

Genetic and non-genetic factors affecting the performance of West African Dwarf (WAD), Yankasa (YAN) and WAD X YAN lambs in the tropics

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Abstract

Genetic and non-genetic factors affecting performance of sheep at the Teaching and Research farm of the Federal University of Technology, Akure, Ondo State, Nigeria were studied from 2005-2006. Genetic groups involved were 8 West African Dwarf sheep (WAD), 10 Yankasa (YAN) and 10 WAD X YAN (XBD). Data were analysed using General Linear Model of least squares analysis of variance to test the influence of genetic group, sex, season and age on weights and linear body measurements such as height at withers (HT), body length (BL), Neck length (NL), Neck circumference (NC), heart girth (HG), Foreleg length (FL), Hind leg length (HL), Face length (FA), Ear length (EA), Headwidth (HW), shoulder width (SW), tail length (TL) and Rump height (RH). Weight, HT, BL, HG, FL, HL, FL, EL, TL and RH were significantly affected by genetic group. Female lambs weighed 0.75kg more than the males ($p<0.01$). Season of birth had significant effect on WT ($p<0.0001$), HT ($p<0.01$), NL ($p<0.001$), FL ($p<0.0001$), HL ($p<0.0.0001$), FA ($p<0.01$), SW ($p<0.01$) and RL ($p<0.05$), the traits were superior in the rainy season. Age significantly affected all parameters considered. The WAD (0.53) and XBD (1.39kg) lambs were and heavier during the rainy season as compared to the dry season. Of the body dimensional traits, HG had the highest correlation coefficients with WT in WAD and YAN lambs estimated at 0.86 and 0.89 respectively, whereas HT was the most correlated trait with WT in XBD lambs. Height at withers and body length were the most important additional variables to heartgirth accounting for 87% prediction of body weight in WAD and YAN lambs, whereas, HT, BL, NC, HG, SW, TL and RH could account for up to 90% of body weight in XBD lambs

Keywords: Genetic, non-genetic, West African Dwarf (WAD), Yankasa and WAD X YAN, lambs

Introduction

In Nigeria, the contribution of sheep in the provision of meat, milk and cash income is disappointingly low compared to their number which is estimated to be about 40 million. This small contribution of sheep to human diet is a reflection of their poor output. There are many factors (genetic and non-genetic) contributing to this low output which reflects the need for improvement in terms of meat and milk. Improvement in performance of sheep through selection has not been given serious consideration in Nigeria, as it is time and money consuming. This has led to seeking improvement by introducing crossbreeding programme using exotic breeds which are not able to adapt to a harsh environment and produce or reproduce at the same level as in the country of their origin (Berhanu *et al.* 1992).

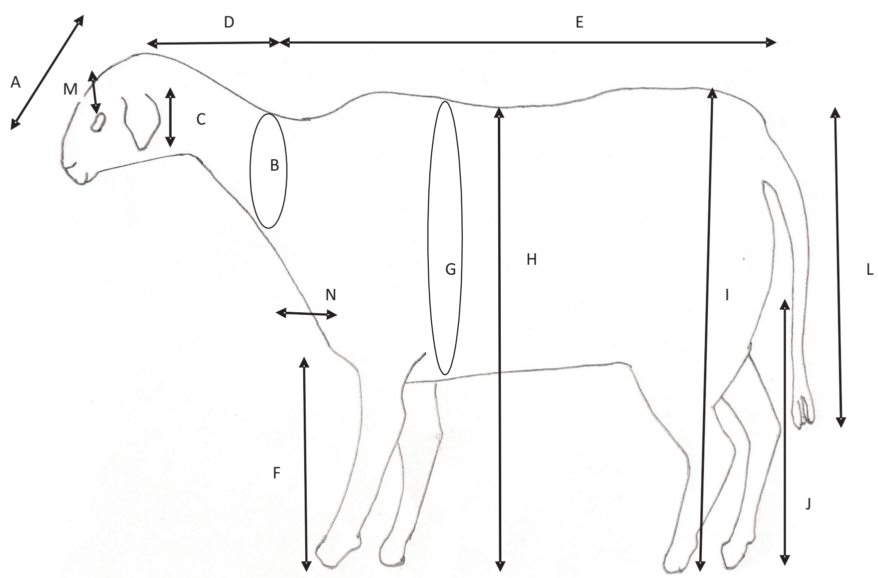
The need to develop productive and adaptive sheep breed for rainforest zone is desirable. Multiplication and distribution of such high quality hybrid sheep definitely would increase small ruminant animal production and animal protein supply where the level of livestock production is quite low (Nwachukwu *et al.* 2012). The use of well adapted West African Dwarf (WAD) and highly productive indigenous Yankasa sheep in 'new breed' formation is an appropriate breeding plan especially from the point view of utilizing local animal genetic resources (AnGR) in realizing local needs. Because sheep are used mainly for meat production in Nigeria, rapid growth rate is of considerable importance for efficiency. Patterns of development are useful in the assessment of conformation (Salako, 1999, 2004).

