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Research Article

On-farm Phenotypic Characterization of Indigenous Cattle Breed in Borana Zone of Oromia Regional State, Ethiopia

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Abstract

The study was conducted in Dire, Golbo, Gomole, Melbe, and Woyama grazing land escapes of Boran Zone, Oromia Regional State, Ethiopia, from September 2021 to June 2023 to undertake farm phenotypic characterization of indigenous cattle populations in the study area. Field studies and collection of data were carried out through observations and linear body measurements of sample cattle and secondary data collection from different sources. A total of 568 adult female and 142 adult male cattle were sampled for morphological description and linear body measurements. The mean linear measurements of female cattle for heart girth, body length, and height at withers, rump height, horn length, and ear length were 149.2cm, 124.5cm, 110.3cm, 118.7 cm, 13.9 cm, and 19 cm respectively. Male cattle had a heart girth of 153.2cm, body length of 125.3 cm, height at withers 110.9 cm, height at rump 120 cm, horn length of 13.8cm, and ear length of 22.7 cm. Linear body measurements were significantly ($P < 0.05$) affected by location and sex. Borana cattle (Qorti) subtypemostly known by their large body size and being tall height withtheir color is mainly white, light gray, fawn, or light brown with gray, black, or dark brown shading on the head, neck, shoulders, and hindquarters as well as the horns are thick at the base, very short and dark with a long tail. In general, the result of the current finding showed that especially most quantitate measurements were a lower than previous work done within the same areas of study.Further characterization of local cattle especially the difference between Qort and Ayuna at the molecular level should be duly required in the study area.

Keywords

Phenotypic, Characterization, Indigenous Cattle, Breed

1. Introduction

The biological foundation and vital component of global food security are animal genetic resources (AnGR) for agriculture and food. Countless impoverished rural communities, numbering in the hundreds of millions, raise livestock and frequently depend on it for a variety of goods and services. Raising cattle is frequently the primary or sole source of income in difficult areas where crop output is unpredictable. As of right now, livestock accounts for around 30% of the agricultural Gross domestic product (GDP in emerging nations; by 2030, that percentage is expected to rise to 40%. According

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to estimates from the World Bank, between 2000 and 2030, there would need to be an almost 80% rise in meat output. More effective techniques for raising animals, cautious management of natural resources, and steps to lower [1]. Pastoralism and agro-pastoralism are the dominant livestock production-based, land-use systems in the arid agro-ecologies of Ethiopia and account for 50% of the total 114 million livestock numbers, out of which 40% of cattle, 52% sheep, 56% of goats, and 100% of camels are originated from this area [2].

It is generally believed that most domestic animals were first domesticated in southwest Asia. The origin and development of African livestock have been a subject of studies in the past and additional African origin has been forwarded for cattle by some of the studies [3-5]. The presence of diverse breeds of livestock in the continent has called for characterizing the breeds for utilization and conservation and, to date, numerous studies have been undertaken.

Characterization of a population of livestock is necessary for proper identification of breeds and to command appropriate breeding programs for sustainable improvement, conservation, and sustainable utilization of animal genetic resources [6]. The current state of knowledge on the characterization of cattle genetic resources in Ethiopia shows that there is inadequate breed-level characterization information [7].

Like in other pastoral and agro-pastoral production systems livestock production forms the basis of the economy, especially the main source of food and income supporter of Borana zone. The phenotypic characteristics of the Borana cattle breed are inadequately documented especially in their natural habitat, hindering efforts to establish breed standards and promote conservation, Therefore, this study was designed with the following objective.

Objective:

To conducton-farm phenotypic characterization of Borana cattlepopulations

2. Material and Method

The study was carried out in five grazing land escapes (Dire, Golbo, Gomole and Woyama) in the Borana, Oromia Regional State, Ethiopia, from September 2021 to June 2023.The Borena Zone is located in the Southern portion of Oromia Regional State at 3o 26' - 6o 32' N latitude to 36o 43' - 40o 46' E longitude [8].

