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Original Article

Morphological Characterization and Structural Indices of Indigenous Cattle in Hadiya Zone, Southern Ethiopia

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ABSTRACT

The study was conducted to morphologically characterize indigenous cattle breeds and to develop structural indices to assess type and function of indigenous cattle in Soro and Misha districts of Hadiya zone Southern Ethiopia. A total of 660 mature cattle (480 cows and 180 bulls) were selected for morphological description. Data was collection by using visual observation and linear measurements and analyzed by Statistical Package for Social Sciences (SPSS version 20), and compared at the significance level P<0.05. The result showed individual variation among cattle in both qualitative and quantitative traits. Most of the cattle in the study area have plain coat colour pattern, curved horn with upward orientation, small humped and straight facial head profile. The overall results of morphometrical measurements in Soro district had higher (P<0.05) values for their body weight and the chest girth for the bulls in age class 1 and 2PPI. However, body weight, chest girth, height at withers and height at rump were higher for Misha district when compared to those bulls at Soro district for age class 3 and 4PPI. For the cows within age group 1 and 2PPI reared at Soro district have higher (P<0.05) body weight, chest girth, height at withers, height at rump and rump length. The results of body indices of the bulls in Misha district were higher values (p<0.05) for body index for age class 1 and 2PPI and cephalic index and over increase index for age class 3 and 4PPI. While, body ratio was higher (p<0.05) for Misha district for age class 3 and 4 PPI. In contrast, body indices for cows in Soro district was higher (p<0.05) for height index, rump length index, body index, body weight index and body ratio, in contrasting cephalic index, body index, over increase index, body weight index, body ration and height slope were higher(P<0.01) for Misha district for age class 3 and 4PPI. The values for estimation of body weight using linear body measurements indicated that chest girth was best predictor body weight. In general, cattle linear body measurements in the current environmental condition were comparable with other indigenous breeds. Therefore, designing appropriate management and breed improvement programme with the participation of

the community are critical to improve the breed. Morphometrical traits of the breed have to be complemented by genetic characterization to fully exploit the potential of the breed.

Key words: Indigenous cattle, morphometrical measurements, structural indices.

INTRODUCTION

Ethiopia is endowed with huge livestock resources of wide-ranging and diversified genetic pools with a wide range of agro ecologies. The country is predominantly agrarian with most of the people residing directly or indirectly dependent on agriculture for their day to day activities. Farm animals as a whole are an integral part of agricultural systems. It is estimated that livestock contribute about 12 - 16% of the total and 47% of the agricultural Gross Domestic Product excluding the value of draft power, manure and other such activities and contributes significantly to the livelihood of their rearers and those dependent on them (Muluye, 2016). In most of the rural households livestock production is at the subsistence level, where livestock are selected for adaptive traits with productivity of individual animals being quite low and the overall productivity comes through their sheer numbers and fulfills multiple purposes that contribute more for food security (Eshetu and Abraham, 2016 & Ftiwi, 2015). According to (CSA, 2016/2017), cattle population in the country is about 59.5 million heads most of which about 98.2% are of native breed's ecotypes. Only about 1.62% and 0.18% of them are crossbreds and exotic types, respectively. Out of these total cattle population heifers/cows constitute about 59.5%. The numbers of cattle reared in Southern Nations Nationalities and Peoples Region (SNNPR) are estimated to be 11.49 million heads which Hadiya zone houses 929,689 heads of cattle (CSA, 2016/2017). Prior to any specific intervention, it is imperative to understand the prevailing production systems and the genetic makeup of the animals reared in the area. Morphometric studies are the prelude of any genetic studies which can be categorized into both of qualitative and quantitative traits (Banerjee, 2015). The former are influenced by a few pairs of genes and their assessment is grossly subjective and moderately to highly heritable (FAO, 2012). This category of traits covers the external physical form, shape, color and their appearance. The quantitative traits on the other hand are greatly influenced by non-genetic factors and are lowly to moderately heritable (FAO, 2012 & Szabolcs *et al.*, 2007). Morphometrical traits include culmination of a series of such measurements is generally used as a first step to characterize a breed and is also known as zoometric/ morphometrical/ phenotypic method of breed classification (Banerjee, 2015 & Delgado *et al.*, 2001). This method of classification is based on some predefined measurements of traits since morphometrical traits are closely correlated with production characters (FAO, 2012 & Salako, 2006).