Research findings have shown that linear body measurements of animals have been widely used to assess the growth of skeletal parts and have been widely shown to be useful in describing generally, the changes in body conformation with age. Linear body measurements could reliably predict body weight fairly well in the situation where weighbridges and scale are not available (Afolayan *et al*. 2006, Oyegunle and Chineke, 2012, Henry *et al.* 2010)

The purpose of this study was to evaluate growth performance of West African Dwarf sheep, Yankasa and their crossbred.

Materials and Methods

Three hundred and sixty –four (364) weekly measurements were taken for twelve (12) weeks from 8 West African Dwarf (WAD) sheep, 10 Yankasa (YAN) breed and 10 WAD X YAN lambs at the Teaching and Research Farm of the Federal University of Technology, Akure, Ondo State, Nigeria from 2005-2006. Akure is situated on 350.52m above sea level at latitude 7^0 14N' and longitude 5^0 14'E. The city falls within the rainforest zone of the humid tropics which is characterized by hot and humid climate. The mean annual rainfall is 1500mm and the rain period is bimodal with a short break in August. The mean annual relative humidity is 75% and that of temperature is 20^0C. West African Dwarf lambs were purchased from local farmers at Ikare Akoko (South-West) while the Yankasa were bought from Zaria (north). Their pen was made of concrete floor not slatted with a roofing sheet and an open yard for exercise. The side wall was made of wood and had a height of 2m. They were normally grazed between 10:00h and 01:30h daily and watered after grazing. Prior to the commencement of the experiment, they were dewormed with Levadex injection (Pantex Holland B.V.) at a dose of 1ml per 50 kg and coccidiostat treatments were administered for 3 days. They were treated against trypanosomiasis with Dimiazine aceturate (Nozomil Kepro, B.V., Holland) at the dose of 3.5mg per kg by intramuscular injection. Oxytetra LA was administerd at the rate of 1ml/10kg against bacterial infection. Ivomec was also administered against mange at 1ml/10kg. They were also vaccinated against Peste des petites Ruminants (PPR) using Tissue Cultures Rinderpest Vaccine (TCRV). The concentrate diet contained maize 15%, brewers dry grain 30%, wheat offal 20%, palm kernel cake 34%, salt 0.5% and bone meal 0.5% and was offered at 200-500g/head/day. After birth, the lambs were allowed to run with their dams throughout the experiment. The traits measured were individual linear body measurements (LBs) such as height at withers (HT), body length (BL), Neck length (NL), Neck circumference (NC), heart girth (HG), Foreleg length (FL), Hind leg length (HL), Face length (FA), Ear length (EA), Headwidth (HW), shoulder width (SW), tail length (TL) and Rump height (RH). Lamb weight (WT) was determined using a hanging scale of 0-100kg graduation. The LB's (cm) were measured weekly with the aid of canvas tape. Each animal was gently restrained while taking the measurements.



KEY: A=Face length, C=Ear length, D= Neck length, B=Neck circumference, E=Body length, M=Head width, N=Shoulder width, G= Heartgirth, F=Foreleg length, H= Height at withers, I=Rump height, J=Hindleg length, L=Tail length

The linear body measurements were defined as follows: Height at withers is the distance between the most cranical palpable spinosus and the ground. Body length is the distance from the head of the humerii to the distal end of the pubic bone. Neck length is the distance from the head of the humerii to the lateral tuberosities of the humerii. Neck circumference is the distance round the mid neck region. Heart girth is measured as body circumference just behind the foreleg. Fore leg length is the distance from the proximal extremity of the olecranon process to the mid lateral point of the coronet. Hind leg length is the distance from the distal extremity of the olecranon process to the mid lateral point of the coronet. Face length is the distance from between the horn site to the lower lip. Ear length is measured from the base of the ear to the tip. Head width is measured as distance between the outer end of both eyes. Shoulder width is measurement taken between the two heads of humerii. Tail length is measured as distance from distal end of the pubic bone to the tip of the tail. Rump height is the distance from the highest point of the rump to the ground.

