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Morphological Variations of Arsi, Kereyu and their Crossbred Cattle under Current Climate Change in Mid Rift Valley of Oromia, Ethiopia

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The Present study was conducted in Fentale and Boset districts, East Shoa Zone, Oromia Region, Ethiopia. The aim of this study was to examine morphometric variation between indigenous cattle breeds of Arsi, Kereyu and their crosses, in the mid rift valley of Oromia Region. Three PA's from each district, a total of Six PA (Huluka, Kawa, Barchota, Benti, Kobo and Daka edu) were selected purposively. Respondent farmers were identified using purposive sampling technique. Kereyu, Arsi and crossbred cattle of the two were reared for milk production, risk aversion and source of income. The major production constraints identified were feed shortage, water scarcity, disease and coverage of grazing land by invasive plants. On the Morphometrical traits of the breeds, Kereyu breed had better morphometric measurement trait (BL:127.44±0.64,HG:149.67+0.57cm) than the rest (BL:124.94+0.59,117.56+0.67 and HG:145.97+0.66,142.68+0.67 cm) for cross and Arsi cattle respectively in the Boset. Most morphometric traits were significantly different between the districts of the same breed and age groups. The most discriminating power (differentiation) of the morphometric traits to identify the breeds were heart girth, height at withers, horn length and neck length. The farmers in the two districts prefer Kereyu breed due to their ability to tolerate drought, diseases and highly adaptable to the area, where as Arsi breed of cattle was susceptible to feed shortage, water scarcity and diseases than other breeds in the area.. This study revealed that the Arsi respondents in the study area prefers to mate breeding female of Arsi with bull of Kereyu breed due to better performing and adaptability of breed

Keywords: Arsi cattle, Crossbred, Kereyu cattle, Morphometry

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INTRODUCTION

Ethiopia has long been recognized as the center of origin of diverse livestock genetic resources both in Africa and the world at large. The existence of broad diversity is due in large part to its geographic location, diverse topography, climate, the wide range of production systems and the huge livestock population size [34]. The total cattle population for the country is estimated to be about 60.39 million [17]

Ethiopian cattle genetic diversity is currently under threat mainly due to extensive planned as well as indiscriminate cross breeding between exotic and indigenous and crossing between indigenous breeds, and interbreeding among the local populations. In this regards, the study by [68] show that Danakil cattle demonstrated the lowest genetic variability (0.370) than other indigenous cattle breeds in Ethiopia and the relatively lower genetic diversity observed in the Danakil cattle population could be due to inbreeding (FIS=0.012) and uncontrolled mating practices that are common among the pastoral herds. As the author noted the high within-population genetic diversity and the unique adaptation of the current populations to wider environmental factors might be a consequence of the peculiar admixture between the different cattle breeds. This interbreeding undertaken among various cattle breeds by different communities may be to withstand the impact of the current climate change on their breed. In this regard, earlier studies [24]; [49] noted that indiscriminate interbreeding or crossbreeding and civil conflicts are the major causes of breeds or strains being classified as at risk in Africa for cattle and for other species. But until now these populations have represented a unique genetic resource and unexploited opportunity that warrants initiatives for their sustainable conservation and utilization. Similarly the study by [30] noted that the Ethiopian cattle are under threat from uncontrolled mating practices and inbreeding among different indigenous cattle breeds and are at high risk of becoming genetically homogeneous. Earlier study of [50] suggested that increasing human migration, trade, cultural and social interactions exacerbate interbreeding between adjacent indigenous breeds.

Genetic diversity is the basis for present day diversified living systems and adaptability and it is a tool for future genetic improvement of livestock breeds. This diversity should be properly utilized, improved and conserved. Conservation and improvement strategies ought to be based on proper genetic characterization in association with phenotypic characterization. The study by [69] indicated that the relationships among Ethiopian cattle populations reflect their history of origin and admixture rather than phenotype based distinctions. The high within individual genetic variability observed in Ethiopian cattle represents an untapped opportunity for adaptation to changing environments and for implementation of within-breed genetic improvement schemes.

Climate change likely affects the productive and reproductive performances of cattle, and consequently their population growth through its indirect effects on the quantity and quality of pastures, availability of water, and posing thermal stresses on animals [61];[41]. Pastoralists and agro-pastoralists that inhabit the African arid and semi-arid lands are among the world's poorest populations. They lack vital infrastructure in the form of accessible roads, electricity and telecommunications, making them liable for extreme external environments and leaving them increasingly isolated. Livestock holdings of cattle, camels, goats and sheep often comprise the bulk of their limited wealth and are an integral part of their socio-cultural life. Along with the unfavorable agro-ecology of the study area and the limited livelihood opportunities both pastoral and agro-pastoral systems of the study areas are exposed to frequent droughts. About 43.1% of the Kereyu cattle died during the 2002/3 drought year and of which about 90% were lactating cows indicating the loss of productive animals and in turn resulted in a serious shortage of milk production which Kereyu people mostly rely on for their diet [52]. This may indicate that many breeds were affected by the recurrent drought and climate change due to loss of their genetic diversity. In support of this, [32] showed that the level of genetic variation influences the ability of species to respond to threats and environmental changes. When a population has a high level of genetic variation, it is better able to adapt to new environmental challenges. On the other hand, low genetic variation in a population will limit a species' ability to respond to the changes in the short term and to persist in the long term [7]. Loss of genetic diversity of cattle due to various reasons increases the risk of difficulties in subsistence for the millions of livestock keepers who depend on these resources to secure their livelihoods.

In this regard, the study by [65] revealed that some of the pastoralists in Afar region, lost interest on their indigenous cattle and started crossing with Kereyu cattle breed. The pastoralists presume that Kereyu cattle breed is more tolerant than Afar breed to the present drought and climate change. This kind of crossing due to climate change is common among different indigenous cattle breeds of Ethiopia including Kereyu and Arsi cattle breeds. As a consequence of uncontrolled crossing between indigenous breeds, the pure line indigenous breeds are threatened for extinction with their valuable traits.

Study by [55] showed that breeding Kereyu cattle with the surrounding local zebu cattle (like Afar and Arsi cattle) and lack of conservation program were among the identified threats for Kereyu cattle. This shows that the different pastoral communities which were found in adjacent area have a perception of existence of different livestock breeds in the rift valley, which have different degree of adaptability and performance under the recurrent drought and climate change observed in the past decades. This perception of the communities necessitate interbreeding of different indigenous pure breeds to exploit traits which could be adaptable and best perform within the recurrent drought and climate change through heterosis.

However, comparative evaluation of morphometric, performance and adaptable characters of purebred and their crossbred cattle was scanty in Ethiopia. Hence, with the above background, this study was conducted to understand if there is variation among the breeds in terms of body measurements and performance with the following objectives.

