

SOME MORPHOMETRIC TRAITS OF BOER, CENTRAL HIGHLAND AND THEIR F₁ CROSSBRED GOATS REARED AT ATAYE FARM, ETHIOPIA

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Abstract

Morphometric measurements are very important method used to evaluate and assess the characteristics of various breeds of animals. The study was conducted to assess the morphometric traits of Boer (B), Central highland (CH) and their F₁ crossbred (CB) goats reared at Ataye farm, Amhara region. Twenty morphometric measurements and live weight (LW) were assessed on both sexes of the three genotypes totaling to 125 goats to collaborate with the breeding objectives of Amhara Agriculture Research Institute, i.e developing meat type goats. The average values of the morphometric traits were compared between genotypes (sex and age). The results indicated that the paunch girth (PG), body length (BL), rump width (RW), ear lengths (ELR, ELL), head length (HDL), neck circumference (NC), canon circumference (CC), fore limb (FL) and LW were ($p < 0.05$) higher among the B bucks aged 2 years. The measurements among the does of the same age indicated that the chest girth (CG) and chest depth (CD) were higher ($p < 0.05$) for the CB and CH. However, the results indicated higher values for the morphometrical traits in B when compared to the CB and CH. Thus, it can be concluded that some of the morphometric traits of the CB goats were improved and exhibited meat type traits.

Keywords: Morphometric traits, Boer goats, Crossbreds, Central highland goats

Introduction

Goats are multi-purpose livestock, reared in different parts of the globe for their meat, milk and fiber. They also play socio cultural roles among many traditional societies. Goats are often termed as the 'poor man's cow' and are an important source of savings for the agrarian community, especially in the developing countries (Seyed *et al.*, 2014).

Ethiopia has one of the largest livestock populations in the African continent with an estimated population of 24.1 million heads of goats. Most of the goats are distributed across the different agro-ecological zones of the country (CSA, 2012/2013). Unfortunately the potential of these caprines are yet to be fully exploited (EARO, 2000; Kassahun and Solomon, 2009).

The term "Morphometrics" refers to the quantitative analysis of form, a concept that encompasses size and shape (Elewa, 2004). Morphometric analyses are commonly useful in phenotypically analysis of farm animals (Elewa, 2004). The morphometric traits can be categorized into three main groups viz. traits associated with length, height and girth (cross sectional area) (Yakubu, 2010a).

Morphological measurements are very important method used to evaluate and assess the characteristics of various breeds of animals. These measurements can help to provide the basic information on the suitability of the animals towards their selection (Nesamvuni *et al.*, 2000, Mwacharo *et al.*, 2006, Martins *et al.*, 2009 and Yakubu, 2010).

Measurements of phenotypic traits can be used as selection tool for growth. It also enables the breeder to recognize early maturing and late maturing animals of different size (Nesamvuni *et al.*, 2000). Therefore, the objectives of this study are to assess some morphometrical traits and effect of season on some morphometrical traits of Boer, Central highland and their F₁ crossbreds.

Materials and methods

Description of the study area

The study was conducted in Ataye farm of Debre Berhan Agricultural Research Center, Ethiopia. Ataye is the administrative center of the Efratana Gidim woreda. It is known as Effison on the map and is located in the central highlands of Ethiopia about 290 km north of Addis Ababa at an altitude of 2780 m above sea level and at a longitude of 39° E and latitude 10° N. Nearby cities to Ataye are Debre Berhan, Dessie, Hirna (Amhara region agricultural research institute).

Experimental animals and their management

A total of one hundred and twenty-five goats which comprised of Boer, crossbred and indigenous goats of Central highland reared at the farm. The flock comprised of 35 bucks and 90 does age 2 years. The Boer goats and crossbreds were supplemented with concentrates and received newly cultivated *Pennisetum purpureum* (Napier) grass while the native goats were given concentrates and allowed to graze on natural pasture. The concentrate feed were provided three times per day and the goats were taken to water source two or three times a day depending on the season. The animals were vaccinated against commonly occurring disease in the area viz. anthrax, black leg and pasturelosis. The animals were regularly dewormed against commonly occurring parasites using antihelmenthics viz. albendazole, tetraclozole and ivermectin in rotation.

Data collection procedures

Quantitative morphometrical characters:

Data were collected on twenty morphometrical traits from the bucks and does. The study lasted for 9 months and was divided into three seasons: February to March; July to August followed by October to November in the year 2014. During each of the period all the animals were measured for the morphometrical traits and were weighed using a spring balance. All the measurements were taken by the researcher in order to avoid any measuring error. For the assessment of morphometrical traits, only those bucks and does aged 2 years were considered. The FAO (2012) qualitative and quantitative goat/sheep breed descriptor list was followed to characterize the goat types phenotypically and morphologically as shown in Table 1.