Statistical Analysis

The data generated were analysed by General Linear Model using Statistical Analysis System (SAS, 2005). Significant differences among means were determined using Duncan's multiple range test procedure.

Results

The mean live weight of lambs of the three genotype is presented in Figure 1. Least square means of different factors affecting live weight at different ages are presented in Tables 1 and 2. Pearson correlation matrix and regression equations are presented in Tables 3 and 4. The mean live weight of lambs of the three genotype increased with age (Figure 1). There were significant ($p<0.05$) genetic group differences on most traits studied with the exception of NL, NC, HW and SW. YAN x WAD were heavier than WAD lambs by 0.57kg in weight, whereas YAN lambs were heavier than WAD and YAN X WAD by 0.76 and 0.19 respectively. The YAN lambs were superior to WAD and XBD in WT, BL, HG, FL, HL, EL, TL and RL being significant at ($p<0.0001$, $p< 0.01$, p, 0.0001, $p< 0.0001$, $p<0.0001$ and $p< 0.0001$ respectively). Female lambs weighed 0.75kg more than the males ($p<0.01$). Female lambs were superior to male lambs in FL ($p<0.001$), HL ($p<0.01$), TL ($p<0.01$) and RL ($p<0.01$). Season of birth had significant effect on WT ($p<0.0001$), HT ($p<0.01$), NL ($p<0.001$), FL ($p<0.0001$), HL (p<0.0.0001), FA ($p<0.01$), SW ($p<0.01$) and RL ($p<0.05$) were significantly superior in the rainy season.

Age was the most important parameter which exerted significant effect on all parameters considered. The WAD and XBD lambs were 0.53 and 1.39kg heavier during the rainy season. As expected, lambs at the initial age were smaller in weight, shorter in height, length and girth than lambs at older age for all the genotypes considered. Age exerted significant influence on all body traits except NL, NC and SW in WAD lambs and HW only in XBD lambs. However, age effect was high and significant for all body traits in YAN lambs. Live weight was highly ($p<0.0001$) correlated with body dimensional traits (0.20 – 0.86) for WAD lambs, (0.42- 0.89) for YAN lambs and (0.16 -0.90) for XBD

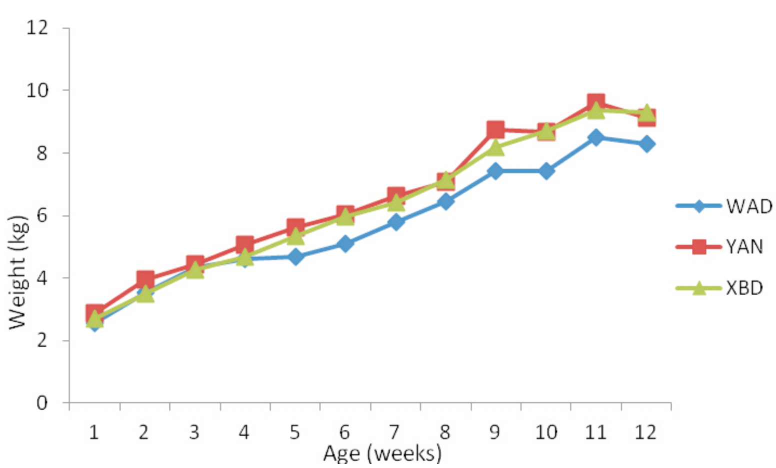


Figure 1. Growth rate of West African Dwarf, Yankasa and Crossbred lambs

Table 1: Least square means and standard errors for weight(kg), height at withers, body length, neck length, neck circumference, heart girth and foreleg length (cm) of West African Dwarf,