However, the livestock in the tropics are reared for several functions; it becomes important to classify the strains/breeds according to their types and functions that they can perform (Salako, 2006). The assessment of type and function of livestock is also important to access when it comes to understanding of the development goals of the yesteryears and also provides direction for their future development (Banerjee *et al.*, 2014). Globally cattle are classified as dairy,

beef or dual type and hence these 'types' are generally assessed through the structural indices (Chacón *et al.*, 2011). Thus, structural indices are ratios of closely related morphometrical traits which can provide a better understanding about the types and function of the livestock because it incorporates measure of desirable traits (Chiemela *et al.*, 2016 & Salako, 2006). It can be useful to provide potential purchaser with reliable evaluation of animals and as a measure in young animals to enable earlier assessment of breeding animals for selection and to predict mature rating (Chacón *et al.*, 2011 & Chiemela *et al.*, 2016). Morphological characterization can serve as basis for the sustainable improvement and conservation of indigenous animal genetic resources. However, indigenous cattle of Hadiya Zone have not been characterized and documented in terms of morphological characteristics and information on morphometrical traits and the type and function for which the cattle were developed are yet not assessed. Hence, this study was attempted to morphologically characterize and to assess the type and function of the cattle using the structural indices of indigenous cattle in Hadiya Zone.

MATERIALS AND METHODS

Study Area Description

The study was conducted in Hadiya zone of the Southern Nations Nationalities and Peoples Regional State (SNNPRS). Hadiya zone is one of the thirteen zones and nine special woredas of the SNNPR of Ethiopia. Its capital city is Hossana, which is located 232km south of Addis Ababa and 160km west of Hawassa town. The elevation of the zone lies between 1500 to 3000 meters above sea level (m.a.s.l.). The study location is situated between 7°45"N latitude and 38°45"E longitudes. The mean annual rainfall ranging between 469.98 and 156.66mm, the mean maximum annual temperature is 22.54°c and mean minimum temperature is 10.35°C. Based on agro-climatic zones, the Zone can be divided into three broad climatic zones, namely midland areas of 1500-3000 m.a.s.l., which accounts nearly two third (64.7%) of the zone, high land >2,300 m.a.s.l., which accounts for 23.7% of the total land, and lowland which accounts for 11.6% of the total land of the zone.

Sampling techniques and sample size

Hadiya zone is structured into 10 districts and one urban town, which was stratified and two districts were purposely selected based on their cattle population and accessibility. Of which two districts was purposively selected based on the cattle population and accessibility. From each selected district; three Rural Kebeles were selected with the help of the respective district's agricultural experts and development agents based cattle population. We followed the general phenotypic characterization guideline developed by (FAO, 2012) for cattle phenotypic characterizations. A total of 110 adult cattle (30 bulls and 80 cows) were considered from each rural kebele for linear body measurements. In general, a total of 660 cattle were considered for both qualitative and quantitative trait studies. Pregnant, sick and emaciated animals were excluded in the sampling to avoid bias because of the effect that can produce on parameters like thoracic measurements.

Data collection on morphological and linear body measurement

Phenotypic data (body measurement and visual morphological characteristics) was collected and recorded based on format adopted from the standard breed description list developed by FAO (FAO, 2012). Fourteen qualitative variables were identified to phenotypically characterize and describe the selected cattle populations. The standard breed descriptor list for the cattle developed by (FAO, 2012) was closely followed in selecting morphological variables. Body measurements were taken for 17 quantitative traits using scales, calipers, heart-girth tape

and measuring tapes (FAO, 2011). A graduated measuring stick was used for the height measurements, the length and muzzle circumferences measurements were done using a flexible tape, heart girth was measured by using a 'heart girth' measuring tape and calibrated wooden caliper was used for the width measurements. Body weight of the animals was measured by using an instrument called 'heart girth tape' which is designed particularly for tropical cattle to estimate body weight. This tape was specifically developed for Ethiopian zebu breeds by JAICA (Japan Agency for International Cooperation) and was taken on loan from Adami-Tullu Research Center. Body measurements were done by the same person and on the morning to avoid individual variations and the effect of feeding and watering on animal's size on selected adult cattle of both sexes.

Table 1: Methods of calculating structural indices

Indices types	Calculation methods
Length Index_1 (LI_1)	Body length /wither height
Height Index (HI)	Height at withers / body length X 100
Cephalic Index (CI)	Head width / head length X 100
Rump Length Index (RLI)	Rump length/ body length X 100
Pelvic Index (PI)	Rump width/ Rump length X100
Body Index (BI)	Body length X 100/Chest girth)
Over Increase Index (OVII)	Height at rump/Height at wither X 100
Width Slope (WS)	Rump width - chest width
Body Weight Index (BWI)	Body Weight X Height at Wither X 100
Depth Index (DI)	Chest depth/Withers height
Balance (Ba)	(Rump Width X Rump Length)/(Chest Depth X Chest Width)
Body Ratio (BR)	Height at withers/Height at rump.
Length Index_2 (LI_2)	Body length/Chest depth
Height Slope (HS)	Height at Rump - Height at withers

Sources: (Banerjee, 2015 & Banerjee *et al.*, 2014 & Chiemela *et al.*, 2016 & FAO, 2011 & Salako, 2006)

Methods of Data Analysis

The data collected from linear body measurement were subjected to the General Linear Model (GLM) procedure of statistical analysis by using Statistical Package for Social Science (SPSS version 20). The means were considered significant at $P<0.05$ and $P<0.01$. While the qualitative traits were analyzed using non parametric methods (chi-square analysis). Calculation was used to assess the structural indices from the mean of linear body measurements in the study area (Table 1). The effect of location on linear body measurement was analyzed using the following linear model.