General objective

To examine morphometric variation between indigenous cattle breeds of Arsi, Kereyu and their crosses and evaluate adaptive

Specific objectives

- To understand the major morph metric variation of the breeds in the study area.

LITERATURE REVIEW

Origin of Ethiopian Cattle

A number of theories have been developed as to the time and the routes by which cattle were introduced into Ethiopia. They could have been introduced from the Nile valley, the Red Sea littoral, across the Red Sea from Arabia, or by all these routes at different times [47] The review on origin, domestication, and breed development in northeast Africa reveals that Ethiopia has become the region in which longhorn, shorthorn, and zebu types cattle have been crossed and interbred. The interbreeding has produced the Sanga type breeds, whilst continuous upgrading of hump less longhorn and shorthorn cattle with new Zebu blood has produced new zebu type breeds [47; 46].

Phenotypic Diversity of Cattle

In livestock population, genetic diversity is expressed on the phenotypic level as variability in production, morphology, reproduction, health, and other traits/characters. In comparison with natural populations, a wide phenotypic diversity was observed within and between livestock populations [43; 8]. These phenotypic differences are the result of genetic diversity and environmental differences [44]. Genetic diversity can be assessed between species, breeds, and specific lines and within those groups. The phenotypic difference of an animal is measured using what are called genetic parameters or, strictly speaking, phenotypic, genetic and environmental parameters [8].

Classification of Ethiopian Cattle Breeds

The early breed identification and characterization studies in the country classified the available cattle genetic resources into five major groups viz, Large East African Zebu, Small East African Zebu, Senga, Zenga and the Taurine (humpless shorthorn) breeds [50; 49]. These major breed groups were further classified into more than 32 breeds/ecotypes 18] . Furthermore, molecular characterization has shown high genetic diversity between and within breeds populations. All of these cattle types were described as having considerable adaptability to harsh climate, poor nutrition and diseases endemic to their respective areas. The local breeds are generally named after the area they occupy.

The highest proportion that found in the highlands and low lands of the country is Small East African Zebu. Three other breeds, the Ethiopian Boran, Murle and Arsi are classified in the Large East African Zebu group. The Sanga mainly comprises the Danakil and Raya Azebo (from northern and northeastern Ethiopia) and Anuak and Aliab Dinka (from far southwest lowlands of the country). Three other breeds (Horro, Fogera and Arado) from central highlands are classified under Zenga (sanga-zebu interbreeds) breed. There is only one representative of the hump-less shorthorn group of cattle in Ethiopia, which is the Sheko (from the mid-altitude southwest of the country). In addition, some reports indicated that, recently, four other cattle types are identified in the country, which are the Babbawa, Jiddu, Red Bororo and Tigray. But the newly identified cattle types are not well studied clearly as to which group they belong to [64].

Ecology of Natural Habitat of the Kereyu Breed

The home tract of the Kereyu cattle type is Fentalle district. Their breeding environment is characterized by low input-output, high environmental stress and no infrastructure for livestock development programmes. The current estimated total cattle population in Fentalle district is 125 thousand. Maya cattle (Kereyu x Arsi) are common in the district and the proportion of pure Kereyu breed of cattle was not determined in this study. However, a gradually decreasing trend of pure Kereyu breed was reported. Recurrent drought, rangeland degradation, population pressure, feed and water shortage, interbreeding with the surrounding local zebu cattle and lack of conservation program were among the identified threats to the Kereyu cattle type [54].

The Kereyu people are among several pastoralist groups living in the Upper Awash Valley within the Great Rift Valley in Ethiopia. Almost all of the Kereyu, who are primarily cattle herders, live within Fentale district, which is administered under the East Shoa Zone of the Oromia Regional State. The Kereyus' are believed to be early inhabitants of the area [62]. Kereyu have complex seasonal grazing systems [23] in comparison to their pastoralist neighbors, such as the Afar. Before the 1960s, the Kereyu utilized the whole area within Fentale and a small portion of the neighboring district, Boset. Recently, the Kereyu community used three major traditional grazing zones: the primarily open grassland plain (ona ganna) Harollee and Carcar area for the wet season, the riverine and adjacent wooded savanna vegetation (ona birra) for the early dry season, and the thorn bush between the two zones highland districts of West and south west Shiraro to Sidamo area (ona bona) for the late dry season [23]. Even within these major ecological zones, different villages may be required to travel to different parts of a specific zone for livestock grazing during the appropriate season. Livestock movement between these grazing zones is regulated through traditional rules and regulations, as well as varied and complicated rituals and ceremonies [11; 23].

Performance of Cattle Breeds in Ethiopia

The [16] estimated 3.06 billion liters of cow milk produced annually from indigenous breeds and average milk yield per cow per day and the average lactation period per cow were 1.37 liters and 6 months, respectively. Cattle produce a total of 0.331 million tons of meat annually [29]. Although Ethiopia possesses high cattle genetic resources, their productivity is considerably low.

Ethiopia has diverse animal genetic resources and its relatively large livestock population (approximately 100 million) is well adapted to and distributed among diverse ecological conditions and management systems [39]. In Ethiopia, as in case of many developing countries, livestock play multiple roles. Despite the huge number of cattle and their economic importance, the productivity is low due to the constraints of disease, nutrition, poor management and poor genetic worth of indigenous breeds. These constraints result in poor reproductive performance of dairy cattle. Among the major problems that have direct impact on reproductive performance of dairy cows are abortions, dystocia, Retained Fetal Membrane (RFM), metritis, prolapse (uterine and vaginal), anoestrus and repeat breeder. These could be classified as prepartum and postpartum reproductive problems [57; 39].

However, expansion and productivity was constrained by quantitatively and qualitatively inadequate and imbalanced nutrition, sporadic disease outbreak, scarcity of water, lack of appropriate livestock extension services, insufficient and unreliable data to plan the services, and inadequate information to improve animal performance, marketing, processing and integration with crop and natural resources for sustainable productivity and environmental health.

Ethiopia has high potential in livestock genetic resources; however, livestock productivity is below the African average. Total herd off take rate of cattle is estimated at about 7% annually; with carcass weight of 100 to 110 kg. Cows in Ethiopia do not reach maturity until 4 years of age, calves every second year [35]. Reproductive performance is commonly evaluated by analyzing female reproductive traits. The main indicators that would be considered in assessing reproductive performance are age at puberty, age at first calving, calving interval, days open and number of services per conception [19].