Classification	No	WT	HT	BL	NL	NC	HG	FL
Genotype								
WAD	96	5.73^{b}	41.55^{c}	34.62^{b}	15.66	22.00	44.20^{b}	28.00^{c}
YAN	120	6.49^{a}	46.40^{a}	36.14^{a}	16.21	21.87	45.80^{a}	31.18^{a}
XBD	120	6.30^{a}	44.61^{a}	34.78^{b}	16.32	21.41	45.21^{ab}	29.78^{b}
Sex								
Male	156	5.80^{b}	43.37^{b}	34.55	16.45	21.47	44.77	29.02^{b}
Female	180	6.55^{a}	45.24^{a}	35.79	15.78	21.98	45.45	30.43^{a}
Season								
1	168	6.61^{a}	45.05^{a}	35.24	15.33^{b}	21.88	45.14	30.24^{a}
2	168	5.80^{b}	43.69^{b}	35.20	16.86^{a}	21.61	45.13	29.31^{b}
Age								
1	28	2.27^{i}	35.71^{h}	26.42^{i}	10.76^{g}	20.07^{d}	33.98^{i}	24.98^{f}
2	28	3.68^{h}	38.71^{g}	29.68^{h}	13.39^{f}	20.21^{d}	38.57^{h}	28.14^{e}
3	28	4.35^{gh}	40.11^{fg}	31.14^{gh}	13.89^{ef}	20.93^{d}	39.83^{gh}	28.30^{de}
4	28	4.79^{fg}	41.39^{f}	31.93^{fgh}	14.32^{def}	21.14^{cd}	41.50^{fg}	28.64^{de}
5	28	5.26^{ef}	42.04^{f}	32.07^{fg}	14.36	20.64^{d}	42.64^{f}	28.93^{de}
6	28	5.75^{de}	44.43^{e}	33.89^{ef}	15.30^{de}	19.68^{d}	43.28^{ef}	28.59^{de}
7	28	6.32^{cd}	44.96^{de}	35.75^{de}	15.89^{cd}	20.60^{d}	45.21^{de}	29.68^{cd}
8	28	6.91^{c}	46.75^{cd}	36.68^{cd}	17.50^{bc}	21.61^{bcd}	46.07^{d}	30.46^{bc}
9	28	8.18^{b}	48.75^{bc}	39.57^{b}	19.43^{a}	23.36^{abc}	50.93^{c}	32.71^{a}
10	28	8.33^{b}	48.54^{bc}	38.61^{bc}	19.61^{a}	23.75^{ab}	51.71^{bc}	31.18^{b}
11	28	9.21^{a}	50.04^{ab}	42.96^{a}	19.64^{a}	24.54^{a}	53.29^{ab}	32.46^{a}
12	28	8.95^{ab}	51.04^{a}	43.93^{a}	19.00^{ab}	24.89^{a}	54.57^{a}	33.18^{a}
Overall mean± SEM	336	6.20±0.13	44.37±0.35	35.22±0.36	16.09±0.23	21.74±0.24	45.13±0.40	29.77±0.19

Yankasa and crossbred

le 2: Least square means and standard errors for hindleg length, face length, ear length, head width, shoulder width, tail length and rump height (cm) of West African Dwarf, Yankasa and crossbred

Classification	No	HL	FA	EL	HW	SW	TL	RH
Genotype								
WAD	96	32.16^{b}	13.62^{b}	9.14^{c}	8.00	11.32	18.78^{c}	43.14^{c}
YAN	120	35.13^{a}	14.14^{a}	9.93^{a}	8.31	11.38	23.48^{a}	48.22^{a}
XBD	120	34.72^{a}	14.46^{a}	9.44^{b}	8.46	11.20	20.95^{b}	46.23^{b}
Sex								
Male	156	33.29^{b}	13.97	9.40	8.47	11.43	20.39^{b}	44.92^{b}
Female	180	34.86^{a}	14.23	9.64	8.10	11.19	21.96^{a}	47.03^{a}
Season								
1	168	35.38^{a}	14.42	9.48	8.28	10.95^{b}	21.43	46.60^{a}
2	168	32.89^{b}	13.79	9.58	8.27	11.65^{a}	21.03	45.51^{b}
Age								
1	28	28.25^{g}	10.46^{h}	7.57^{h}	7.99^{cde}	8.63^{f}	15.91^{f}	37.05^{g}
2	28	30.93^{f}	11.82^{g}	8.61^{g}	7.51^{de}	9.95^{e}	17.00^{ef}	39.89^{f}
3	28	31.14^{f}	12.43^{fg}	8.75^{fg}	7.95^{cde}	10.30^{de}	18.64^{de}	41.14^{ef}
4	28	32.75^{ef}	12.80^{efg}	9.11^{efg}	7.34^{e}	11.04^{cde}	19.38^{d}	43.18^{de}
5	28	33.11^{de}	13.19^{def}	9.32^{ef}	7.71^{de}	11.07^{cde}	20.20^{d}	44.27^{cd}
6	28	33.71^{de}	13.95^{cd}	9.27^{ef}	7.34^{e}	10.57^{cde}	20.07^{d}	45.82^{c}
7	28	34.93^{cd}	13.77^{cde}	9.59^{de}	7.77^{de}	11.36^{bcd}	22.11^{c}	46.25^{c}
8	28	35.75^{c}	14.62^{c}	10.05^{cd}	8.20^{bcde}	12.63^{ab}	22.73^{bc}	48.54^{b}
9	28	36.79^{abc}	16.04^{b}	10.25^{cd}	8.86^{abcd}	12.89^{a}	23.34^{bc}	51.29^{a}
10	28	37.86^{ab}	16.09^{b}	10.09^{cd}	9.20^{abc}	11.79^{abc}	24.25^{b}	50.93^{a}
11	28	35.96^{bc}	16.20^{b}	10.96^{a}	9.50^{ab}	12.75^{a}	24.57^{b}	52.54^{a}
12	28	38.39^{a}	17.93^{a}	10.79^{ab}	9.93^{a}	12.61^{ab}	26.57^{a}	51.79^{a}
Overall mean± SEM	336	34.13±0.26	14.11±0.15	9.53±0.08	8.27±0.14	11.30±0.14	21.23±0.27	46.06±0.36