The morphometrical parameters were obtained using self-devised equipment and according to the method suggested by Maciejowski and Zieba (1982). All measurements were taken early in the morning prior to feeding and were taken to an up-right plane during measurement. Pregnant and lactating animals were avoided in the sampling. Live weight was measured using suspended spring balance with 100 kg capacity with ± 200 g error margin (for heavier animals) and 25 kg capacity with ± 50 g error margin (for lighter ones). The age of the animals were obtained from the farm records.

Table 1: Methods of assessing the morphometrical traits

Parameters	Measuring techniques	Measuring equipment
Chest girth (CG)	Measured by taking the measurements of the circumference of the chest; behind the forelegs	Measuring tape
Chest depth (CD)	From withers to the bottom brisket surface, just behind the elbow	Measuring stick
Chest width (CW)	The widest point of shoulders	Measuring stick
Paunch girth (PG)	Circumference of the belly at the center	Measuring tape
Height at withers (HW)	Measured as a distance from the surface of the platform to the withers of the animal	Measuring stick
Height at rump (HR)	Measured as a distance from the surface of the platform to the rump of the animal	Measuring stick
Rump length (RL)	Measured as the distance from the hip (<i>tuber coxa</i>) to the pin (<i>tuber ischi</i>)	Dividers
Body length (BL)	The distance from the point of shoulder to the pin bone	Measuring tape
Shoulder width (SW)	The width of the chest between the briskets	Measuring stick
Rump width (RW)	The horizontal distance between the extreme lateral points of the hook bone (<i>tuber coxae</i>) of the pelvis)	Dividers
Ear length right (ELR)	Taken from the base to the tip of the ear	Dividers
Ear length left (ELL)		
Head length (HDL)	The length of the front head from the middle of the top head to the end of the mouth	Dividers
Head width (HDW)	The width of the front head from the base of left and right ear	Dividers
Neck length (NL)	The length between the atlas vertebrae till the vertebrae just ahead of the first thoracic.	Measuring tape
Neck circumference (NC)	Measured from dorsal border to ventral border in the center of the neck	Measuring tape
Fore canon length (CL)	The length of the lower part of the leg extending from the hock to the fetlock	Measuring tape
Fore canon circumference (CC)	The circumference of the lower part fore canon bone or the smallest circumference of the foreleg	Measuring tape
Hind limb (HL)	From the hip bone to pin bone (outside)	Measuring tape
Fore limb (FL)	From the breath in points of shoulder joints	Measuring tape

FAO, (2012)

Statistical Analysis

The data were analyzed using SPSS version 19 for Windows. The goats were classified according to genotype and sex and age within a genotype. The average means of the morphometrical traits were compared according to genotype (sex and age) using Independent T-test and Duncan's multiple range test.

Results

Morphometric traits and live weight (LW) of Boer and crossbred bucks aged 2 years

The results pertaining to morphometrical traits and LW of Boer (B) and (Boer x Central highland) (CB) bucks aged 2 years are presented in Table 2. The result indicates that the LW, paunch girth (PG), body length (BL), rump width (RW), ear lengths (ELR, ELL), head length (HDL), neck circumference (NC), canon circumference (CC) and fore limb length (FL) were higher ($p < 0.05$) for B. The result further indicated that there were no significant differences observed among the two genotypes in other morphometric traits.

Table 2: Average (Means \pm SD) values of morphometric measurements (cms) and live weight (LW, kgs) of Boer and crossbred bucks aged 2 years

Traits (cm)	Boer N = 15	Crossbred N = 20
LW	31.55 \pm 2.23 ^a	26.85 \pm 0.68 ^b
CG	69.82 \pm 2.71	66.16 \pm 0.96
CD	27.25 \pm 0.70	27.02 \pm 0.34
CW	19.08 \pm 1.04	18.23 \pm 0.31
PG	87.00 \pm 2.80 ^a	79.01 \pm 0.97 ^b
SW	18.78 \pm 1.04	17.59 \pm 0.24
HW	58.98 \pm 1.95	57.77 \pm 0.81
HR	62.00 \pm 2.67	62.77 \pm 0.84
BL	62.50 \pm 1.83 ^a	55.16 \pm 0.71 ^b
RL	10.95 \pm 0.58	10.40 \pm 0.24
RW	14.40 \pm 0.62 ^a	12.60 \pm 0.16 ^b
ELR	22.80 \pm 0.65 ^a	18.07 \pm 0.21 ^b
ELL	23.33 \pm 0.65 ^a	18.28 \pm 0.19 ^b
HDL	20.23 \pm 0.45 ^a	18.87 \pm 0.21 ^b
HDW	9.02 \pm 0.43	8.62 \pm 0.22
NL	21.33 \pm 1.12	20.98 \pm 0.45
NC	35.17 \pm 2.15 ^a	31.34 \pm 0.61 ^b
CL	20.30 \pm 0.77	19.02 \pm 0.24
CC	9.00 \pm 0.58 ^a	7.42 \pm 0.16 ^b
HL	58.25 \pm 2.80	54.37 \pm 0.67
FL	52.50 \pm 3.45 ^a	47.67 \pm 0.59 ^b