Model 1: For production parameters

$$Y_i = \mu \pm L_i \pm \epsilon_i, \quad \textit{Where,}$$

- ✓ Y_i = the observation pertaining to the i^{th} districts (i =2)
- ✓ μ = overall mean, ϵ_i = random error
- ✓ $L_{i\ =}$ the effect of i^{th} districts (i=Soro, Misha)

RESULTS AND DESCUSION

Qualitative traits

The results pertaining to the qualitative traits of bulls and cows reared in the study areas are presented in Table 30. The findings show that most of the coat color pattern of cattle reared in the study areas (about 64.1%) was plain and the current findings being in close accordance with those of (Asfaw, 2016) from Babile district of East Hararge Zone. Coat color is used as a tool in selection, identification of ownership and naming of

cattle. Among the sampled population the most dominant coat colors of cattle reared in the study areas were light red (20.6%), white and red patchy (19.1%), dark red (15.3%) and black (13.0%) for both males and females. The black with white spotty color made up the lowest proportion of the total population. Cattle targeted for the current study were horned and the findings pertaining to the presence of horns in the cattle too are in close accordance with the findings of (Genzebu, 2009). Horned cattle in one hand have an aesthetic appeal while on the other side such cattle are able to defend themselves and other herd members against predators (Kugonza *et al.*, 2011). The study also indicated that the orientation of the horns are mostly curved moving upwards and the tips pointed laterally, this too may be associated with the character of a breed and also that has an aesthetic appeal for the producers (Kugonza *et al.*, 2011). The length of the coat hair is mostly short to medium which is also in close accordance with the findings of (Genzebu, 2009). Studies by (Banerjee *et al.*, 2014) have indicated that the long haired cattle may be found in the highlands, while short and medium coated animals are found in the mid and lowland altitudes to adapt climatic condition of the environment. The short and medium coats of hair of the cattle are also associated with adaptability traits as suggested by (Mekonnen *et al.*, 2012). The ear orientation is straight edged besides the ear are also carried laterally, which too are in close accordance with the findings of (Yimamu, 2014). It has also been reported that animals with lateral ears have well developed muscles around the region and hence can move their ears to even listen to faint noises coming from distant locations (Asfaw, 2016). The humps of the bulls are well developed and are mostly medium in size, while those of most of the cows are smaller (Tenagne *et al.*, 2016). This may be ascribed to the fact that bulls with medium sized and erect humps are able to take the pressure of the yolk from the ploughs thereby such bulls have a better draftability without much damage to the hide of the bulls. The study also indicates that the perpetual sheaths of the bulls are well developed. The skulls of most of the cattle are coffin (straight) shaped which is in close accordance with the findings of (Asfaw, 2016). Cattle breed involved in the current study have well developed tails vary from medium to long (just at hock or even below the hock). Cattle with long tails are able to drive away flies and irritating insects better than their short tailed counterparts (Banerjee *et al.*, 2014). However, cattle with too long tail are not desirable, hence have disadvantage when they are moving among thorny bushes as their switch can easily get entangled and get damaged (Getachew, 2006).

Quantitative measurements of cattle

The results pertaining to the morphometrical traits of bulls of different age categories reared in the two studied locations are presented in Table 3. The findings show that body weight (BW) of the bulls of age category 1 (aged 1 and 2 PPI) and reared at Soro district were heavier ($P<0.05$) while the reverse was true for the bulls of age category 2 (aged 3 and 4 PPI). The differences as observed may be ascribed to the management of the bulls in the specific locations which may have resulted in higher muscling and therefore body weight. The body weight as observed for the bulls of age category 1 was in close accordance with those reported by (Tenagne *et al.*, 2016). The study also indicated that chest girth (CG) of the cattle followed similar pattern, this may be because the two traits CG and BW are significantly correlated (Lukuyu *et al.*, 2016). The study further indicates that head length (HDL), head width (HDW), body length (BL) did not vary across the locations among the bulls of both age categories. This might be ascribed to the breed effect.

Table 2: Qualitative traits of bulls and cows of indigenous cattle in the study area.

