International Journal of Multidisciplinary Research and Growth Evaluation.

Linear Body Measurements as Indicators for Body Weight in Three Genotypes of Chickens in Zimbabwe

Assan N [1*], Mpofu M [2], Musasira M [3], Mwareya N [4], Muteyo E [5]
[1] Zimbabwe Open University, Faculty of Agriculture, Department of Agriculture Management, Bulawayo Regional Campus, Bulawayo, Zimbabwe
[1] Professor Extraordinaire, University of South Africa, College of Agriculture and Environmental Sciences, Department of Agriculture and Animal Health, South Africa
[2-3] Matopos Research Station, Ministry of Lands and Agriculture, Department of Research and Extension, Private Bag 5137, Bulawayo, Zimbabwe
[4] Zimbabwe Open University, Faculty of Agriculture, Department of Statistics and mathematics, Mutare Regional Campus, Mutare, Zimbabwe
[5] Zimbabwe Open University, Faculty of Agriculture, Department of Agriculture Management, Harare Regional Campus, Harare, Zimbabwe

* Corresponding Author: **Never Assan**

Article Info

ISSN (online): 2582-7138
Volume: 06
Issue: 02
March-April 2025
Received: 24-01-2025
Accepted: 21-02-2025
Page No: 508-515

Abstract

Predicting body weight plays a vital role in poultry breeding, as it significantly affects the productivity and economic viability of poultry operations. Within the field of animal breeding, researchers have identified linear body measurements as effective indicators for estimating body weight. A study of 397 mature hens (155 Australorp; 154 Boschveld; 88 Sasso) was conducted to assess body weight and linear body measures, including neck length (NL), Body Circumference (BC), Body Length (BL), Shank Length (SL), and Shank Circumference. The results showed significant differences in BWT, BC, BL, SC, and SL for all chicken breeds, with p-values less than 0.05. However, there was a slight difference in neck length and shank circumference, with $p<0.05$. Australorp had the highest weight and largest size, followed by Boschveld and Sasso. The study found that Boschveld chickens had the strongest association coefficient with body weight, with a 0.50 correlation between shank circumference and neck length. Sasso chickens showed a positive association with body weight and body dimensions, but the overall relationship was weaker. Australorp chickens can predict body weight by direct selection of the neck length. Australorp chickens had the highest body circumference, body length, shank circumference, and neck length. Linear body measurements as sole predictors of body weight were ineffective, with values ranging from 0.02-0.34, 0.03-0.15, and 0.05-0.27 for SC, AC, and BC, respectively. The most effective multiple linear regression model correlating body weight and linear body measurements was presented by Boschveld ($R^2 = 0.50$). However, its applicability, particularly in smallholder agricultural contexts, remains subject to debate. The study concluded that linear body measurements may not be effective sole predictors of body weight in the Australorp, Boschveld, and Sasso chicken populations of Zimbabwe, and that other predictive models that fit quadratic or cubic growth may need to be explored. Furthermore, the size and body weight of chicken breeds differ, with Australorp being notably larger and heavier. This study illuminates the genetic and environmental elements that affect poultry body weight, allowing breeders to make better-informed choices. Subsequent studies could explore the integration of body weight prediction models with genomic selection techniques to enhance the precision of breeding values and develop prediction models specific to different genotypes in poultry.

DOI: https://doi.org/10.54660/.IJMRGE.2025.6.2.508-515

Keywords: Body Weight, Morphometric Traits, Chicken, Genotype, Zimbabwe

Introduction

Boschveld is a cross of Ovambo, Matabele, and Venda free-range chickens that are native to southern Africa (Bosch, 2011). In the mid-1970s, a white farmer (Mike Bosch) produced a strain to help manage pests (ticks) in beef cattle farms. It consists of 50, 25%, and 25% Venda, Ovambo, and Matabele breed features (Bosch, 2018). Boschveld chickens are raised for both meat and egg production, and at 20 weeks of age, they weigh between 1.7 and 2.6 kg (Okoro *et al* 2017).