^{a,b} Means on the same row followed by different superscripts are significantly different ($p < 0.05$) crossbred (Boer X Central highland), Live weight (LW), Chest girth (CG), Chest depth (CD), Paunch girth (PG), Height at withers (HW), Height at rump (HR), Rump length (RL), Shoulder width (SW), Rump width (RW), Body length (BL), Ear lengths (EL), Head length (HDL), Head width (HDW), Neck length (NL), Neck circumference (NC), Fore canon length (CL), Fore canon circumference (CC), Hind limb length (HL), Fore limb length (FL). N=Number of observations

Morphometric traits and live weight (LW) of Boer, crossbred and Central highland (CH) does aged 2 years

The results pertaining to live weight (LW) and morphometric traits of Boer (B), crossbred (CB) and Central highland (CH) does aged 2 years are presented in Table 3. The results showed that chest girth (CG) and chest depth (CD) were ($p < 0.05$) in CB and CH than those of the B does. Furthermore, the chest width (CW) and shoulder width (SW) values were higher ($p < 0.05$) in the B and CB. Height at wither (HW), height at rump

(HR), hind limb length (HL) and fore limb length (FL) were higher ($p < 0.05$) among the CH does followed by CB and B respectively. The higher ($p < 0.05$) rump width (RW) value was observed in CH but there was no difference ($p > 0.05$) between CB and B does. However, the ear lengths (ELs) was higher ($p < 0.05$) for the B does while the head length (HDL) was ($p < 0.05$) in B and CB does than those of CH. Higher canon length (CL) values were observed in CB and CH does than B. The fore limbs (FL) and hind limb (HL) were longer for the CH does while they were shorter in the B.

Table 3: Average (Means \pm SD) values of morphometric measurements (cms) and live weight (LW, kgs) of Boer, Crossbred and Central highland does at age 2 years

Traits (cm)	Boer N=20	Crossbred N=25	Central highland N=45
LW	23.62 \pm 1.49	24.85 \pm 0.29	23.64 \pm 0.33
CG	60.11 \pm 2.73 ^b	63.51 \pm 0.67 ^a	64.82 \pm 0.31 ^a
CD	24.97 \pm 1.03 ^b	27.02 \pm 0.22 ^a	26.43 \pm 0.14 ^a
CW	16.67 \pm 0.87 ^a	17.63 \pm 0.25 ^a	14.60 \pm 0.15 ^b
PG	72.67 \pm 4.04	72.64 \pm 1.07	74.75 \pm 0.52
SW	17.27 \pm 0.85 ^a	16.73 \pm 0.18 ^a	15.39 \pm 0.18 ^b
HW	53.22 \pm 1.96 ^c	56.12 \pm 0.50 ^b	60.36 \pm 0.27 ^a
HR	55.28 \pm 2.03 ^c	60.43 \pm 0.54 ^b	63.96 \pm 0.25 ^a
BL	53.56 \pm 2.19	54.23 \pm 0.57	56.20 \pm 0.43
RL	10.89 \pm 1.33	11.07 \pm 0.12	10.90 \pm 0.13
RW	12.66 \pm 0.59 ^{ab}	12.41 \pm 0.16 ^b	13.13 \pm 0.07 ^a
ELR	20.78 \pm 0.44 ^a	19.41 \pm 0.16 ^b	13.92 \pm 0.12 ^c
ELL	20.09 \pm 0.77 ^a	19.38 \pm 0.17 ^b	14.23 \pm 0.10 ^c
HDL	17.56 \pm 0.54 ^a	17.70 \pm 0.22 ^a	16.48 \pm 0.08 ^b
HDW	7.42 \pm 0.51	7.67 \pm 0.17	7.63 \pm 0.09
NL	20.11 \pm 0.79	20.99 \pm 0.34	21.06 \pm 0.44
NC	25.22 \pm 1.81	25.25 \pm 0.23	26.05 \pm 0.17
CL	18.00 \pm 0.47 ^b	19.09 \pm 0.20 ^a	19.08 \pm 0.09 ^a
CC	7.13 \pm 0.27	7.10 \pm 0.12	6.89 \pm 0.04
HL	50.00 \pm 1.88 ^c	55.11 \pm 0.65 ^b	60.40 \pm 0.28 ^a
FL	44.89 \pm 1.78 ^c	47.58 \pm 0.41 ^b	50.32 \pm 0.22 ^a