Variables	Male (%)	Female (%)	Overall (%)	X^2

Coat color pattern				2.767.
Plain	68.3	62.3	65.3	
Patchy	22.8	25.4	24.1	
Spotty	8.9	12.3	10.6	
Coat color				10.616
Black	13.9	12.7	13.0	
Dark red	17.8	14.4	16.1	
Light red	18.3	21.5	19.9	
Grey	15.0	9.6	12.3	
Brown	3.9	4.4	4.15	
White and red patchy	19.4	19.0	19.2	
White and black patchy	2.8	6.9	4.85	
Black and white spotty	2.2	4.2	3.2	
Red and white spotty	6.7	7.5	7.1	
Horn presence				
Present	100	100	100	
Horn shape				10.761
Straight	22.2	21.2	21.85	
Curved	59.4	64.4	61.9	
Lyre shaped	14.5	12.9	13.7	
Loose	3.6	1.5	2.55	
Horn Orientation				3.212
Tips pointing laterally	29.0	27.7	28.35	
Upward	30.1	31.5	30.8	
Forward	24.5	27.3	25.9	
Downward	16.4	13.5	14.95	
Hair length				8.142
Medium	85.6	79.8	82.7	
Long	14.4	20.2	17.3	
Ear orientation				1.029
Erect	10.0	5.4	7.7	
Lateral	86.7	90.4	88.55	
Drooping	3.3	4.2	3.75	
Hump size				58.209
Absent	0.0	4.2	2.1	
Small	58.9	73.3	66.10	
Medium	32.5	20.2	26.35	
Large	8.6	2.3	5.45	
Hump shape				93.149
Absent	4.4	4.2	4.3	
Erect	68.9	93.3	81.1	
Drooping	26.7	2.5	14.6	
Perpetual sheath				660
Absent	6.7	Absent	6.7	
Small	46.1	Absent	46.1	
Medium	36.1	Absent	36.1	
Large	11.1	Absent	11.1	
Facial head profile				1.373
Straight	86.7	84.0	84.7	
Concave	7.2	10.2	9.4	
Convex	6.1	5.8	5.9	
Tail length				2.670
Short	8.3	5.6	6.95	
Medium	32.2	37.5	34.9	
Long	59.4	56.9	58.15	

The HDL of bulls as observed in the study is in close accordance with those of (Terefe *et al.*, 2015). While longer HDL was also reported by (Banerjee *et al.*, 2014) for Boran bulls of similar age categories. The study further indicates that the HDW values as observed in the study are in close accordance with the findings of (Banerjee *et al.*, 2014) for Borana breed and (Szabolcs *et al.*, 2007) for Red Angus breed. While narrower HDW have been reported by (Szabolcs *et al.*, 2007) among beef breeds for Limousin breed. The skull dimension is a breed character and bulls with wider skulls are usually preferred as the trait is associated with masculinity (Banerjee *et al.*, 2014). The results pertaining to the Height at Withers (HAW) indicated that the trait did not vary across bulls reared in the two locations, the skeletal dimension is associated with the length of the scapula, humerus, radius, carpus, metacarpus and phalanges and also the accessory bones thereof (Banerjee *et al.*, 2014). It has been reported that cattle with longer fore and hind limbs length have higher HAW. The cattle with higher HAW usually have capacity for grazing for long time and able to walk longer distances (Banerjee *et al.*, 2014). The HAW values as reported among the bulls in the current study are in close accordance with the findings of (Zeleke *et al.*, 2017) for Gamo Gofa cattle. However, higher values for HAW have also been reported by (Terefe *et al.*, 2015) for Mursi cattle. The Body Length (BL) of the bulls of different age categories indicates that the trait is similar across the bulls (of a particular age category) and reared in the two areas, this may be ascribed to the genetic makeup of the breed. The BL of the bulls as obtained in the study are in close accordance with the findings of (Tenagne *et al.*, 2016). The BL as observed are shorter than those bulls from Arsi highland of Oromia region reported by (Yimamu, 2014). However, bulls with long body usually have higher carcass weight as there are enough spaces for the internal organs to develop. The study also indicates that the Horn Length (HRL) of the bulls of age category 1varied in the two studied areas. The HRL as observed in the study are in close accordance with the findings of (Ftiwi, 2015). However, lower HRL was observed in a study by (Taye, 2005). Bulls with longer horns have an aesthetic appeal and hence are preferred by many of the cattle producers (Kugonza *et al.*, 2011). The study pertaining to the Muzzle Circumference (MC) also indicates that there was no differences in the traits among the bulls (of a particular age category), the MC observed in the current study are in close accordance with the findings of (Tenagne *et al.*, 2016). The study further indicates that the Chest Width (CW) did not vary among the bulls (of a particular age category) reared in the two locations. The CW as reported are lower than the findings reported by (Banerjee *et al.*, 2014). Bulls with wider chest usually have better working capacity as the thoracic cavities of such bulls are usually wider (Banerjee *et al.*, 2014). This may also be ascribed to the distances between the two scapulas. The Height at Rump (HR) also followed similar pattern as those of the earlier morphological traits, which was in close accordance with the findings of (Bekele, 2015). The HR corresponds to the length of the Ileum, femur, tibia, tarsus, metatarsus and the phalanges. Cattle with well-developed bones have a higher height and can travel long distances (Banerjee *et al.*, 2014). Moreover, if the HR is high the cattle are able to tolerate higher temperatures as the vital organs are further away from the ground and hence suffer less due to radiation from the ground (Banerjee *et al.*, 2014). The study also indicates that the Rump Length (RL) also did not vary among bulls (of a particular age category) reared in the two locations. The RL of the bulls reported in the currents study are nearly in close accordance with the observation of (Yimamu, 2014). The Neck Length (NL) of the cattle corresponds to the length of the cervical bones beginning from the Atlas and ending at the last cervical bone. The NL also did not vary between the study locations for bulls of a particular age category and the values as obtained are in close