lambs (Table 3). Of the body dimensional traits, heart girth was the most correlated trait to weight in WAD and YAN lambs and the correlation between these two traits were 0.86 and 0.89 respectively where as height at withers was the most correlated trait to weight in XBD lambs.

A stepwise multiple regression analysis was carried out when other body measurements were added, one at a time to HG in WAD and YAN lambs and HT in XBD lambs. The essence was to determine how other body measurements would influence the precision of liveweight predictions compared to HG and HT alone. It was observed that animal height and length appeared to be important additional variables to heartgirth up to 87% prediction of body weight in WAD and YAN lambs, whereas, animal length and width were important additional variables to HT to obtain up to 90% of body weight in XBD lambs

Discussion

The overall mean weight for WAD, YAN and XBD lambs were 5.73, 6.49 and 6.30kg respectively. These values are higher than values reported by Agbede *et al.* (2000) in West African Dwarf sheep who reported body weights of 4.6 and 6.1kg for WAD and YAN lambs respectively. The heavier weight in the northern Nigeria may be due to the low incidence of diseases and the favourable climatic condition. The low weight recorded in this study may due the fact that their dams were subjected to partial milking making substantial part of the milk unavailable to the lambs to suckle. The WAD X YAN lambs were heavier than WAD lambs. This may probably be due to the superiority of improved breeds of WAD and / or heterosis. This indicates improvement in body weight following crossbreeding for the YAN and WAD individuals. Significant improvement in

Table 3: Phenotypic correlation between weight and linear body measurements of West African Dwarf, Yankasa, crossbred and pooled data

Linear body measurements	Genotype			
	WAD	YAN	XBD	POOLED
WT	1.00	1.00	1.00	1.00
HT	0.85***	0.85***	0.90***	0.86***
BL	0.79***	0.87***	0.86***	0.85***
NL	0.54***	0.69***	0.47***	0.56***
NC	0.20*	0.65***	0.78***	0.50***
HG	0.86***	0.89***	0.89***	0.88***
FL	0.66***	0.69***	0.74***	0.69***
HL	0.64***	0.76***	0.65***	0.69***
FA	0.75***	0.72***	0.75***	0.73***
EL	0.60***	0.65***	0.64***	0.63***
HW	0.44***	0.59***	0.16	0.29***
SW	0.37***	0.42***	0.53***	0.44***
TL	0.78***	0.66***	0.85***	0.72***
RH	0.71***	0.83***	0.84***	0.80***

Table 4: Stepwise regression of liveweight on linear body measurements of West African Dwarf, Yankasa, crossbred and pooled data