^{a,b,c} Means on the same row are significantly different ($P < 0.05$) crossbred (Boer X Central highland), Live weight(LW), Chest girth(CG), Chest depth(CD), Paunch girth(PG), Height at withers(HW), Height at rump(HR), Rump length(RL), Shoulder width(SW), Rump width(RW), Body length(BL), Ear lengths (EL), Head length(HDL), Head width(HDW), Neck length(NL), Neck circumference(NC), Fore canon length(CL), Fore canon circumference(CC), Hind limb length (HL), Fore limb length(FL)

Effect of season on morphometric traits and live weight (LW) of Boer and Crossbred bucks aged 2 years

The results pertaining to the effect of season on some morphometrical traits and LW of Boer and crossbred bucks are presented in Table 4. Except for the ear length values all the traits are more or less similar among both genotypes in the first season. The lengths of the ear (ELR, ELL) being longer ($P < 0.05$) among the B. The results further indicate that in the second season the values for rump width (RW), body length (BL), ear lengths (ELR, ELL), neck circumference (NC), canon circumference (CC), and the live weight (LW) were higher ($P < 0.05$) among the B bucks. The results in the third season indicate most of the traits measured were significantly different ($P < 0.05$). The B bucks had higher values than those of the CB viz. CW, PG, BL, ELR, ELL, HDL, NC, CC, HL and FL.

Table 4: Effect of season on morphometric traits and LW (Means \pm SD) of Boer and crossbred bucks aged 2 years

Traits (cms)	First season		Second season		Third season	
	Boer N= 15	Crossbred N=20	Boer N=15	Crossbred N=20	Boer N=15	Crossbred N=20
LW (kg)	25.50 \pm 1.50	25.73 \pm 1.15	36.95 \pm 1.05 ^a	26.35 \pm 1.36 ^b	32.20 \pm 2.20	27.70 \pm 0.99
CG	63.70 \pm 2.70	67.89 \pm 1.57	71.00 \pm 1.00 ^a	65.36 \pm 1.65 ^b	74.75 \pm 6.25	65.95 \pm 1.58
CD	25.75 \pm 0.25	26.53 \pm 0.74	27.00 \pm 1.00	26.96 \pm 0.58	29.00 \pm 1.00	27.28 \pm 0.53
CW	17.25 \pm 0.25	17.62 \pm 0.74	18.50 \pm 0.50	17.64 \pm 0.67	21.50 \pm 2.50 ^a	18.92 \pm 0.32 ^b
PG	81.50 \pm 6.50	80.72 \pm 1.82	87.50 \pm 4.50	79.71 \pm 1.58	92.00 \pm 0.00 ^a	77.75 \pm 1.58 ^b
HW	55.45 \pm 1.45	57.34 \pm 1.70	58.00 \pm 1.00	56.07 \pm 1.45	63.50 \pm 4.50	58.45 \pm 1.24
HR	58.00 \pm 2.00	59.58 \pm 2.00	59.00 \pm 2.00	61.07 \pm 1.49	69.00 \pm 5.00	64.10 \pm 1.30
RL	10.15 \pm 0.95	9.40 \pm 0.40	11.30 \pm 1.80	10.59 \pm 0.48	11.40 \pm 0.00	10.73 \pm 0.30
SW	17.35 \pm 2.15	16.71 \pm 0.39	18.00 \pm 0.00	17.58 \pm 0.51	21.00 \pm 2.00	17.99 \pm 0.29
RW	12.55 \pm 0.25	12.64 \pm 0.41	14.95 \pm 0.45 ^a	12.46 \pm 0.24 ^b	11.40 \pm 0.00	12.69 \pm 0.26
BL	58.00 \pm 2.00	54.56 \pm 1.68	62.00 \pm 0.00 ^a	53.43 \pm 0.94 ^b	67.50 \pm 0.50 ^a	56.65 \pm 1.09 ^b
ELR	23.25 \pm 1.75 ^a	18.36 \pm 0.32 ^b	22.50 \pm 1.50 ^a	18.23 \pm 0.28 ^b	22.65 \pm 0.85 ^a	17.82 \pm 0.37 ^b
ELL	23.75 \pm 2.25 ^a	18.46 \pm 0.28 ^b	22.95 \pm 0.95 ^a	18.49 \pm 0.29 ^b	23.30 \pm 0.10 ^a	18.06 \pm 0.33 ^b
HDL	20.25 \pm 0.75	18.39 \pm 0.67	19.30 \pm 0.20	19.08 \pm 0.31	21.15 \pm 0.85 ^a	18.94 \pm 0.26 ^b
HDW	8.35 \pm 0.55	7.70 \pm 0.43	10.05 \pm 0.55	8.51 \pm 0.33	8.65 \pm 0.75	9.12 \pm 0.31
NL	19.00 \pm 0.00	19.06 \pm 0.71	20.50 \pm 1.50	20.94 \pm 0.73	24.50 \pm 0.50	21.88 \pm 0.69
NC	29.00 \pm 3.00	31.19 \pm 1.65	38.00 \pm 1.00 ^a	30.89 \pm 0.93 ^b	38.50 \pm 1.50 ^a	31.63 \pm 0.95 ^b
CL	19.55 \pm 0.55	18.26 \pm 0.73	20.60 \pm 0.40	19.05 \pm 0.34	20.75 \pm 2.75	19.34 \pm 0.31
CC	7.50 \pm 0.50	7.19 \pm 0.35	9.50 \pm 0.50 ^a	7.29 \pm 0.32 ^b	10.00 \pm 1.00 ^a	7.63 \pm 0.22 ^b
FL	46.75 \pm 1.75	46.89 \pm 1.79	51.25 \pm 1.25	46.50 \pm 0.96	59.50 \pm 9.50 ^a	48.85 \pm 0.69 ^b
HL	57.00 \pm 0.00	54.39 \pm 1.50	53.50 \pm 5.50	52.50 \pm 0.97	64.25 \pm 5.25 ^a	55.68 \pm 1.00 ^b