accordance with the findings of (Banerjee *et al.*, 2014). For a bull it is desirable that the NL is shorter with wider Neck Circumference (NC) (Kugonza *et al.*, 2011). The Check Depth (CD) also indicated similar trends for other skeletal structures. The CD values correspond to the length of the ribs emerging of the thoracic vertebrae being joined together at the sternum. Deeper chest also has advantages as it has a larger pleural cavity and therefore helps in the expansion of the lungs. The CD values as obtained in this study are lower than the findings of (Banerjee *et al.*, 2014). The results pertaining to the Ear Length (EL) of the bulls are also in close accordance with the findings of (Genzebu, 2009). It has been reported in a study by (Banerjee *et al.*, 2014), which cattle with longer EL are better adapted to the warm climates as the skin is usually thin and have well developed vagus nerves. The tail length as observed in the study is also in close accordance with the observations of (Terefe *et al.*, 2015). Bulls with longer tails usually have the ability to drive away the flies and hence are less prone to attacks of the external parasites (Banerjee *et al.*, 2014). The NC as observed in this study are in close accordance with those of (Banerjee *et al.*, 2014) for Borana bulls. The bulls should have short but thick necks (Khargharia *et al.*, 2015).

The findings as presented in Table 4 correspond to the morphometrical measurements of cows aged 1 and 2 PPI (category 1) and 3 and 4 PPI (category 2). The study shows that BW varied among the heifers and cows (of a particular age category) reared in the two locations. This may be ascribed to the differences in management and nutrition provided to the heifers/cows provided to the cattle in Soro district. The BW of the heifers and cows as recorded in the two locations are lower than the findings of (Tenagne *et al.*, 2016) and (Alebachew, 2017). The CG values followed the above trend, the values as recorded are in close accordance with the findings of (Yimamu, 2014). The HDL of the heifers/cows was similar to the findings of (Genzebu, 2009*) (Taye, 2005). While, the HDW varied among the heifers with higher values recorded among the heifers reared in Misha district, the values as recorded in the study are in close accordance with those of (Szabolcs *et al.*, 2007) for Hungarian Simmental, Aberdeen Angus, Red Angus and Charolais. The BL of the heifers and cows did not vary between the studies areas, the values are in close accordance with those of (Terefe *et al.*, 2015). The BL of cows correspond with their uterine capacity, while cows with shorter BL have decreased uterine capacity and vice versa. Thus, cows need to be bred with bulls based on their body capacity. The HRL varied among the heifers with the values being higher among those reared in Soro district. The HRL as observed in the study are in close accordance with those of (Alebachew, 2017) and (Tenagne *et al.*, 2016). However, the HRL as observed in the current study are lower than those of Mursi breed as reported by (Terefe *et al.*, 2015) and Gamo Gofa cattle reported by (Zeleke *et al.*, 2017). The shorter HRL in the heifers/cows are desirable as it is linked with the feminity. The study result indicates that the CW did not vary among the heifers/cows (within a particular age category) in the two locations. The study also indicates that the HR was higher ($P<0.05$) among the heifers reared at Soro district while there were no such differences recorded among the cows reared at Misha district. The HR as recorded in this study is in close accordance with the findings of (Bekele, 2015). The value obtained for RL showed that there were no differences amongst the heifers and cows reared at both the locations which was in close accordance with the findings of (Yimamu, 2014) from Arsi Highland of Oromia region and (Girma *et al.*, 2016) for Fogera cattle from Northwestern Amhara region. The study also indicated that the RW recorded were nearly in close accordance with the findings of (Girma *et al.*, 2016). The RW of the heifers is one of the most important traits as those heifers with a wider rump have lesser chances of dystocia (Banerjee *et al.*, 2014). The NL of

heifers and cows did not vary across the studied locations (within a particular age category), the NL values as observed are in close accordance with those of (Genzebu, 2009). Longer NL and thinner NC is a feminine trait and heifers/cows are desired (Taye, 2005). The study also indicates that there was no variation across the heifers/cows reared in the two locations. Similar trend was also recorded among the heifers/cows for EL. The EL values as observed in the current study are in close accordance with the findings of (Bekele, 2015) among indigenous cattle in Bako Tibe and Gobu Sayo districts of Oromia region. The study also indicates that TL of heifers and cows did not vary among the cattle reared in the two studied locations, the values as recorded are in close accordance with those of (Terefe *et al.*, 2015) on South Omo Zone cattle.