Other national report indicated that the average lactation period per cow at country level is estimated to be about six months, and average daily milk yield (DMY) per cow is about 1.32 L [14]. It has also been well documented that, in breeding schemes, the raise in milk production through selection is 1% per year or 3-4 kg per lactation. Moreover, the milk production potential of the zebu breed in the highland of mixed crop livestock system of Ethiopia cannot exceed 400-500 kilograms of milk per lactation per cow. Milk production potential of indigenous Boran, Horro, Barka, Arsi and Fogera cattle is low, ranging from 494 to 809 kg per lactation [21]. Information on Breed variation, productive and reproductive performance traits of traditionally managed cattle including the intended breed that going to be studied in their home tract in the country is scanty.

Breed Characterization and its Importance

Indigenous cattle genetic diversity within and among breeds are useful for the future to satisfy changing market conditions, new knowledge of human nutritional requirements, threats to animal health and environmental changes in general [25]. Proper identification, optimum utilization and conservation of these germ plasm resources can be achieved through characterization and formation of inventory of breed resource [10]. Genetic studies are helpful in identification of the different breeds existing within the region and also help to establish the relationship between the different breeds besides differentiating the strains/types within breeds.

Molecular markers provide a large unbiased basis for the estimate of breed similarities and /or differences.

Describing differences and similarities in DNA of animal can provide a “fingerprint” but it cannot provide a useful description of what the animal looks like and how it will perform. Hence, the phenotypic characterizations serve as complementary to the biological tools for measuring genetic diversity at genome level [27]. Phenotypic characterization involves conducting baseline surveys in order to establish the uniqueness and characteristics of the individual populations.

The information generated through characterization studies are an important part and parcel related to planning and management of animal genetic resources [27]. However, in the absence of adequate information about the phenotype of the population can often lead to take decision which may have long term adverse consequences and may also lead to erosion of the base population through unplanned and misdirected crossbreeding and breed replacement programs [28; 60].

Phenotypic characterization of cattle in Ethiopia

Qualitative Traits of Indigenous Cattle

Phenotypic traits of cattle such as body coat color and the orientation of some external body parts exhibit the distinctive features of a breed [28]. Coat colors constitute an important group of qualitative traits for cattle characterization and color characteristics have widely been used by farmers to define livestock breeds [15]. Traits related to external body part in cattle include horn shape, horn size, udder size, prepuce size and navel-flap size. Udder size, teat size and rump profile may have relationship with milk production [59; 4]. Body extremity size traits are also related to efficiency of heat dissipation [12]. Traditionally, Zebu cattle with horns are preferred by most of the breeders which also have a socio-cultural significance [58].

Morphometric Traits of Cattle

The morphometric traits have significant correlations with many production traits such as body weight, body length and height at withers are used as proxy indicators of the production traits. Morphometric measurements provide a scientific basis to describe the biological variations between breeds as well as within a breed and thus can serve as a basis for measuring the performance, productivity and carcass characters [36; 38]. Biometrical traits have been used to evaluate the characteristics of animals that vary due to the influence of breed, environment and nutrient [45; 6]. Objective measurements have been used for breed characterization and to describe change in size and shape as well as weight [48]. The morphometrical traits are generally associated with production and reproduction traits of cattle [37; 4; 40].

Mating System of Indigenous Cattle Breeds in Different Communities

In the traditional livestock production system of the tropics, uncontrolled breeding is predominant. Some pastoralists who do have large stock practice selecting breeding of bull from their herds, moreover often favor particular breeds. In contrast, smallholders having much smaller flocks or herds rely heavily on formal or informal exchange and transfer of breeding stock or genetic material between households, between villages, between government farms and their animal enterprise, or between the commercial and communal. According to [67] in Semien Mountains and Wegera, mating was completely uncontrolled in Semien Mountains and partially controlled in Wegera. However, in Dembia in the plains of Fogera, and in western lowlands; herders select male and female breeding cattle. Similarly, in Oromia regional state, around 70% farm households practice uncontrolled mating. In the region the proportion of households practicing controlled mating increases with increasing livestock densities. Households found in the pastoral area practice uncontrolled mating. Moreover, except in northern Shoa zone that practice artificial mating (amounting 10% of the total farm households) the rest part of the region used natural mating [63].

Breed Preferences of the Livestock Holders

Majority of the Kereyu people preferred to continue rearing Kereyu cattle and one-third of the respondents wanted to keep other breed in addition to Kereyu cattle. Most reported preference was for Borana breed and next Arsi breed for the purpose of milk production. Their preference for sex was higher for breeding females than breeding males. This high reported preference for breeding females was associated with the social and cultural value that they attach to their own breeding males in maintaining the desired quality of their animals in that particular environment [56].

Effect of Climate Change and Coping Mechanism of Pastoralist on Husbandry and Breeding Practices

Mobility is an inherent strategy of pastoralists to optimize production under a heterogeneous landscape and a precarious climate. The search for water (for human and livestock consumption) and forage, trigger mobility and migration; these strategies were most intensified by drought [42]. Distance trekked to livestock water sources is almost tripled during the drought, from an average (across zones) of 5.9 km pre-drought to 15.8 km during the drought; pure pastoralists trek greater distances than agro pastoralists. Distances to grazing sites also increase, from an average (across zones) of 5.5 km pre-drought to 20.4 km during the drought, with pure pastoralists trekking greater distances than agro pastoralists [42].

Climate Change Threats to Farm Animal Genetic Resource

According to Pilling (2010), different threats to AnGRs include disasters and emergencies, disease epidemics and control measures, inappropriate breeding management, strategies and policies, changing production system and livelihoods, and cross-cutting threats. Climate change has the potential to drive gradual changes in production systems (e.g. affecting the availability of feed resources), to cause more frequent climatic disasters, and to increase the exposure of breed populations to unfamiliar epidemic diseases. Other cross-cutting threats include lack of awareness of the significance of AnGR among decision-makers and lack of consultation with livestock keepers and other relevant stakeholders [26] both of which contribute to many threats to arise because of policy and management decisions. In Ethiopia, indiscriminate breeding, disease, feed shortage and agro-chemicals are some causes of threats to maintenance of animal genetic diversity [34]. Feed shortage and disease burden are exacerbated by climate change. Livestock health problems such as the high prevalence of Trypanosomiasis in the lowlands are among the challenges that affect livestock fertility. Challenges such as climate change underline the importance of retaining a diverse portfolio of livestock breeds [27]. Livestock productions both contribute to and are affected by climate change [33].There are evidences that livestock and environmental trade-offs are currently substantial and that these will increase significantly in future as a result of the increased demand for livestock products from the growing population [31].

MATERIALS AND METHODS

Description of the study area

The study was conducted in Oromia regional state, east Showa zone in two districts (Fentale and Boset) of the mid rift valley of Ethiopia. The map showing the study area is presented in Figure 1.