^{a,b} Means on the same row are significantly different ($p < 0.05$) within season. Live weight (LW), Chest girth (CG), Chest depth (CD), Paunch girth (PG), Height at withers (HW), Height at rump (HR), Rump length (RL), Shoulder width (SW), Rump width (RW), Body length (BL), Ear lengths (EL), Head length (HDL), Head width (HDW), Neck length (NL), Neck circumference (NC), Fore canon length (CL), Fore canon circumference (CC), Hind limb length (HL), Fore limb length (FL)

Effect of season on morphometric traits and live weight of Boer, Crossbreds and Central highland (CH) does aged 2 years

The results pertaining to the effect of season on morphometrical traits and LW of does are presented in Table 5. The results indicate significant variation among the three genotypes for most of the traits studied. As observed during the first season the result for the LW was higher ($P < 0.05$) for the B and CB. The Table also indicates that the chest depth (CD), chest girth (CG), rump length (RL) and canon circumference (CC) were higher ($p < 0.05$) among the CB, while shoulder width (SW), ear lengths (ELR, ELL) were higher ($p < 0.05$) among the B. The Central Highland does at the same season had higher ($p < 0.05$) height at wither (HW), height at rump (HR) and hind limb length (HL). The lengths of fore leg (FL) were similar among the CB and CH does, while chest width (CW) and neck length (NL) were similar among the B and CB.

The results from the second season indicates that the CB had intermediate values (between the two parental types) for most of the traits viz; SW, ELR, ELL, HDL, NC and CC, while the CH does had higher ($p < 0.05$) values for traits like HW, HR, HL and FL. The values for CG were similar among the B and CH does, which was higher ($p < 0.05$) than the CB. The results further indicated similar CW values among the B and CB which was higher ($p < 0.05$) than those of the CH does.

The results for the third season indicates that the CB were superior to the two genotypes for CW and head length (HDL) while on the other hand the other morphometrical traits were similar to either of the parental types. The traits like CG, CD, PG, SW, HR, BL, NC and canon length (CL) were higher and similar among CB and CH does. Contrary to the above the rump width (RW), ELR, ELL values were similar to those of the B does. The differences observed may be due to genotype environmental interaction where specific environment collating with the sampling period may favor a specific or group of similar genotypes.