Structural Indices Calculated from Morphometrical Traits of Cattle

The summary of the structural indices of the indigenous cattle of different age groups in the study area are indicated in Tables 7 and 8. The findings show that the Height Index (HI) did not vary between the study areas in both the age categories. The HI values show that the HAW was slightly lower than those of BL of the cattle, these observations are in close accordance with the findings of (Szabolcs *et al.*, 2007). Studies by (Chiemela *et al.*, 2016) have indicated that the animals with shorter height and longer bodies are prone to slip disc problems, however as the values are not very different hence the chances of it happening are too less. The results pertaining to the Length Index (LI_1) of the cattle supports the above claim; it is in close accordance with the findings of (Alderson, 1999). The results pertaining to the Cephalic Index (CI) indicate that the head length was longer than those of the head width which comply with the findings of (Chacón *et al.*, 2011 & Szabolcs *et al.*, 2007). The results pertaining to the Rump Length Index (RLI) indicate that the rump length is around 30% of the body length, indicating bulls have space for the development of the gut contents and hence can digest fibrous feed. The RLI values as obtained in the study are in compliance with the findings of (Szabolcs *et al.*, 2007). The value for the Pelvic Index (PI) also shows that the rump width is more than the rump length. The wider rump is beneficial especially for the heifers/cows as it reduces the chances of dystocia (Banerjee *et al.*, 2014) (Taye, 2005). The results pertaining to the Body Index (BI) of the bulls and cows reared in the two studied locations indicate that the chest girth is quite well-developed when compared to the body length. A well-developed CG is quite important when bulls are expected to be employed for draft purpose while the trait is also important to indicate the grazing ability of the cows especially in the rough terrain areas (Banerjee, 2015) (Khargharia *et al.*, 2015). The findings related to the Over Increase Index (OVII) indicate that the HR is slightly higher than those of the HAW, the observations being in close accordance with those of (Szabolcs *et al.*, 2007). The study pertaining to the Width Slope (WS) indicates that the rump width is wider than those of the chest width, which indicates an angular shaped body of the cattle, which is quite beneficial for the heifers and cows (Khargharia *et al.*, 2015). The findings regarding the WS indicates that, the RW is wider than the CW of the cattle and the values being more among the heifers/cows (Szabolcs *et al.*, 2007). The results pertaining to the BWI index indicates that the values are more or less similar to the actual body weight for the class of the bulls and cows as assessed in the study using the measuring tape.

Table 3: Summary of body weight (kg) and other body measurements (cm) (Mean±SE) for bulls reared in the two districts

Traits	Dentition class 1 & 2 PPI			Dentition class 3 & 4PPI		
	Soro (N = 5)	Misha (N = 13)	Overall (N=18)	Soro (N = 85)	Misha (N = 77)	Overall (N = 162)
BW(kg)	184.4±7.64*	153.2±1.38	161.89±4.03	214.79±1.44	220.79±2.07*	217.64±1.26
CG	134.6±2.15*	125.8±0.41	128.28±1.14	142.4±0.35	143.95±0.48*	143.14±0.30
HDL	41.0±31.62	37.8±0.11	38.72±0.36	41.5±0.12	41.64±0.118	41.59±0.08
HDW	20.2±0.37	19.08±0.13	19.39±0.18	21.15±0.08*	20.90±0.10	21.03±0.64
HAW	106.8±2.22	101.54±1.19	103.0±1.17	109.16±0.46	110.81±0.38*	109.95±0.31
BL	116.2±3.88	113.15±0.88	114.0±1.22	117.96±0.55	118.25±0.57	118.10±0.39
HRL	14.2±2.89*	7.69±0.86	9.50±1.19	19.68±0.55	20.08±0.63	19.87±0.42
MC	38.4±0.40	37.2±0.13	37.56±0.19	40.07±0.14	40.99±0.15	40.51±0.11
CW	36.8±0.97	31.58±0.64	33.03±0.77	36.58±0.29	37.22±0.33	36.89±0.22
HR	109.4±2.01	103.6±1.2	105.25±1.18	111.69±0.44	112.92±0.38*	112.27±0.30
RL	33.6±0.51	31.58±0.86	32.14±0.66	35.15±0.28	34.76±0.30	34.97±0.21
RW	38.5±1.03	35.0±0.53	35.97±0.58	41.01±0.28	39.66±0.29	40.37±0.21
NL	33.0±1.27	32.69±1.19	32.78±0.91	35.86±0.35	36.75±0.33	36.28±0.24
CD	54.0±1.30	49.62±0.78	50.83±0.81	54.78±0.35	55.71±0.38	55.22±0.26
EL	18.5±0.22	17.5±0.22	17.78±0.20	20.14±0.19	20.26±0.16	20.19±0.12
TL	75.6±1.83	73.46±0.51	74.06±0.64	75.94±0.49	77.43±0.33*	76.65±0.31
NC	79.2±3.15	70.46±1.14	72.89±1.49	85.96±0.85	79.9±0.82	80.45±0.59

The values in the same row with different superscript are significantly different ($p<0.05$) for specified class.BW= Body Weight, CG= Chest Girth, HDL= Head Length, HDW= Head Width, HAW= Height At Withers, BL= Body Length, HRL= Horn Length, MC= Muzzle Circumference, CW= Chest Width, HR= Height at Rump, RL= Rump Length, RW= Rump Width, NL= Neck Length, CD= Chest Depth, EL= Ear Length, TL= Tail Length, NC= Neck Circumference, SE= Standard Error, N= Number.