Boset district is located at a distance of 125 km from the capital city of Ethiopia, Addis Ababa and the district have semi-arid type of climate; an erratic, unreliable and low rain fall averaging between 600-900 mm per year at an altitude of 1400-2500 masl. The minimum and maximum annual temperatures are 15° and 30 °C, respectively. The district is bounded by Fentale district at East, Adama district at West, Amhara region (minjar) at Norht-East and Arsi Zone at South. Human populations in the area were 79,430 female, 77,682 male with a total of 157,112. Livestock population in the area were cattle 243,459, sheep 64,893, goat 189,516, Horse 10,050, Mule 758, donkey 42,555, Camel 28,980 and poultry 110,307. Pastoralism and agro-pastoralism are the main livelihood systems in the area. Major crops in the district (in order of importance) are maize, tomatoes, onions and teff from Livestock and fishery office of the district.

Fentalle district is also located in east Shoa zone of Oromia, southern part of the northern Rift Valley of Ethiopia and the area falls within an altitude range of 800 to 1100 masl. However, there are high peaks on the Fentalle Mountain from which the district derives its name, reaching up to 2007 masl [2]. The district falls in a semi-arid zone, and receives an annual rainfall ranging from 400 to 700 mm. Temperature ranges from 29 to 38°C and the district is found at a distance of about 200 km from the capital city of Ethiopia, Addis Ababa, on the way to Harar and bounded by Boset district at West, Afar region at East, Amhara region at South and East Arsi Zone at north. It is affected by recurrent droughts due to disrupted rainfall patterns. There are diverse livestock breeds and population including Cattle 53682, Sheep 106934, Goat 129424, Donkey 12293, Horse 516, Mule 4, camels 20290 and poultry 6446 and Human population of 59311 of these male 31662 and female 27,649 in the area.(District livestock and fishery office)

Breeds

Arsi cattle are one of the indigenous breed/strains identified and included in the cattle breeds/strains list in the country. The Arsi cattle are categorized under large East African Zebu cattle and distributed throughout the Arsi and Bale and also at some part of Shewa, up to the higher altitude of Sidama and West Harerghe and certain part of the low lands within the mid rift valley of Ethiopia [51; 64; 18].

Kereyu breed is one of the indigenous livestock breeds whose adaptive traits permit survival and reproduction under the harsh climatic conditions of the study areas. Regarding the origin of the breed, some respondents did not knew any history on the origin of the breed. However, some of the key informants tend to associate origin of the breed with that of the ethnic group maintaining kereyu breed. The breed is also named 'Doba' by the Kereyu people who keep the breed in the Fentalle district of east Shoa zone of Oromia, which is the major natural breeding tract of the breed [53].

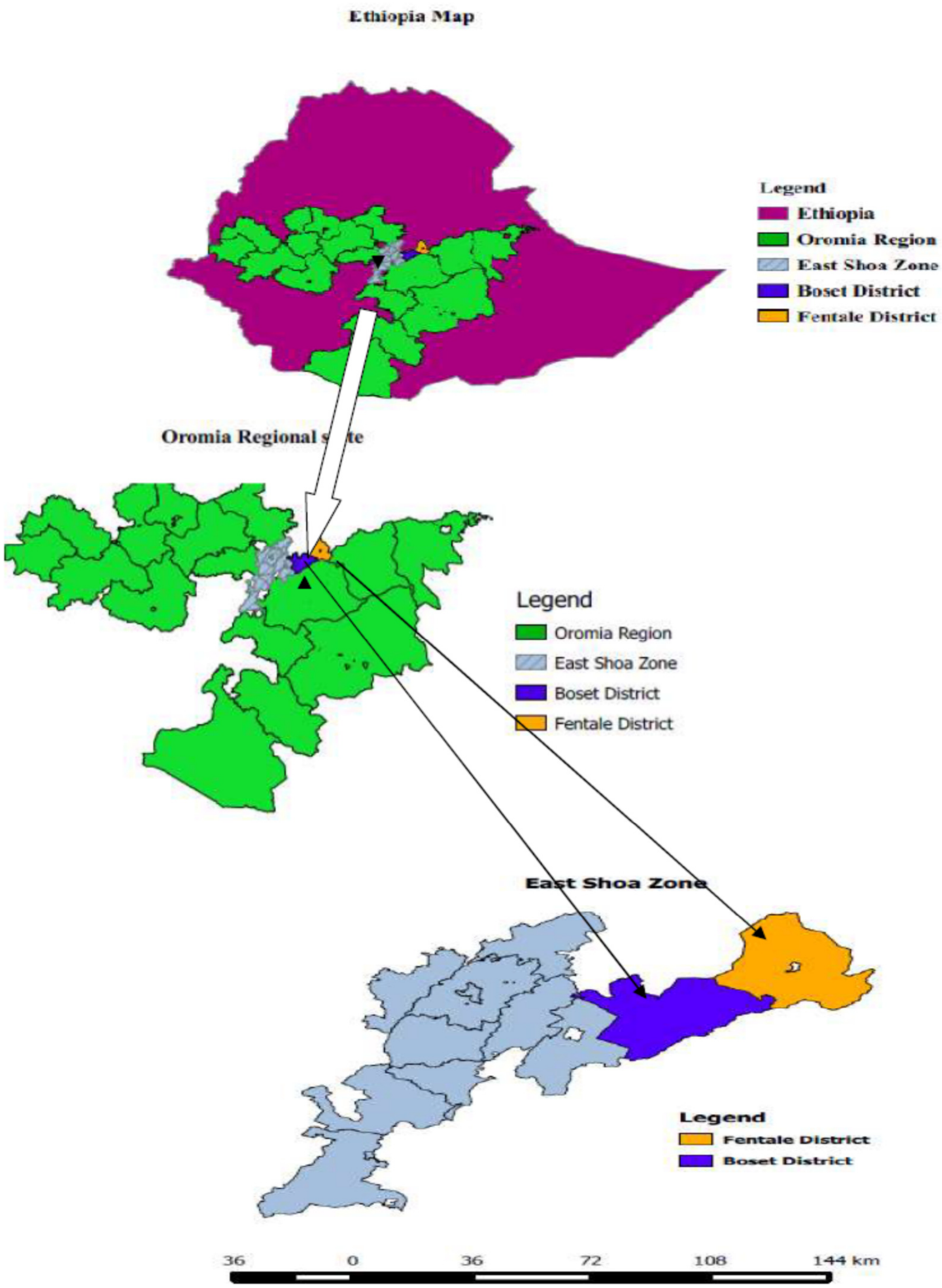

Figure 1. Map of the study area

Linear Body measurements and sample size

In East Shoa zone of Oromia region there are 1,138,454 heads of cattle (CSA 2015/2016) in which the major cattle breeds are Arsi and Kereyu breeds of cattle. From Boset and Fentale districts a total of 450 heads of cattle, 150 adult cattle each Arsi, Kereyu and their Crossbreds were selected. Out of 150 adult cattle 75of each breed were selected from each district and 25 from each kebele.