Table 5: Effect of season on morphometric traits and LW (Means \pm SD) of Boer, Crossbred and Central highland (CH) does aged 2 years

Traits (cms)	First season			Second season			Third season		
	Boer N=20	Crossbred N= 25	CH N =45	Boer N=20	Crossbred N=25	CH N=45	Boer N=20	Crossbred N=25	CH N=45
LW(Kg)	21.20 \pm 2.42 ^a	22.75 \pm 0.62 ^a	19.37 \pm 0.40 ^b	26.20 \pm 3.03	25.45 \pm 0.28	24.52 \pm 0.45	23.47 \pm 2.27	25.83 \pm 0.19	24.84 \pm 0.46
CG	58.67 \pm 2.73 ^b	63.79 \pm 1.62 ^a	61.59 \pm 0.47 ^{ab}	66.67 \pm 1.33 ^a	61.73 \pm 0.71 ^b	65.30 \pm 0.44 ^a	55.00 \pm 6.66 ^b	64.36 \pm 0.97 ^a	66.66 \pm 0.48 ^a
CD	23.23 \pm 0.15 ^c	27.00 \pm 0.63 ^a	24.89 \pm 0.21 ^b	27.00 \pm 1.00	27.37 \pm 0.25	26.75 \pm 0.20	24.67 \pm 2.85 ^b	26.83 \pm 0.24 ^a	27.21 \pm 0.21 ^a
CW	17.17 \pm 0.17 ^a	18.58 \pm 0.59 ^a	12.99 \pm 0.21 ^b	18.67 \pm 0.33 ^a	17.35 \pm 0.26 ^a	14.94 \pm 0.24 ^b	14.17 \pm 1.92 ^b	17.19 \pm 0.32 ^a	15.41 \pm 0.22 ^b
PG	72.33 \pm 3.53	72.04 \pm 1.25	70.42 \pm 0.81	80.00 \pm 3.21	72.86 \pm 3.16	74.65 \pm 0.75	65.67 \pm 11.02 ^b	72.89 \pm 1.41 ^a	77.97 \pm 0.85 ^a
WS	17.40 \pm 0.59 ^a	15.92 \pm 0.21 ^b	12.61 \pm 0.18 ^c	19.17 \pm 0.17 ^a	16.89 \pm 0.40 ^b	16.25 \pm 0.22 ^b	15.23 \pm 2.12 ^b	17.15 \pm 0.26 ^a	16.52 \pm 0.23 ^{ab}
HW	53.67 \pm 1.33 ^b	54.33 \pm 1.11 ^b	57.88 \pm 0.46 ^a	54.00 \pm 2.08 ^b	56.05 \pm 1.03 ^b	60.79 \pm 0.40 ^a	52.00 \pm 6.25 ^c	57.29 \pm 0.49 ^b	61.72 \pm 0.39 ^a
HR	56.17 \pm 1.69 ^b	59.00 \pm 0.96 ^{ab}	61.77 \pm 0.48 ^a	56.67 \pm 1.86 ^b	59.27 \pm 0.86 ^b	64.08 \pm 0.33 ^a	53.00 \pm 6.25 ^b	62.00 \pm 0.79 ^a	65.42 \pm 0.37 ^a
BL	51.33 \pm 2.03	53.56 \pm 1.12	52.22 \pm 0.55	57.00 \pm 3.06	54.45 \pm 1.61	57.43 \pm 0.69	52.33 \pm 5.93 ^b	54.53 \pm 0.52 ^{ab}	57.84 \pm 0.68 ^a
RL	9.00 \pm 0.58 ^b	10.63 \pm 0.21 ^a	9.09 \pm 0.17 ^b	10.67 \pm 0.60	11.07 \pm 0.32	11.61 \pm 0.15	13.00 \pm 4.07	11.35 \pm 0.13	11.50 \pm 0.18
RW	11.83 \pm 0.44	12.14 \pm 0.16	12.37 \pm 0.10	13.47 \pm 0.80	12.88 \pm 0.27	13.32 \pm 0.10	12.67 \pm 1.66 ^{ab}	12.30 \pm 0.28 ^b	13.49 \pm 0.11 ^a
ELR	21.60 \pm 0.61 ^a	19.32 \pm 0.33 ^b	15.29 \pm 0.15 ^c	20.83 \pm 0.83 ^a	19.38 \pm 0.30 ^b	13.31 \pm 0.17 ^c	19.90 \pm 0.74 ^a	19.49 \pm 0.23 ^a	13.54 \pm 0.17 ^b
ELL	20.77 \pm 1.95 ^a	19.27 \pm 0.30 ^b	15.62 \pm 0.15 ^c	20.17 \pm 1.17 ^a	19.34 \pm 0.38 ^b	13.70 \pm 0.12 ^c	19.33 \pm 1.20 ^a	19.47 \pm 0.25 ^a	13.77 \pm 0.14 ^b
HDL	18.20 \pm 0.42 ^a	18.52 \pm 0.28 ^a	16.96 \pm 0.14 ^b	18.00 \pm 0.58 ^a	16.13 \pm 0.44 ^b	16.31 \pm 0.13 ^b	16.47 \pm 1.44 ^b	18.09 \pm 0.17 ^a	16.30 \pm 0.14 ^b
HDW	5.67 \pm 0.50	6.38 \pm 0.13	6.01 \pm 0.11	8.40 \pm 0.31	8.44 \pm 0.27	8.19 \pm 0.07	8.20 \pm 0.67	8.05 \pm 0.17	8.25 \pm 0.06
NL	19.00 \pm 0.58 ^a	19.47 \pm 0.37 ^a	17.80 \pm 0.15 ^b	21.00 \pm 1.15	21.88 \pm 0.99	21.51 \pm 0.26	20.33 \pm 2.19	21.43 \pm 0.31	22.96 \pm 1.09
NC	24.00 \pm 2.31	25.75 \pm 0.58	24.96 \pm 0.30	29.67 \pm 3.33 ^a	25.00 \pm 0.50 ^b	26.32 \pm 0.27 ^b	22.00 \pm 2.65 ^b	25.08 \pm 0.21 ^a	26.57 \pm 0.29 ^a
CL	17.67 \pm 0.33	18.03 \pm 0.31	19.04 \pm 0.23	19.33 \pm 0.33	18.96 \pm 0.35	19.05 \pm 0.12	17.00 \pm 1.00 ^b	19.84 \pm 0.24 ^a	19.13 \pm 0.12 ^a
CC	6.73 \pm 0.43 ^{ab}	7.07 \pm 0.14 ^a	6.45 \pm 0.06 ^b	7.67 \pm 0.33 ^a	7.11 \pm 0.12 ^b	7.06 \pm 0.06 ^b	7.00 \pm 0.58	7.11 \pm 0.25	8.16 \pm 1.11
HL	50.67 \pm 2.73 ^b	53.35 \pm 0.93 ^b	58.59 \pm 0.36 ^a	51.33 \pm 2.59 ^c	55.92 \pm 2.15 ^b	60.78 \pm 0.46 ^a	48.00 \pm 5.03 ^c	55.76 \pm 0.36 ^b	61.32 \pm 0.50 ^a
FL	43.67 \pm 0.33 ^b	47.17 \pm 0.82 ^a	49.40 \pm 0.40 ^a	47.67 \pm 1.33 ^b	47.32 \pm 0.62 ^b	50.15 \pm 0.33 ^a	43.33 \pm 5.51 ^c	47.65 \pm 0.67 ^b	51.16 \pm 0.37 ^a