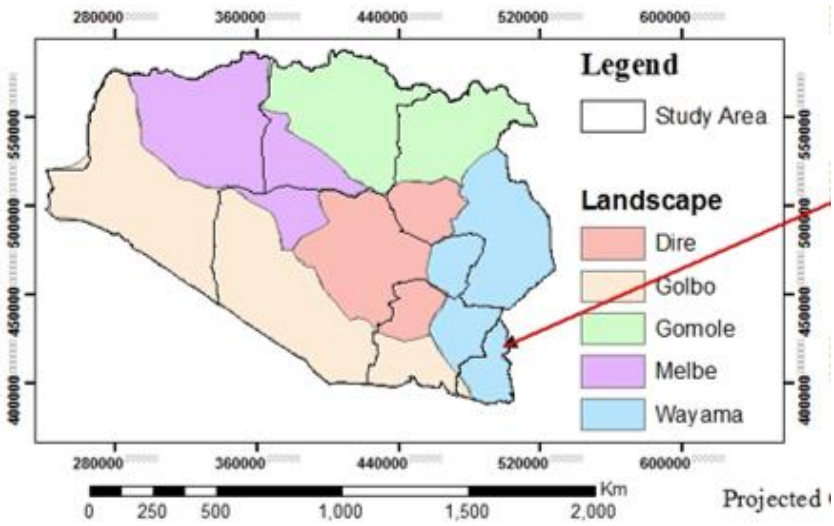

Figure 1. *Map of the five indigenous landscapes of Borana rangelands (Dire, Golbo, Gomole, Melbe, Wayama).*

2.1. Site Selection and Sampling Techniques

To have primary data on the external appearances of the indigenous cattle, the linear body measurements and other physical characteristics were measured and observed while interviewing the sample household. These characteristics were taken from matured and unrelated male and female cattle (Table 1).

Table 1. *Number of mature animal sampled by sex and grazing land escape.*

Grazing land escapes	Number of animals		Total
	Female	Male	
Dire	106	16	122
Golbo	97	10	107

Grazing land escapes	Number of animals		Total
	Female	Male	
Gomole	136	31	167
Malbe	123	64	187
Woyama	106	21	127
Total	568	142	710

The sample size was selected according to [9] guidelines about 10-30 males and 100-300 females cattle population physical measurement should be taken for phenotypic characterization

2.2. Statistical Analysis

General linear model procedures (PROC GLM) of the statically analysis system (SAS 9.2) were employed for quantitative variables to detect statistical differences among sample cattle populations. Mean comparisons were made for variables showing significant differences between sample populations. Taking districts and sex as main fixed effects, the following model was used.

$$Yijk = \mu + Li + Dijk$$

Where:
Yijk = observed value of trait of interest
μ = overall mean
Li = fixed effect of ith location effect
Dj = fixed effect of jth sex type
eijk = residual random error associated with the [ijk]th observation

3. Results and Discussion

3.1. Observations and Linear Body Measurements

3.1.1. Quantitative Variation

Table 2 indicates the least square means of linear body measurements (cm) for all sites and sex.Except tail length all the quantitative dependent variables were highly significantly ($p<0.05$) affected by sex. Hence variance analyses were performed separately for the two sexes.In the female cattle population,the average measured value for heart girth, body length and height at withers were 149.2, 123.8, and 110.8 respectively. Except Body length (BL) heart girth, height at wither, height at the rump and horn length of females for current findings were lower than the findings of [10] which were 148.2, 114.8, 123.1 and 14.3 cm respectively for Borana cattle of the same sex and study areas. The study of [11] for Horro female cattle indicates a lower value of body length, chest girth and height at withers than the current finding. The study by [12] for native female Ogaden cattle, in Eastern Ethiopian ecology, close to the border of the Hararghe plateau, revealed lower values for body length (104.1±0.50), height at the withers (113.5±0.39 of Ogaden), but shows similar values for chest girth (149.1±0.66) with the current findings.In the male cattle population, the average measured value for heart girth, body length and height at withers and rump were 115.5, 132, 114.8 and 121.5 cm respectively. Except for body length which was higher, height at withers and height at rump were lower while heart girth and horn length were comparable in male cattle of the finding of [11] for the same breed. The present result was less favorable than [13] 137.0±0.10, 136.0±0.09, and 168.9±0.10cm, and for male Begait cattle. The current results, however, were remarkably higher than the average measured values for body length, chest girth (131.53 cm), and height at withers of Horro cattle, which were determined to be (99.42 cm), and 107.18 cm, respectively, reported by [11] and [14].

Table 2. *Least square means ±SE of linear body measurements (cm) for all sites by sex.*

Dependent variables	Female (568)	Male (142)	Sex
Heart Girth	148.2±0.40	155.5±0.80	<.0001
Body length	123.8±0.57	132.0±1.10	<.0001
Height at withers	110.8±0.36	114.8±0.70	<.0001
Rump height	115.7±0.32	121.5±0.64	<.0001
Front leg length	61.8±0.22	65.0±0.43	<.0001
Hind leg length	68.0±0.24	71.3±0.46	<.0001
Neck length	40.8±0.61	52.5±1.21	<.0001
Face length	41.6±0.16	43.1±0.32	<.0001
Horn length	10.6±0.33	13.9±0.65	<.0001
Ear length	19.8±0.24	22.8±0.47	<.0001
Tail length	75.7±0.40	76.1±0.77	0.6203
Dewlap width	18.0±0.23	23.2±0.44	<.0001
Chest depth	55.5±0.20	59.2±0.39	<.0001