Selection was based on dentitions and age information obtained from the owner . From all selected heads of cattle, 10 morphometric measurements were taken at morning to avoid gut fill or feeding of animal before measurement.

The variables for quantitative measurements were; Body Length (BL), Height at Withers (HW), Heart Girth (HG), Ear Length (EL), Face Length (FL), Horn Length (HL), Tail Length (TL), Foreleg Length (FoLL), hind leg Length (ReLL),Neck Length (NL) and they were measured from a total of 450 matured and unrelated cattle for the two breeds and their cross (Arsi x Kereyu) (150 animals for each breed with 24 males and 126 females). All the above linear measurements were taken by measuring tape and calibrated (lebeled) stick. Data were recorded on the prepared format.

Sampling Techniques and Methods of Data Collection

Multi-stage purposive sampling technique was employed for the selection of study districts and kebeles. Discussions were held with zonal Livestock and Fishery Development office experts in order to have information on breeds of cattle and its distribution in the districts of East Shoa zones, Fentale and Boset. Sampling districts were selected based on the presence of Arsi cattle and their distribution in the districts. The first stage was selection of districts based on potential and presence of Kereyu and Arsi cattle breed in adjacent area of East Shoa zone, then selection of three rural kebeles (PA) per district were undertaken.

A multistage sampling technique (both random and purposive) sampling procedure were used to select owner of the breeds, area of concentration of breeds in the study area, adjoining point of the two breeds and individual animal in the population. From each Kebele 10 Kereyu, Arsi and crossbred cattle owners were randomly selected for administration of semi-structured questionnaire.

Questionnaire and group discussion

A survey questionnaire for collecting data was designed with a scope limited to the objective of the study. Semi-structured questionnaire was designed to assess the socio-economic practices of the community including cattle husbandry practices such as feeds and feeding, source of water, disease and disease control methods, livestock production system, factors affecting cattle reproduction and production performance (change of rainy season, drought, and degradation of grazing land) and difference between the breeds and preference of the farmer in Boset and Fentale district. Information on the production and reproduction performance including age at first mating, age at first calving, number of calves produced per cow's life time and calving intervals were assessed using designed questionnaire from 30 selected respondents in each district. Key informant interview with 22 and 19 livestock husbandry those in Boset and Fentale, respectively was undertaken to cross check the information gathered through questionnaires.

Quantitative traits

Body measurements were made on adult cattle of both sexes. Adult cattle of both sexes were selected based on dentition technique in both Fentale and Boset districts of the studied location. Animals with three and above permanent pair of Incisor teeth were selected for body measurements. The physical/morphological measurements were taken using measuring tape and labeled stick.

Statistical Data Analysis

All the collected data were analyzed to compute the mean, standard deviation and coefficient of variation of each measurement. General linear model (GLM) SAS, 2008 procedure was employed for analysis of quantitative variables to detect statistical differences between sampled cattle population in the study areas. For the significant difference observed between sample means, Dunken's test was used for mean comparisons. The degree of association between all pairs of metric variables was also computed for each breed using SASCORR procedure of SAS. The SPSS statistical software (Ver.20) was used to analyze qualitative survey data. The results pertaining to the survey were analyzed using Chi-square test.

Multivariate analysis

The quantitative variables from female and male animals were separately subjected to: Discriminant analysis (PROC DISCRIM of SAS 9.2, version 2008), canonical discriminant analysis (SAS 9.2, version, 2008), step wise discriminant analysis (PROC STEP DISC SAS version 9.2, 2008) and Principal component analysis.

Stepwise discriminate procedure

It was applied using PROSTEPDISC to determine which morphological traits have more discriminating power than the others or to gain information about traits particularly important in the separation of populations.

Canonical discriminant analysis

CANDISC procedure was employed to calculate the Mahalanobis distance between cattle breeds/populations of the two districts. The quantitative variables from female and male cattle collected were subjected to discriminant analysis (PROC DISCRIM) and canonical discriminant analysis (SAS 9.2, version, 2008) to ascertain the existence of population level phenotypic differences in the study area

Principal component Analysis

Principal component analysis (PCA) was carried out for the two sexes separately to determine different variables or parameters for differentiation of cattle populations into different groups that were mutually exclusive, and to summarize the variables into few meaningful ones that accounted for most of the variations in the population.

RESULTS AND DISCUSSION

Socio-economic Characteristics of Households

Age of the respondents

The means for age and family size of the respondents are presented in Table 1. The age of the respondents included in the study area were between 34-60 years old with an overall mean of 42.78±0.80 years. There was significant *(P<0.05)* differences *in* the average family size per household in the two districts. The family size was larger in Fentale district than in Boset districts. The higher family size in Fentale district was due to the perception of the ethnic group that having many children as a good gift of God without considering economic standards and future problem since majority of the respondents was illiterate. Besides that the pastoral practice of polygamy contributed to large family size.

Table 1: Age and family size (Mean± S.E) of the respondents in study areas

District	Age(yr.)	Family size(No)
Boset	42.43 ±1.23	6.36^{b} ±0.23
Fentale	43.13 ±1.05	8.23^{a} ± 0.36
Total	42.78±.80	6.30± 0.24

*The different superscript indicate the variation between sample means

As the study of [1] indicated, over a period of time larger family size would result in fragmentation of farm land by distributing among children which can have negative consequences on the living standard of parents over time. Thus, there could be a need for implementing family planning activities in the study area, which can thereby improve the overall family income. The overall family size as observed in this study was lower than reported by [5] from Borana area.

Sex, Source of Income and Educational level of respondents

As shown in Table 2, majority of the respondents were male headed households and this shows that whenever there are intervention through training in livestock production male household head should be included. There was significant (P<0.05) difference on educational level of the respondents in the study area in which higher illiterate respondents were found in Fentale than Boset district. Even though Fentale district is only 200 km far from the capital city of Addis Ababa, the presence of more illiterate simply indicate either less access of the community to education service or the life style of the pastoral community. Hence the Federal and regional Government should design and implement appropriate education access in the area. The presence of many illiterate respondents in Fentale district may hinder the adoption of new agricultural technologies. A study by [54] in the same district reported 90% illiterate respondents. This percentage of illiterate respondents in Fentale district in the current study was very higher than previous studies reported average illiterate respondents of 42 and 42.65% in the pastoral area of Shebele zone and the southern periphery of the country, Guji zone, Odo-Shakiso and Adola districts, respectively.