Table 4: Summary of body weight (kg) and other body measurements (cm) (Mean±SE) for heifers/ cows reared in the two districts

Traits	Age group 1 and 2 PPI			Age group 3 and 4 PPI		
	Soro (N = 11)	Misha (N = 14)	Overall (N =25)	Soro (N = 229)	Misha (N = 217)	Overall (N = 446)
BW	168.45±6.77*	165.71±4.24	166.92±3.73	202.79±1.13**	196.01±0.81	199.49±0.72
CG	130.55±1.96*	130.0±1.33	130.24±1.11	140.14±0.30**	138.44±0.21	139.31±0.19
HDL	38.27±0.38	38.18±0.32	38.22±0.24	39.94±0.09	40.04±0.10	39.99±0.07
HDW	18.73±0.21	19.64±0.33*	19.24±0.22	20.08±0.07	20.53±0.08	20.30±0.054
HAW	104.91±0.78*	102.0±1.34	103.28±0.87	105.56±0.29	104.14±0.32	104.87±0.22
BL	112.91±0.80	110.71±1.19	111.68±0.77	113.31±0.29	113.93±0.29	113.61±0.21
HRL	15.18±2.57*	13.71±0.87	14.36±1.21	21.54±0.43	20.75±0.40	21.15±0.29
MC	38.41±0.56*	37.29±0.32	37.78±0.32	38.71±0.09	39.19±0.09	38.94±0.07
CW	34.27±0.47	34.07±0.52	34.16±0.35	35.75±0.21	35.21±0.23	35.49±0.15
HR	106.82±0.89*	104.5±1.42	105.52±0.89	107.67±0.30	106.74±0.31	107.22±0.22
RL	33.64±0.47*	32.79±0.81	33.16±0.49	34.16±0.23	32.56±0.22	33.38±0.17
RW	38.77±0.78	37.75±0.47	38.20±0.44	39.65±0.19	40.10±0.20	39.87±0.14
NL	29.73±0.52	32.0±0.62	31.00±0.47	35.77±0.26	36.06±0.28	35.91±0.19
CD	52.55±0.59	50.21±0.62	51.24±0.49	53.13±0.15*	53.10±0.18	53.12±0.12
EL	18.27±0.36*	16.93±0.19	17.52±0.23	19.26±0.09	18.92±0.09	19.10±0.06
TL	73.36±0.70	74.0±0.53	73.72±0.43	72.91±0.23	74.83±0.28	73.84±0.18
NC	68.73±0.63	72.21±1.64	70.68±1.004	72.87±0.39	73.53±0.42	73.19±0.29

The values in the same row with different superscript are significantly different ($p<0.05$) for specified class.BW= Body Weight, CG= Chest Girth, HDL= Head Length, HDW= Head Width, HAW= Height At Withers, BL= Body Length, HRL= Horn Length, MC= Muzzle Circumference, CW= Chest Width, HR= Height at Rump, RL= Rump Length, RW= Rump Width, NL= Neck Length, CD= Chest Depth, EL= Ear Length, TL= Tail Length, NC= Neck Circumference, SE= Standard Error, N= Number

Table 5: Comparison means of body indices (Mean±SE) for bulls with in different age classes

Indices	Age class 1 & 2 PPI			Age class 3 and 4 PPI		
	Soro	Misha	Overall	Soro	Misha	Overall
HI	92.14±2.27	89.77±1.08	90.43±0.99	92.65±0.44	93.80±0.36	93.19±0.3
LI_1	1.09±0.03	1.12±0.01	1.11±0.01	1.08±0.005	1.07±0.004	1.075±0.01
CI	49.26±0.63	50.41±0.29	50.09±0.3	50.92±0.1*	50.18±0.19	50.57±0.1
RLI	29.01±0.79	27.90±0.72	28.21±0.56	29.85±0.27	29.46±0.31	29.66±0.20
PI	114.68±3.5	111.62±2.8	112.47±2.2	117.22±1.15	114.72±1.27	116.03±0.8
BI	86.39±2.98	89.93±0.79*	88.95±0.98	82.87±0.43	82.17±0.34	82.54±0.28
OVII	102.46±0.27	102.09±0.14	102.19±0.1	102.33±0.1*	101.90±0.10	102.12±0.1
WS	1.70±0.54	3.42±0.52	2.94±0.44	4.43±0.296	2.44±0.27	3.48±0.21
BWI	172.82±7.4	151.14±2.10	157.16±3.4	196.90±1.29	199.24±1.71	198.01±1.0
Ba	0.65±0.01	0.71±0.02	0.69±0.02	0.72±0.01	0.67±0.0096	0.70±0.01
DI	0.51±0.01	0.49±0.01	0.49±0.01	0.50±0.003	0.50±0.003	0.50±0.01
BR	0.98±0.003	0.98±0.001	0.98±0.001	0.98±0.001	0.98±0.01*	0.98±0.01
LI_2	2.151±0.04	2.29±0.03	2.25±0.03	2.16±0.14	2.13±0.012	2.14±0.01
HS	2.60±0.25	2.15±0.14	2.25±0.129	2.524±0.11*	2.10±0.107	2.32±0.079