Genotype		R^2
WAD		
	WT = -5.81 + 0.26HG	0.75
	WT = -8.90 + 0.19HT + 0.16HG	0.82
	WT = -9.03 + 0.16HT + 0.09BL + 0.11HG	0.84
	WT = -9.72 + 0.13HT + 0.09BL + 0.10HG + 0.06RL	0.86
	WT = -10.79 + 0.09HT + 0.09BL + 0.10HG + 0.08HL + 0.06RL	0.87
YAN		
	WT = -8.10 + 0.32HG	0.80
	WT = -10.28 + 0.15HT + 0.21HG	0.84
	WT = -9.82 + 0.12HT + 0.11BL + 0.15HG	0.85
	WT = -11.02 +0.09HT + 0.12BL + 0.11HG + 0.11HL	0.87
XBD		
	WT = -10.12 + 0.37HT	0.81
	WT = -10.45 + 0.21HT + 0.16HG	0.87
	WT = -10.06 + 0.18HT + 0.10BL + 0.11HG	0.88
	WT = -10.00 + 0.15HT + 0.08BL + 0.10HG + 0.12TL	0.89
	WT = -10.39 + 0.15HT + 0.07BL + 0.10NC + 0.07HG + 0.13TL	0.89
	WT = -10.81 + 0.12HT + 0.06BL + 0.10NC + 0.06HG + 0.12TL + 0.05RL	0.90
	WT = -10.66 + 0.12HT + 0.06BL + 0.10NC + 0.09HG – 0.10SW + 0.11TL + 0.06RL	0.90
POOLED		
	WT = -7.63 + 0.31HG	0.78
	WT = -9.75 + 0.17HT + 0.19HG	0.84
	WT = -9.53 + 0.14HT + 0.10BL + 0.13HG	0.86
	WT = -10.13 + 0.11HT + 0.10BL + 0.13HG + 0.06HL	0.87
	WT = -9.36 + 0.12HT + 0.13HG -0.09FL + 0.08HL	0.87
	WT = -9.51 + 0.10HT + 0.11BL + 0.13HG – 0.09FL + 0.07HL + 0.04RL	0.87

body weight and linear body parameters in half bred RS X WAD goats have been reported by Ozoje and Herbert (1997).

Growth pattern in the three lamb genotype followed a definite pattern. Body weights and other measurements considered in this study increased with increase in age, implying a better performance in the long run and heavier market weights and sizes. The positive relationship between body weights and other measurements at various ages indicted that increase in the growth rate of any of the components would correspondingly increase live weight (Morenikeji *et al.*, 2012)

The effect of non-genetic factors on weight and body dimensional traits were not consistent. Sex exerted a significant effect on WT, the females being heavier than males. This result contrast the findings of Afolayan *et al.* (2006) and Salako (1999) but similar to the findings of Fajemilehin and Salako (2008). At the growth phase, sex differences were highly significant for all body dimensional traits except height and girth (Afolayan *et al.* 2006). The differences between male and female may be due to the higher number of female than male lambs in this study. This observation with that reported by Fajemilehin and Salako, (2008)

Season of birth was a significant source of variation on weight, HT, NL, FL, HL, SW and RL. The seasonal influence resulting from this investigation though at variance with Salako, (1999) might be mainly due to the availability of good quality feed to the dam during suckling. This coupled with the availability of good forages for the lambs resulted into reasonable weight and body dimensional traits.

The heartgirth accounted for 86% and 89% of body weight for WAD and YAN in this study. It was found to predict body weight with higher precision and also better than the other measurements (body height and length) in estimating liveweight. The second best correlation with body weight was found for body height. This observation agrees with that reported for YAN sheep (Afolayan *et al.* 2006) and WAD sheep (Sowande and Sobola, 2008). Heartgirth responds more to the environment than others suggesting absence of selection. Heartgirth measurements are usually affected by gut fill and are highly variable (Salako, 2004).

In XBD lambs, HT seems to predict body weight with higher precision. Heterotic effect of crossing is seen in HT. EAAP and FAO have used HT as a principal indicator of type (Simon and Buchenauer, 1993) . Height at withers does not respond to environmentand can be used in selection. Heigth at withers at any given time reflects the heritable size of animal skeletal size (Jeffery and Berg 1972)

The high phenotypic correlation among live weight and body dimensional traits implies that body dimensional traits are more useful for selection purposes that are focused towards increased growth rate as required in fattening ranches. The inclusion of rump height in predicting weight in WAD and XBD lambs is worth noting. The rump, which is one of the six-hindquarter cut of choice in carcass evaluation, would be an important parameter in a selection and breeding programme.

Thus, in some practical management situations where the scale could not be assessed, measurement of heart girth may be a better indicator of weight than height in WAD and YAN lambs while height could be a better indicator of weight in XBD lambs.

Conclusion

This study indicates that for a breeder or stockman to have a fairly good knowledge of the liveweight of WAD sheep, measurement of heartgirth, height at withers, , body lenght will be useful Selection and breeding based on these body measurements could result in improved liveweight. Crossing West African Dwarf with Yankasa improved live weight and body parameters in West African lambs but provided little benefit since the crossbred perform similar to the Yankasa in weight and linear body measurements.

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Received: 21st August, 2013
Accepted: 25th July, 2014