Table 2. Sex of the respondents, Educational Level and source of income in the studied area

Response category		Districts		
		Boset N (%)	Fentale N (%)	Total N (%)
	Male	21^{a} (70.0%)	22^{a} (73.3%)	43(71.7)
	Female	9^{a} (30.0%)	8^{a} (26.7%)	17(28.3)
Total		30 (100%)	30(100%)	60(100)
Education	Illiterate	10^{a} (33.3%)	19^{b} (63.3%)	29(48.3)
	Read &write	11^{a} (36.7%)	9^{a} (30.0%)	20(33.3)
	Primary school	5^{a} (16.7%)	2^{a} (6.7%)	7(11.7)
	Second school	4^{a} (13.3%)	0^{b} (0.0%)	4(6.7)
	Total	30 (100.0%)	30 (100.0%)	60(100)
Source of income				
Livestock production only		2^{a}(6.7)	27^{b}(90)	29(48.3)
Livestock Crop Production		16^{a}(53.3)	1^{b}(3.3)	17(28.3)
Livestock and off farm source		12^{a}(40)	2^{b}(6.7)	14(23.3)
Total		30(100)	30(100)	60(100)

The different superscript indicate the significant variation between sample means

Cattle Production System

Livestock production system in the study area is indicated in Table 4. The production systems in the two districts were significantly (P<0.05)) different and majority of the respondents in Fentale were pastoralists with few agro-pastoral, whereas in Boset district more than 2/3 of the respondents were crop-livestock mixed production system and 1/3 of them were agro-pastoral. Types of crop cultivated by agro-pastoral respondents in Fentale district were maize and sorghum in small amounts, which was similar with the study of [54]. In the group discussion with the respondents of Fentale district it is revealed that there was no any intervention in animal health, animal production and in all livestock activities.

Table 3. Livestock production system in the study area

Districts		Livestock production systems			
		Crop livestock production	Agro pastoralist	Pastoralist	Total
Boset	N	21	9	0	30
	%	70%	30%	0%	100%
Fentale	N	0	2	28	30
	%	0.0%	6.7%	93.3%	100%
Total	N	21	11	28	60
	% of	35.0%	18.3%	46.7%	100%
P-value		0.000 **	0.000 **	0.000 **	

Livestock Possession and Herd Structure

The livestock possession of the study areas are summarized in Table 4. There was significant (*P<0.05*) difference in livestock number of the study area which was higher in Fentale for sheep, cattle, goat,and camel number than Boset district. While higher number of chicken and horse were found in Boset district than Fentale districts. High number of cattle is ascribed to the importance of cattle in the overall farming economy, availability of farm lands year round and inputs [53]. High possession of livestock in Fentale show that majority of the respondents depended on livestock production than crop. Landholdings were higher and that the land allocated to grazing was also higher in Fentale than Boset due to more land allocation for cultivated land in Boset districts. The numbers of chicken and horse are higher in

Boset which can be ascribed to their adaptability to the agro ecologies and farming practices. Equines are mainly kept for transportation purposes. This study indicated the presence of high number of camels and ruminant species per household which require attention from agricultural development stakeholders.

Table 4. Livestock possession of the respondents in the two districts (head/HH)

Woreda		Number of cattle	number of goats	number of sheep	number of donkeys	number of chicken	number of horses	number camels
Boset	Mean±SE	27.16±1.52	25.1±1.99	20.03±0.82	3.83±0.38	21.10±0.61	0.46±0.11	3.33±0.96
	Min	10	15	10	0	17	0	0
	Max	47	60	31	7	29	2	16
Fentale	Mean±SE	34.76±1.84	34.70±2.59	25.46±2.15	4.40±0.40	15.23±1.27	0.06±0.04	9.33±1.17
	Min	18	14	11	0	0	0	0
	Max	65	75	50	7	24	1	21
Over all	Mean±SE	30.96±1.28	29.9±1.73	22.75±1.19	4.11±0.28	18.16±0.79	0.26±0.06	6.33±0.85
	Min	10	14	10	0	0	0	0
	Max	65	75	50	7	29	2	21
P value		0.002	0.005	0.022	0.320	0.000	0.002	0.000

SE=Standard Error, Min=Minimum number of livestock respondents own, Max=Maximum number of livestock respondents own

Morphometric Traits of Kereyu, Arsi and Crossbred of Arsi and Kereyu 'Maya' Cattle

Table 5 indicated that the morphometric traits of Kereyu, Arsi and crossbred of Arsi and Kereyu 'maya' varied in the study locations based on GLM procedure of simple statistics t-test for mean comparison (LSMean and LSD) analysis. The findings showed that Kereyu breed reared in Boset has better body length, height at withers, heart girth, ear length, tail length, front leg length and hind leg length than other breeds in the same district and also Keryu in Fentale districts except neck length in that Kereyu in Fentale has higher neck length than Kereyu in Boset. However, Arsi breed has lower value in all traits measured than Kereyu and crossbred except equal EL in Fentale and FL in Boset district. The results also indicated that crossbred of Arsi and Kereyu cattle had better morphometric traits than Arsi but lower than Kereyu in the two districts. This is due to the genetic merit of the Kereyu breed since 50% of the crossbred were from either dam or sire of the breed. The findings indicated that Morphometric traits of Arsi, Kereyu and crossbred breeds in the study location is higher than that of [22] of Bonga cattle in their production environments of Kaffa Zone with mean body length of 11.25±0.44 cm, height at withers 101.24±0.29 cm, heart girth 136.09±0.51 cm, ear length 16.54±0.09 cm and horn length 21.66±0.33 cm.