Pair-wise comparisons of female cattle among grazing land escapes for linear body measurements are shown in Table 3. The finding revealed that except dewlap, all linear body measurements were significantly ($P < 0.05$) affected by location. As a result, the female cattle population at the Woyama grazing land escape had the greatest hearth girth and body length from the rest of the cattle grazing land escapes. In addition, the female cattle population of Golbo grazing land

escape had the highest body length, height at withers and tail length. The current finding was consistent with earlier reports which found that cattle populations in different ecological zones have distinct morphological characteristics, including variation in linear body measures such as height, length, and girth as a result of natural selection pressures and adaptation to specific environmental conditions [15].

Table 3. *Least squares means and pair wise comparisons between grazing land escapes of linear body measurements (cm) for female cattle population.*

Dependent	**Grazing land escapes**				
variables	**Dire**	**Golbo**	**Gomole**	**Melbe**	**Woyema**
N	**106**	**97**	**136**	**123**	**106**
Heart Girth	149.2 ±0.84b	144.3 ±1.10d	148.1 ±0.74bc	146.3 ±0.78cd	152.2 ±0.89a
Body length	124.5 ±0.97ab	126.6 ±1.26a	123.1 ±0.85c	119.8 ±0.90d	127.5 ±1.00a
Height at withers	110.3 ±0.20b	115.8 ±.90a	111.4 ±0.60b	107.8 ±0.65c	111.2 ±0.73b
Rump height	118.7 ±0.65a	107.6 ±0.85d	117.3 ±0.58ab	114.8 ±0.60c	116.6 ±0.7b
Front leg length	61.37 ±0.50b	60.8 ±0.63b	63.8 ±0.43a	60.7 ±0.45b	61.3 ±0.50b
Hind leg length	68.3 ±0.47b	69.0 ±0.62ab	69.7 ±0.42a	65.5 ±0.44c	67.8 ±0.50b
Neck length	40.4 ±0.57bc	39.3 ±0.74c	41.11 ±.5b	43.0 ±0.53a	39.0 ±0.60c
Face length	41.5 ±0.23bc	42.0 ±0.3ab	40.95 ±0.20c	42.1 ±0.22a	41.8 ±0.25ab
Horn length	13.9 ±0.50a	12.0 ±0.63b	7.5 ±0.43d	9.9 ±0.43c	11.4 ±0.50b
Ear length	19.0 ±0.20c	21.9 ±0.33a	19.8 ±0.22b	19.7 ±0.24bc	19.7 ±0.27bc
Tail length	71.3 ±0.68c	81.3 ±0.88a	76.9 ±0.6b	75.3 ±0.63b	75.7 ±0.71b
Dewlap width	18.3 ±0.40a	18.5 ±0.53a	17.7 ±0.36a	18.1 ±0.38a	17.8 ±0.43a
Chest depth	56.0 ±0.43b	57.7 ±0.56a	54.4 ±0.38c	54.5 ±0.40c	56.0 ±0.45bc

Means with different superscripts within the same row are significantly different ($p<0.05$)

Pair wise comparisons of male cattle among districts for linear body measurements are shown in Table 4. The finding revealed that except front leg length, all linear body measurements were significantly ($P < 0.05$) affected by location. Mean comparison for male cattle population of this study revealed that Gomole grazing land escape wassignificantly superior ($P<0.05$) in body length height at withers and rump than males of the rest four grazing land escape cattle populations in the study area. In general this study revealed that Gomole grazing land escape male cattle were large frame and longer in height than other fourgrazing land escape cattle population in the study area

Phenotypic correlations between quantitative traits in female and male Borana cattle showed low to high positive values in Table 5. One of the most popular and helpful statistics for describing the strength of association between two variables is the correlation. In the case of the female sample population, the strongest degree of relationship was seen between hind leg length and Front leg length ($r = 0.81$) followed by hind leg length and height at rump ($r=0.59$). The correlation of Hearth girth withbody length, height atwither height at the rump, and chest depthof female cattle were found to have a positive, moderate relationship (r=.5-5.9),

In the case of male Borana cattle the strongest degree of relationship was observed between height at the rump and face length ($r=0.85$) followed by height at the rump and hind leg length (r=.82). There was also a strong relationship between ear length and dewlap width as well as between heart girth and height at wither ($r=0.74$). In general, this result showed that there are significant sex-specific differences in the size or intensity of the association between linear body measurements and the environment or grazing types where the animals are raised.