*The values of the same row with in specific age class are significantly different *(P<0.05); HI= Height index, LI_1= Length Index_1, CI= Cephalic Index, RLI= Rump Length Index, PI = Pelvic Index, BI = Body Index, OVI = Over increase Index, WS = Width Slope, BWI = Body Weight Index, B = Balance, DI = Depth Index, BR = Body Ratio, LI_2 = Length Index_2.*

Table 6: Comparison of means of body indices (Mean±SE) for cows and heifers with in different age classes

Indices	Age class 1 and 2 PPI			Age class 3 and 4		
	Soro	Misha	Overall	Soro	Misha	Overall
HI	92.95±0.83*	91.58±3.52	92.03±0.57	93.19±0.19	91.43±0.2	92.34±0.15
LI_1	1.08±0.01	1.09±0.01*	1.09±0.01	1.07±0.002	1.095±0.003	1.08±0.002
CI	48.94±0.34	50.99±0.46	50.32±0.37	50.25±0.11	51.27±0.14**	50.75±0.09
RLI	29.81±0.46*	27.92±0.63	28.53±0.47	30.17±0.22	28.61±0.21	29.41±0.15
PI	115.51±2.86	120.05±2.7	118.6±2.06	117.28±0.96	124.33±1.00	120.71±0.7
BI	86.71±1.59*	86.50±0.73	86.57±0.69	80.93±0.26	82.32±0.21**	81.61±0.08
OVI	101.81±0.13	102.35±0.3*	102.18±0.16	102.003±0.1	102.5±0.17**	102.3±0.06
WS	4.50±0.965	3.24±0.55	3.65±0.49	3.90±0.22	4.88±0.246	4.38±0.17
BWI	160.7±6.8**	157.57±2.5	158.59±2.72	192.41±1.17	188.4±0.8**	190.47±0.7
B	0.73±0.02	0.69±0.02	0.70±0.02	0.72±0.006	0.70±0.007	0.71±0.005
DI	0.50±0.01	0.49±0.01	0.49±0.01	0.50±0.002	0.51±0.0012	0.51±0.001
BR	0.98±0.001*	0.98±0.002	0.98.0.002	0.98±0.001	0.98±0.01**	0.98±0.001
LI_2	2.15±0.026	2.25±0.28	2.22±0.02	2.14±0.007	2.15±0.007	2.14±0.005
HS	1.91±0.15	2.39±0.26*	2.24±0.18	2.11±0.811	2.60±0.08**	2.35±0.58

*The values of the same row with in specific age class are significantly different *(P<0.05) and **(P<0.01); HI= Height index, LI_1= Length Index_1, CI= Cephalic Index, RLI= Rump Length Index, PI = Pelvic Index, BI = Body Index, OVI = Over increase Index, WS = Width Slope, BWI = Body Weight Index, B = Balance, DI = Depth Index, BR = Body Ratio, LI_2 = Length Index_2.*

The CW and CD values are higher than the RW and RL values indicating that the cattle are slightly off balance. However, the heifers/cows have a better balance and can therefore travel for longer distances when compared to the steers/ bulls of the same age. The Depth Index (DI) values indicate that the CD is around half of the withers height which indicates as good lung capacity of both the sexes (Banerjee, 2015). The study also indicates that the Body Ratio (BR) also indicates that the HAW is slightly lower than those of the HR therefore such animals are slightly forward inclined and the observations are in close accordance with those of (Chacón *et al.*, 2011).

The length index_2 (LI_2) also indicates that BL is twice that of the CD which is a common feature in the cattle, the observations are in close agreement with the findings of (Banerjee *et al.*, 2014). The findings of HS indicate that the height at rump is more than those of the withers, which correspond to the earlier findings of the body ratio (Banerjee *et al.*, 2014). Therefore, the study indicates that the cattle population involved in the current study are a dual type (bulls for light draft and the cows as mothers for the bulls) and are well suited for moderate grazing.

CONCLUSION AND RECOMMENDATION

- ✓ The morphometrical measurements indicated that body weight and chest girth of the bulls in both age classes showed significant variation ($p<0.05$) between the studied locations. Similarly, body weight and chest girth for cows were significantly higher in Soro district than those in the Misha district, this might be due to agro-ecology difference. The structural indices for bulls in age class 3 and 4 PPI such as cephalic index, over increase index and height slope were significantly higher in Soro district. However, for cows in age class 3 and 4 PPI cephalic index, body index, over increase index, body weight index, body ratio and height slope showed highly significant ($p<0.01$) variation between the two districts.
- ✓ Even though, cattle give multiple purposes for mixed crop livestock production, further and detailed investigations are needed to be accompanied to find more comprehensive characterization result to confirm that linear measurements be related to production characteristics and to identify the type and function of the animal.

Molecular characterization should be done including the related breeds.

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