Table 5. Morphometric measurements (cm) of cattle breeds in the two districts

	Districts					
Traits	Boset			Fentale		
	Arsi	AxK	Kereyu	Arsi	A x K	Kereyu
	M±SE	M±SE	M±SE	M±SE	M±SE	M±SE
BL	117.56[c] ± 0.67	124.94[b] ±0.59	127.44[a] ±0.64	116.46[c] ±0.49	121.05[b] ±0.39	125.06[a] ±0.51
HW	109.62[c] ±0.48	118.52[b] ±0.45	121.27[a] ±0.51	108.23[c] ±0.38	117.33[b] ±0.45	119.4[a] ±0.44
HG	142.68[c] ±0.67	145.97[b] ±0.66	149.67[a] ±0.57	137.57[c] ±0.47	139.25[b] ±0.32	144.36[a] ±0.55
EL	18.53[b] ±0.22	20.37[a] ±0.24	20.68[a] ±0.22	19.16[a] ±0.23	19.85[a] ±0.21	20.46[a] ±0.24
FL	42.56[a] ±0.30	42.10[a] ±0.38	43.90[a] ±0.33	40.77[b] ±0.22	41.00[b] ±0.35	44.26[a] ±0.36
HL	36.49[c] ±0.54	45.64[b] ±0.77	49.27[a] ±0.62	35.57[c] ±0.45	42.61[b] ±0.46	52.4[a] ±0.50
TL	92.36[b] ±0.93	103.3[a] ±0.61	104.5[a] ±0.51	92.28[c] ±0.60	100.94[b] ±0.83	103.57[a] ±0.74
FLL	61.14[c] ±0.55	67.78[b] ±0.44	70.43[a] ±0.47	59.22[c] ±0.48	66.24[b] ±0.45	68.80[a] ±0.33
HLL	74.72[c] ±0.56	81.78[b] ±0.44	84.43[a] ±0.47	73.22[c] ±0.48	80.24[b] ±0.45	82.80[a] ±0.33
NL	39.17[b] ±0.37	41.73[a] ±0.36	42.71[a] ±0.37	34.48[c] ±0.32	41.84[b] ±0.36	44.84[a] ±0.34

Axk: Cross of Arsi and Kereyu ,M: mean, SE: standard Error, BL: body length, HW: height at withers, HG: heart girth, EL: ear length, FL: face length, HL: horn length ,TL :tail length, FLL: front leg length, HLL: Hind leg length, NL: neck length

The findings indicated that the morphometric measurements of the female cattle is different (P<0.05) between the same breed across the study location. This implies that the management system and small variation of agro ecology between the location affect body measurement of the animal. This is also true for male cattle (Table 6).The findings indicated that the male cattle of the breeds morphometric measurements were better than that of female cattle in both districts except FL which is in agreement with [22] who noted body length, height at withers, heart girth, ear length and horn length of male and female of Bonga Cattle in their production environment in Kafa Zone.

For both female and male breed of current study, the body measurements are higher than reported by [22] for Bonga Cattle while smaller than Begait cattle but comparable on ear length (21.06±0.11), neck length (44.70±0.27) and tail length (97.66±0.37) for female and 21.74±0.07, 47.14±0.09 and 100.3±0.06 respectively for male, while Arsi breed was slightly smaller in neck length and tail length.

Table 6. Morphometric measurements (cm) of cattle breeds (male and female) in the study area

	Female			Male		
	Arsi	A xK	Kereyu	Arsi	A xK	Kereyu
	M±SE	M±SE	M±SE	M±SE	M±SE	M±SE
BL	116.66^{c} ±0.48	122.73^{b} ±0.42	125.41^{a} ±0.41	118.83^{c} ±0.60	124.37^{b} ±1.02	130.70^{a} ±1.12
HW	108.76^{c} ±0.34	117.88^{b} ±0.34	119.87^{a} ±0.32	109.75^{c} ±0.69	118.16^{b} ±0.94	122.70^{a} ±1.28
HG	139.96^{c} ±0.50	142.38^{b} ±0.49	146.78^{a} ±0.49	140.95^{c} ±1.18	143.79^{b} ±1.22	148.25^{a} ±1.19
EL	18.83^{b} ±0.18	20.12^{a} ±0.18	20.57^{a} ±0.18	18.91^{b} ±0.41	20.04^{a} ±0.40	20.62^{a} ±0.35
FL	41.50^{c} ±0.22	41.60^{b} ±0.30	44.39^{a} ±0.25	42.50^{a} ±0.39	41.21^{a} ±0.39	42.41^{a} ±0.72
HL	35.58^{c} ±0.40	44.29^{b} ±0.50	51.01^{a} ±0.44	38.37^{c} ±0.44	43.25^{b} ±1.19	50.00^{a} ±1.27
TL	92.01^{c} ±0.60	102.21^{b} ±0.56	103.76^{a} ±0.48	93.91^{b} ±1.41	101.75^{a} ±1.41	105.41^{a} ±1.18
FLL	60.02^{c} ±0.41	66.99^{b} ±0.35	69.31^{a} ±0.27	61.01^{c} ±0.85	67.12^{b} ±0.84	71.16^{a} ±1.09
HLL	73.80^{c} ±0.35	80.99^{b} ±0.35	83.30^{a} ±0.28	74.87^{c} ±0.88	81.12^{b} ±0.84	85.16^{a} ±1.09
NL	36.80^{c} ±0.41	41.82^{b} ±0.29	43.83^{a} ±0.29	36.95^{c} ±0.68	41.58^{b} ±0.45	43.66^{a} ±0.69

Axk:Cross of Arsi and Kereyu ,M: mean, SE: standard Error, BL: body length, HW: height at wither, HG: heart girth, EL: ear length, FL: face length, HL: horn length ,TL :tail length, FLL: front leg length, HLL: Hind leg length, NL: neck length

Generally the findings showed that female and male Kereyu breed of cattle had better in all morph metric trait measured but HG is lower than reported by [54] of the same Kereyu breed in Fentale.(151.8cm) and higher in BL,HW and HL in Fentale district while Kereyu, Arsi and crossbred have lower BL, HW, HG, NL, and FL than Begait cattle in western Tigray. While the crossbred 'maya' had higher morphometric traits measured than Arsi. The findings show that Arsi breed of cattle in the study location has low morphological traits. They vary across the study locations; the values were however lower than those of many other zebu breeds of Ethiopia [54]; 20] for Kereyu breed in Fentale Arado cattle in northern Tigray, respectively.

The results from the study also indicates that the BL and HG of the Arsi cattle as obtained in this study was lower than those reported by [54] for Kerayu breed and [9] for Boran breed. Short body size cattle require lower maintenance requirements and hence can be reared easily by the small holder farmers [3]. The findings indicated that the BL and HG of crossbred 'maya' of Arsi and Kereyu is higher than that reported by [55] which were BL (117.06±0.3), HW (116.2±0.4), TL (79.6±0.36) and HL (23.90±0.9) for male and BL (113.7±0.2), HW (140.3±0.3), TL (77.7±0.24) and HL (21.8±0.5) for female indigenous cattle population in west Gojjam zone, Amhara region.