Table 4. *Least squares mean and pair-wise comparisons between districts of linear body Measurements (cm) for male population.*

Dependent	Grazing land escapes				
variables	Dire	Golbo	Gomole	Melbe	Woyema
N	16	10	31	64	21
Heart Girth	153.2 ±2.60ab	148.3 ±4.20b	154.8 ±1.85ab	158.4 ±1.30a	151.8 ±2.25b
Body length	125.3 ±4.83b	121.8 ±7.88b	144.0 ±3.46a	129.7 ±2.40b	127.7 ±4.2b
Height at withers	110.9 ±2.58a	110 ±4.20ab	117.8 ±1.85a	116.6 ±1.30a	109.2 ±2.25b
Rump height	120 ±1.86b	119.2 ±3.03ab	124.6 ±1.34a	121.4 ±0.93ab	119 ±1.62b
Front leg length	63.9 ±1.20a	66.2 ±1.90a	64.7 ±0.84a	65.3 ±0.60a	64.9 ±1.00a
Hind leg length	67.4 ±1.60b	71.8 ±2.64ab	72.9 ±1.20a	72.5 ±0.80a	68.4 ±1.40b
Neck length	55.2 ±6.82ab	42.5 ±11.14ab	44.1 ±4.90b	53.2 ±3.40ab	63.6 ±5.33a
Face length	39.4 ±1.53b	42.67 ±2.5ab	44.1 ±1.00a	45.2 ±0.77a	38.0 ±1.33b
Horn length	13.8 ±3.12b	11.5 ±5.10ab	10.5 ±2.24b	13.2 ±1.56b	22.1 ±2.72a
Ear length	22.7 ±2.70b	21.5 ±4.35ab	21.4 ±1.90b	21.5 ±1.33b	29.1 ±2.32a
Tail length	73.1 ±3.32ab	73.3 ±5.42ab	77.9 ±2.34ab	77.9 ±1.66a	71.0 ±2.9b
Dewlap width	25.6 ±1.94ab	21.3 ±3.20ab	21.4 ±1.40b	22.1 ±0.97b	27.9 ±1.70a
Chest depth	58.3 ±1.20ab	58.3 ±1.90ab	59.4 ±0.84ab	60.0 ±0.60a	57.5 ±1.03b

Means with different superscripts within the same row are significantly different ($p<0.05$)

3.1.2. Prediction of Live Body Weight (LBW)

Table 6 shows a stepwise prediction of live body weight for the Borana cattle population in both sexes based on linear body measurements. In the current result, the heart girth (HG), Body length (BL), height at the rump (HR), and height at the withers (HW) alone were good estimators of body weight and explained 14, 11, 23, and 20% of the variation, respectively, according to the stepwise multiple regression prediction of linear body measurements (R2) fitted the districts and sex together in which the other variations were distributed to other variables. Furthermore, according to [16], the relationship between body weight and heart girth increased significantly (r = 0.99). In comparison to actual weaning and yearling weight, predictions of live weight made from linear body measures (HG and BL) taken from a weight tape were accurate. Overall, it was found that height at the withers, height at the rump, and hearth girth (HW, HR and HG), which together account for the biggest percentage of variances in both animal types, are the closest estimators of live weight in Borana cattle Even though the extra gain was just a little 1 cm, the results of the multiple regression studies showed that the addition of other measurements to HG would significantly enhance prediction accuracy. In light of their strong correlation and higher R2 values, body length and heart girth can be used to determine the weight of female calves. Consequently, [(151.87*age+ (-3.68) + (127.93*age+ (-4.10)] was an estimated 451.3 kg for those female cattle population), as opposed to [(151.87*age+3.68) + (127.93*age+4.10)], which was 459.78kg for male cattle under 5 years cattle populations. Since age does have a substantial impact on the fluctuation of weight in herds employing linear measurements, the age of the animal is in this case a crucial factor in calculating the live weight of the cattle. This finding was in line with the reports by [17] the average weight of Borana cattle when their growth is finished is 650-850 kilograms (1,430-1,870 lbs) for bulls and 350-500 kilograms (770-1,100 lbs) for cows.

3.2. Qualitative Traits

Respondents and focus group discussion confirmed the presence of two distinct sub-types of the Ethiopian Boran cattle. The traditional large-framed Qorti, and the smaller-framed Ayuna/Gelaba strains. The main criteria for classification were their body size (length and height) and color.Accordingly, the Qorti sub typemostly known for their large body size and being tall height their color is mainly white, light gray, fawn, or light brown with gray,black, or dark brown shading onthe head, neck, shoulders, and hindquarters (Figure 2). The horns are thick at the base, very short and dark as well as long tail.The dewlap is well developed. In the male, the perpetual sheath is pendulous. While in the

female, the udder is well developed. This finding also showed that the color of Qorti was red, red with white and some colors other than black whileAyuna is described by Figure 3.