^{a,b,c} Means on the same row are significantly different ($p < 0.05$) within season. Live weight (LW), Chest girth (CG), Chest depth (CD), Paunch girth (PG), Height at withers (HW), Height at rump (HR), Rump length (RL), Shoulder width (SW), Rump width (RW), Body length (BL), Ear lengths (EL), Head length (HDL), Head width (HDW), Neck length (NL), Neck circumference (NC), Fore canon length (CL), Fore canon circumference (CC), Hind limb length (HL), Fore limb length (FL)

Discussion

Morphometric traits and LW of Boer (B) and Crossbred (CB) bucks aged 2 years

The results as presented in Table 2 indicate that live weight (LW) for the B was higher ($p < 0.05$) than the CB bucks. The result is similar to those reported by Keith *et al.*, (2009) for B bucks at pubertal age, Cameron *et al.*, (2001) for (B X Angora) and Shumuye *et al.*, (2014) for (Abergelle X B). The result pertaining to the LW of the mature B bucks as obtained in the present study indicate variation from those reported by (Keith *et al.*, 2009). The difference may be attributed to genotype by environment interaction effect. The differences between the LW of the two genotypes could be attributed to breed effect *i.e* B vis-à-vis the CB bucks. The results attributed to the paunch girth (PG), body length (BL), rump width (RW), ear lengths (ELR, ELL), head length (HDL), neck circumference (NC), canon circumference (CC) and fore limb length (FL) were significantly higher among the B bucks which may be attributed as a breed character.

The BL for the B is comparable to the finding of Keith *et al.*, (2009) for Boer goats and Ford Jr. *et al.*, (2009) for Kiko goats, while the BL for the CB are lower to that of Cuban Creole crossbreds (Chacon *et al.*, 2011). The RW for both genotypes were lower to the findings by Keith *et al.*, (2009) for the B bucks and Chacon *et al.*, (2011) for CB bucks. The results for CC are comparable to those reported by Özkan *et al.*, (2012) in Honamli goats. The differences among LW and morphometrical traits are a fall out of both genotype and environment where the animals are reared. The observations are in accordance with those of Safari *et al.*, (2005) who observed within breed variation among goats.