Canonical discriminate analysis

Table 7 Presented the total sample standardized canonical coefficient, canonical correlation and total variation explained by each canonical variable. The first canonical variable or fisher linear discriminant function explained 62.26% of the total variation which can be considered reasonable. Accordingly heart girth, front leg length, neck length and body length had higher weighing in extracting CAN1. The canonical variable presented high weighing for heart girth demonstrating its importance to discriminate and classify the population;

Table 7. Total sample standardized canonical coefficients and canonical correlation

Variables	Can1
Body length	0.133728361
Height at withers	-0.492445253
Heart girth	1.396859513
Ear length	-0.081868035
Face length	-0.007175288
Horn length	-0.318827244
Tail length	-0.245116804
Front leg length	0.785460559
Hind leg length	-0.743584544
Neck length	0.297819140
Boset	0.6226160189
Fentale	-.6226160189

The discriminant function is estimated by measuring the generalized squared distance. Mahalanobis distance between breeds of cattle population in Boset and Fentale was 4.41288 for male and 1.533 for female (Table 8). Pair-wise squared Mahalanobis distances between breeds for male sample populations were higher. The long distances among male groups of breed show that small numbers of male cattle breeds population in both study areas and number of sample for male is small. As sample size decrease, variation might increase. This study also indicates the cattle husbandry in the study area prefers to have more number of female cattle than male. Farmers used mostly female as generating income throughout their life and do not sold early. This might be the factor why female cattle groups in the two districts are related as revealed by pair -wise squared Mahalanobis distances between the groups in the study location. The males are shown above diagonal and females below diagonal.

Table 8. Squared Mahalanobis distance between groups of cattle breeds population

Districts	Boset	Fentale
Boset		4.41288 (Male)
Fentale	1.53388 (Female)	

Stepwise discriminant analysis

Stepwise discriminant procedure was applied using PROCSTEPDISC to determine which morphological traits have more discriminating power than the others in the separation of population of the breeds. The result of the stepwise discriminant analysis is presented in Table 13. Five standard canonical discriminant traits were extracted in the study. The significant ($P<0.001$) differences between means of Heart girth, height at withers, horn length, neck length and tail length producing high F values. Table 9 indicated that these variants have high discriminating power and better ability to differentiate the groups of breeds.

By comparing the F-value and the P-value statistics for each significant explanatory variable, we can conclude that heart girth and height at withers shows the highest amount of significant discriminative potential, while horn length, neck length and tail length shows less significant discriminative power in differentiating the breeds.

Table 9. Summary of discriminate stepwise selection among the study locations of breeds

Steps	Variables	Partial R^2	F-statistics	Significant	Wilki λ	Pr < λ
1	HG	0.2063	116.44	<.0001	0.79370881	<.0001
2	HW	0.0587	27.89	<.0001	0.74709920	<.0001
3	HL	0.0097	4.39	0.0367	0.73981511	<.0001
4	NL	0.0147	6.65	0.0102	0.72891654	<.0001
5	TL	0.0071	3.18	0.0753	0.72373731	<.0001

HG=heart girth, HW=height at withers, HL=horn length, NL = neck length; TL= tail length λ = lambda

Discriminant analysis system shows that in the studied location the distribution of population in the two districts.52% population in Fentale district similar to the population in Boset and 60 of population in Boset similar population in Fentale.

Table 10 : Number of observation and percent classified into district from district

Districts	Boset	Fentale
Boset	165(73.33)	6o(26.67)
Fentale	52(23.1)	173(76.89)

SUMMARY AND CONCLUSIONS

Ethiopian cattle genetic diversity is currently under threat mainly due to extensive planned as well as indiscriminate cross breeding between exotic and indigenous and crossing between indigenous breeds, and interbreeding among the local populations. Some previous studies demonstrated low genetic variability which could be due to inbreeding (FIS=0.012) and uncontrolled mating practices that are common among the pastoral herds. Climate change likely affects the productive and reproductive performances of cattle, and consequently their population growth. The interbreeding undertaken among various cattle breeds by different communities may be ascribed to the need to develop a breed that can withstand the impact of the current climate change on their original breed. The present study was carried out to examine morphometric variation between indigenous cattle breeds of Arsi, Kereyu and their crosses and evaluate adaptive, productive (milk yield) and reproductive performance of the breeds.

A total of 60 respondents were involved in the study area, 30 respondents were from Boset and the other 30 respondents involved from Fentale district. Majority of the respondents were male headed households (71.7%) and Female headed household of 28.3%. Most of the respondents in Fentale district were illiterate and none of the respondents attended secondary school. The major livestock production constraints in the area are drought, disease, expansion of unwanted trees on grazing land and water scarcity. The overall mean livestock possession (head/HH) in the study area was 30.96, 29.9, 22.75, 4.11, 18.16, 0.26, and 6.33 for cattle, goat, sheep, donkey, chicken, horse and camel, respectively. The findings show that there was number of Cattle, Sheep and goat than others livestock. The main feed source was natural pasture, crop residues, industrial byproducts and concentrates. Water harvested from rain during rainy season, Dam and pond are the main water sources during dry season.

Culling of animals by different methods was common among the herds owned by the respondents. The respondents have done these activities differently in the two districts by selling and slaughtering. Of these activities, selling of low productive and diseased animals was common. Kereyu breed reared in Boset had better measure of body length, height at withers, heart girth, ear length, tail length, front leg length and hind leg length than other breeds in the same district and also Keryu in Fentale. However, Arsi breed has lower value in all traits measured than Kereyu and crossbred Arsi and Kereyu. However, they are better than the same Arsi breed in Fentale. The results also indicated that crossbred of Arsi and Kereyu cattle has better morphometric traits than Arsi, but lower to that of Kereyu in the two districts.

The canonical variable or Fisher linear discriminant function explained 62.26% of the total variation, which can be considered reasonable. Accordingly, heart girth, front leg length, neck length and body length had higher weighing in extracting CAN1. The canonical variable presented high weighing for heart girth demonstrating its importance to discriminate and classify the population. Squared Mahalanobis distance between breeds of cattle population in Boset and Fentale was 4.41288 for male and 1.533 for female. Pair-wise squared Mahalanobis distances between the breeds male animal sample populations were higher. The long distances among male groups of breed shows that small numbers of male cattle population is kept in both study areas and number of sample for male is small. Five standard canonical discriminant traits were extracted in the study. The significant ($p<0.001$) differences between means of Heart girth, height at withers, horn length, neck length and tail length producing high F values describe that they have high discriminating power and better ability to differentiate the groups of the breeds. Discriminant analysis system show the distribution of population and revealed that 52% of population in Fentale district was similar to the population in Boset and 60% of population in Boset was similar to population in Fentale. With this the following recommendations were forwarded

- Conservation of the Kereyu breed needs to be carried out to avoid genetic dilution
- It is also recommended that community based breeding or open nucleus breeding program should be implemented in the area to improve the genetic performance of the adaptive breed.
- The perception of the farmers and the results that indicate the variation between breeds in their adaptive capacity need further study detail to draw strong recommendation for future breed utilization and breed development.
- The respondents need to be trained in conservation of hay and crop residues to utilize during scarce period.

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APPENDIX

Figure 2. Morphometric Measurement of heart girth and body length