5.39[ab]	2.59±0.65[b]	11.65±1.56[b]	8.23±2.85	61.02±5.15	22.36±2.43	12.83±2.37	68.60±5.88[b]	62.15±4.68
Jarso	26.38±5,52[a]	2.68±0.26[b]	11.99±1.39[b]	8.50±2.61	60.68±4.37	23.79±2.15	12.74±1.25	72.71±4.80[a]	61.03±5.30
Age (dentition)	*	*	*	*	*	*	NS	*	*
0PPI	19.07±3.24[d]	2.52±0.45[c]	11.86±1.35[c]	6.13±2.31[b]	55.96±3.20[c]	21.97±3.10[c]	12.17±1.33	63.86±4.52[c]	57.68±3.13[c]
1PPI	22.44±3.90[c]	2.69±0.49[bc]	12.55±1.46[ab]	8.62±2.77[a]	59.63±4.73[b]	23.31±2.18[a]	12.93±1.08	67.55±4.65[b]	61.17±4.73[b]
2PPI	24.10±4.04[b]	2.61±0.52[c]	11.88±1.65[c]	8.18±2.55[a]	60.51±4.13[b]	23.80±1.87[a]	12.77±2.50	68.92±4.66[b]	61.25±4.35[b]
3PPI	28.62±4.67[a]	2.88±0.59[a]	12.13±1.70[bc]	8.79±3.03[a]	63.03±4.52[a]	22.25±4.72[b]	13.00±1.59	73.04±5.18[a]	63.83±5.96[a]
4PPI	28.59±5.08[a]	2.81±0.48[ab]	12.78±1.71[a]	8.69±2.78[a]	64.36±3.83[a]	-	12.52±1.74	74.18±4.46[a]	62.92±4.17[a]

BW= Body weight, TL= Tail length, HL= Horn length, BL= Body length, SC=Scrotum circumference, EL= Ear length, CG=Chest girth, WH=Wither height

Table 4. Overall Pearson correlation for body weight, body condition score, tail length, horn length, body length, scrotum circumference, ear length, chest girth and wither height

Traits	BW	BCS	TL	HL	BL	SC	EL	CG	WH
Body_weight									
Body_condition score	0.52^{**}								
Tail_length	0.31^{**}	0.37^{**}							
Horn_length	0.59^{**}	0.32^{**}	0.30^{**}						
Body_length	0.76^{**}	0.43^{**}	0.34^{**}	0.56^{**}					
Scrotum_circumference	0.40^{**}	0.32^{**}	0.41^{**}	0.43^{**}	0.35^{**}				
Ear_length	0.13^{*}	0.13^{*}	0.08^{NS}	0.16^{**}	0.13^{*}	0.24^{*}			
Chest_girth	0.86^{**}	0.46^{**}	0.27^{**}	0.57^{**}	0.67^{**}	0.51^{**}	0.13^{*}		
Whither_height	0.64^{**}	0.34^{**}	0.30^{**}	0.44^{**}	0.57^{**}	0.44^{**}	0.14^{**}	0.56^{**}	

BW = Body Weight; BCS = Body Condition Score; TL = Tail Length; HL = Horn Length; BL = Body Length; SC = Scrotum Circumference (cm, males only); EL = Ear Length; CG = Chest Girth; WH = Wither Height. **Correlation is significant at the 0.01 level (2-tailed). *****Correlation is significant at the 0.05 level (2-tailed).

3.4 Statistical analysis

3.4.1 Correlation analysis

As shown in Table 4, Pearson correlation coefficients revealed strong, positive, and highly significant associations ($p < 0.01$) between body weight and several linear measurements such as chest girth (CG): r = 0.86, body length (BL): r = 0.76, and wither height (WH): r = 0.64. These measurements are reliable indirect indicators of live weight, making them valuable for field-based selection where weighing equipment is unavailable especially at market places. Almost similar findings were reported for goats in Gamo and Gofa area goats (Dereje et. al, 2019; Dereje et. al., 2020).

3.4.2 Regression for body weight prediction

Three models were developed using stepwise multiple regression to predict body weight (BW) from linear measurements.

Table 5. Sex-specific and overall multiple regression equations for predicting body weight (BW) of Woyto-Guji goats

Sex	**Model equation**	**R^2**	**Significance**
Male	BW = -41.05 + 0.03TL+ 0.12HL+ 0.25BL- 0.01EL+ 0.57CG+ 0.16WH	0.87	0.000
Female	BW = -38.41 - 0.01TL+ 0.09HL+ 0.29BL+ 0.01EL+ 0.51CG+ 0.15WH	0.75	0.000
Overall	BW = -37.27 + 0.518 × CG + 0.246 × BL + 0.172 × WH	0.80	0.000

Multiple regression analysis showed strong relationships between body weight (BW) and linear body measurements in both sexes (Table 5). The male model explained 87% of BW variation ($R^2 = 0.87$; $p < 0.001$), while the female model explained 75% ($R^2 = 0.75$; $p < 0.001$), likely reflecting sexual dimorphism and greater body size variability in males (Tesfaye et al., 2020).

Across sexes, chest girth (CG) was the strongest predictor of BW, consistent with reports on indigenous goats where CG closely reflects body volume and muscle mass (Getachew et al., 2016; Dereje et al., 2019; Tesfaye et al., 2020). Body length (BL) and height at withers (WH) also contributed positively but to a lesser extent.

The reduced overall model retaining CG, BL, and WH explained 80% of BW variation ($R^2 = 0.80$; $p < 0.001$). Excluding tail, horn, and ear lengths was justified by their low explanatory power and potential collinearity. Similar parsimonious models have been reported under smallholder systems (Getachew et al., 2016). Sex-specific equations improved prediction accuracy and are recommended for field application, particularly where weighing scales are unavailable (Dereje et al., 2019; Tesfaye et al., 2020; Getahun et al., 2020). The CANDISC analysis also confirms significant morphological differentiation among villages, with male goats showing greater separation than females. In both sexes, chest girth, body length, and body condition were the primary traits contributing to discrimination.

4. Conclusion

The phenotypic characterization of Woyto-Guji goats revealed substantial variation in both qualitative and quantitative traits across villages, sexes, and age classes. Significant differences were observed in body weight, chest girth, body length, wither height, tail length, and horn length, with older goats (3PPI and 4PPI) exhibiting larger body measurements. Males had longer horns and greater wither height, while females were slightly heavier, reflecting sexual dimorphism and management practices favoring the retention of productive females. Chest girth, body length, and wither height showed strong positive correlations with body weight, and regression models based on these traits explained up to 80% of body weight variation, providing reliable tools for field-based weight estimation. Qualitative traits, including coat color, color pattern, horn orientation, and the presence of wattles and ruffs, varied significantly among villages, suggesting underlying genetic diversity and the influence of local farmer selection preferences. These findings provide essential baseline information for breeding programs and support evidence-based selection and management strategies for Woyto-Guji goats.

Conflict of Interest

The authors declare no conflict of interest regarding the publication of this paper. All data were collected and analyzed objectively, and there are no financial or personal relationships that could have influenced the research findings.

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