Morphometric traits and LW of Boer (B), Crossbred (CB) and Central highland (CH) does aged 2 years

The CG value in Table 3 for CH does is comparable with the findings by Theodros, (2014) in Afar goat but higher values of the same trait were reported for Abergelle, Arsi-Bale and Woito-Guji goats (Solomon, 2009). Consistent with this study, the CG value for the CB was lower when compared to the findings of Chacon *et al.*, (2011) and Cameron *et al.*, (2001) in (B X Angora). Furthermore, higher value for CG was reported by Keith *et al.*, (2009) in B goats when compared to the results of the present study. The CD value for CH does is comparable to the observation made by Yakubu *et al.*, (2010) for West African Dwarf (WAD) goats of Nigeria. The HDL value indicated that B and CB have longer head than CH does. The study by Hammond *et al.*, (1971) indicated that the head of improved meat type animals is longer than unimproved types. Similar values were observed for HDL of Cuban Creole crossbreds and their indigenous counterparts (Chacon *et al.*, 2011). The CW values for the CB and CH are comparable to the findings of Chacon *et al.*, (2011) in Cuban Creole crossbreds and also in WAD goats (Yakubu *et al.*, 2010). Furthermore, results of the studies of Newman and Patterson, (1997) for (B X Cashmere crossbreds); Nimbkar *et al.*, (2000), Jiabi *et al.*, (2004) and Merlos-Brito *et al.*, (2008) too supported the present observations.

Shoulder width (SW) was lower for B when compared to the observation of Keith *et al.*, (2009). This might be attributed to difference in nurture/management of the B goats at two different locations. However, higher value for the same trait were recorded in CH when compare to the findings by Yakubu *et al.*, (2010) in WAD and Red Sokoto goats. The HDL values for the CH and CB are comparable to the findings by Chacon *et al.*, (2011). The value for HW, HR, HL and FL were higher among the CH does followed by CB indicating a genetic difference in skeletal traits. The result pertaining to HW for CH does is comparable to those reported by Chacon *et al.*, (2011), Yakubu and Mohammed, (2012) and Theodros, (2014). The result related to RW was similar among the B and CH does, while it was also comparable among the B and CB does. The ear lengths (ELR, ELL) values were found higher in B followed by CB and CH does. The result of these findings indicates significant differences in morphometrical traits among the three genotypes. The better performance of the CB (in terms of

live weight) vis-à-vis CH is in accordance with the findings of Newman and Patterson (1997) and Merlos-Brito *et al.* (2008). Similar observation pertaining to improvement in morphometric traits as a result of crossbreeding have been reported by Wilson and Morayi (1988), Kassahun *et al.*, (1989) and Rhone (2005).

Effect of season on morphometric traits and LW of Boer (B) and Crossbred (CB) bucks aged 2 years

The results of the first season indicated that the performance of the B is comparable with the CB bucks while in the second season most of the morphometric traits of the B were better than the CB. The results pertaining to the third season indicated that the B outperformed the CB in most of the traits. This is in accordance with the report by Gaddour *et al.*, (2007) who observed differences in productivity of animals can fluctuate between favorable and less favorable environments.

Effect of season on morphometric traits and LW of Boer (B), Crossbreds (CB) and Central highland (CH) does aged 2 years

The significant effect of season on morphometric traits as observed in this study agrees with the reports of Otuma (2004). This indicates the adaptability of the CB and CH during the third season to thrive on roughages. Findings of Otuma, (2004) supported the results during the third season who suggested that it could be as a result of low incidence of both ecto and endo parasites, the higher values for the LW as assessed could be correlated with the adequate availability of crop aftermaths and also better grazing facilities. The observations are in accordance with the findings of (Adedeji *et al.*, 2011). The differences observed among the genotypes across different season may be attributed to the genotype environment interaction during the period. The differences as observed are in accordance with those of Le Gal Planchenault, (1993) who reported differences in growth often correlate with the weather conditions and feed availability.

Summary and conclusion

This study was carried out to assess morphometrical traits of Boer, Central highland and their F₁ Crossbred (Boer X Central highland goats) raised at Ataye farm in Amhara region. The results pertaining to the morphometric traits and LW for the B and CB bucks indicated variation in most of the traits favoring the B goats in most of the traits. The results observed on morphometric traits for the B, CB and CH does indicated variation among the three genotypes on some of the traits. Thus it can be concluded from the study that while there were some encouraging results from the crossbreeding experiment and that most of the morphometric traits of the crossbreds were improved. However the overall efficacy of the CB was not quite as expected. Furthermore, the adaptability and the overall productivity of the CB need to be studied further especially at the beneficiaries (farmers) end.

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