Table 5. *Pearson's correlation coefficient (r) for quantitative traits in females (above diagonal line) and males (below diagonal line) for sample populations.*

	HG	BL	HW	HR	FLL	HLL	NL	FL	HL	EL	TL	DW	CHD
HG		0.51	0.53	0.50	0.24	0.27	0.28	0.24	0.19	0.02	0.09	0.20	0.54
BL	0.43		0.43	0.43	0.29	0.35	0.26	0.19	0.23	0.27	0.26	0.39	0.49
HW	0.74	0.35		0.29	0.48	0.51	0.42	0.02	0.12	-0.04	-0.01	0.13	0.45
HR	0.13	0.09	0.16		0.49	0.59	0.25	0.34	0.00	0.32	0.27	0.05	0.42
FLL	0.32	-0.05	0.46	-0.01		0.81	0.23	0.16	-0.02	0.29	0.06	-0.05	0.21
HLL	-0.02	-0.06	0.11	0.82	0.27		0.26	0.14	0.13	0.25	0.09	-0.01	0.29
NL	0.18	-0.01	0.10	0.13	0.04	0.06		0.06	0.20	0.00	0.07	0.14	0.36
FL	-0.02	0.08	-0.07	0.85	-0.24	0.73	-0.01		0.11	0.24	0.10	0.11	0.15
HL	0.28	0.01	0.14	-0.54	0.33	-0.41	-0.11	-0.57		-0.02	0.01	0.20	0.25
EL	0.12	-0.01	0.08	-0.76	0.36	-0.61	-0.09	-0.86	0.69		0.13	0.07	0.15
TL	0.16	0.13	0.17	0.64	-0.16	0.50	0.08	0.68	-0.40	-0.66		0.12	0.24
DW	0.27	0.30	0.20	-0.64	0.31	-0.61	-0.04	-0.75	0.59	0.78	-0.48		0.27
CHD	0.68	0.33	0.59	0.14	0.20	0.04	-0.02	0.09	0.11	0.03	0.25	0.15	

HG=Heart Girth, BL=Body length, HW=Height at withers, HR= Rump height, FLL= Front leg length, HLL= Hind leg length, NL=Neck length, FL=Face length, HL=Horn length, EL= Ear length, TL= Tail length, DW=Dewlap width, CHD= Chest depth

Table 6. *Linear Regression of weight prediction for both female and male Borana cattle population.*

	Prediction equation	RMSE	R2
Hearth girth	151.87*age+(-3.68F, +3.68M) HG	9.28	0.14
Body length	127.93*age+(-4.10F, +4.10M) BL	15.63	0.11
Height at withers	113.76*age+(-3.80F, +3.80M) HR	8.07	0.23
Height at Rump	119.41*age+(-3.45F, +3.45M) HW	7.16	0.20

*F-Female; *M-Male; HG: Heart girth; BL: Body length; HR: Height at rump; HW: Height at withers

Figure 2. *Typical Borana breeding female (left) and breeding bull (right).*

Figure 3. *Pastoral herd tracking long distance for watering during drought of2023 around Dida Hara PA.*

4. Conclusion and Recommendation

Almost all quantitative dependent variables had a significant ($p<0.05$) effect on the phenotypic variance depending on the animal's sex and location. Height at wither, Height at the rump, and hearth girth (HW, HR and HG), which together account for the biggest percentage of variances in both animal types, are the closest estimators of live weight in Borana cattle. The traditional large-framed Qorti and the smaller-framed Ayuna/Gelaba strains were the two sub-types of Borana cattle. In general, the finding stated that lower for most quantitate measurements from previous work done within the same areas of study. As recommendation further characterization of local cattle especially the difference between Qort and Ayuna at the molecular level should be duly required in the study area.

Abbreviations

ACTESA	Alliance for Commodity Trade in Eastern and Southern Africa
AnGR	Animal Genetic Resources
BL	Body Length
BPDO	Borana Zone Agricultural and Pastoral Development
CHD	Chest Depth
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
DW	Dewlap Width
EL	Ear Length
FL	Face
FLL	Front Leg Length
HG	Heart Girth
HL	Horn Length
HLL	Hind Leg Length
HW	Height at Withers
HR	Rump Height
PROC GLM	General Linear Model
NL	Neck Length
SAS	Statically Analysis System
TL	Tail Length

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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