Sasso chicken is a French hybrid broiler raised for eggs and high-quality meat. Originating in 1978, they grow rapidly, weigh over a pound, lay 240 eggs per year, and have a high hatch rate (Bekele *et al*, 2010; Dawud *et al*, 2018; Alemayehu and Negasi, 2020) [4, 8, 2]. They require ample space, are resistant to diseases, and adapt well to hot and humid conditions. Sasso chickens are one of the most popular poultry species and may be kept in the backyard or on a large scale (Dzungwe *et al* 2022) [10]. Because of their capacity to tolerate African poultry-keeping conditions, they are prevalent in Africa. Nonetheless, Sasso hens are characterized for their quick development, flavor, and soft flesh, as well as for roaming in fields and consuming other natural foods such as grass, maize, and leaves (Aman *et al*, 2017; Dawud *et al*, 2019) [3, 7]. Dual-purpose chicken breeds, such as Sasso, are chosen because of their egg and meat production, as well as their performance in village poultry production systems (Melkamu, 2016; Dawud *et al*, 2019) [15, 7]. The Sasso is a chicken breed that has helped alleviate the extent of bound supply as well as accessibility of chicken meat and eggs in Africa (Bekele *et al*, 2010; Dawud *et al*, 2018; Alemayehu and Negasi, 2020) [4, 8, 2]. An unusual breed of chicken, Sasso, was chosen for its larger eggs and heavier body weight. One possible explanation for the higher hatching weights of the Sasso chickens might be their larger egg masses. Using this dominance phenomenon, Sasso genes were inherited, leading to superior carcass cuts.

The exotic dual-purpose Black Australorp (BA) breed was brought in to interbreed with native chickens (Gondwe and Wollny, 2003) [13]. Originally created in the early 1900s by crossbreeding Rhode Island Red, White Leghorn, and Langshan chickens with orpingtons. Black are dual-purpose Australorp birds kept for their meat and eggs. Owing to their adaptability, Australorp hens can be kept in coops or sheds or given opportunities to roam freely. The weight of an Australorp with a typical size is 3–4 kg. They are regarded as a breed of tall chicken. An Australorp of normal size weighs between 0.7 and 1.2 kilograms. On average, cooks are larger and heavier than hens are.

Body weight prediction is a crucial aspect of poultry breeding, as it directly impacts the efficiency and profitability of poultry production. An animal's body weight may be predicted from its body dimension, as previous studies have demonstrated a strong and positive correlation between physical attributes and live weight in a variety of chicken strains (Olawumi, 2013. Live body weight and morphometric measures have been demonstrated to be strongly correlated (Rance *et al*, 2002; Yang *et al*, 2006; Ojedapo *et al*, 2008; Yakubu). The coefficient of variance for morphometric features suggests that body size measures differed more among the chicken genotypes. Particularly for rural chicken breeders with limited resources, the approach of determining body weight from body measurements (i.e., morphometric features) has been shown to be simple and practical (Semacula *et al* 2011) [22]. Maciejowski and Zeiba (1982) [14] noted that biometric features such as body girth, shank length, and diameter are markers of breast growth and leg development, respectively. In addition to being a useful measure of body weight, morphometric features may also be utilized to create breeding plans by combining the appropriate body measures in the right ways to maximize body weight and financial gains (Chineke *et al* 2002) [6]. Farm animal pricing and poultry rearing decisions are often centered on linear body measures. Along with body weight, a wide range of architectural features have been proven to be an accurate indicator of a chicken's market capitalization and body development (Abdel – Latif, 2019) [1].

Various authors have established prediction models for determining live weight by employing linear body measurements, given that it is difficult to accurately measure live weight in the field (Assan 2013, Momoh, and Kershima 2008; Ige *et al* 2006). Live body weight and the size of different physical characteristics are illustrations of physical characteristics that generally correspond to production parameters. Due to this strong relationship and its strong association with meat yield, body weight is used by the FAO (2012) [11] as a stand-in for a production indicator. These traits comprise measures for body weight, breast width, keel length, and pelvic width, in addition to measurements of chest circumference, wing length, back length, shank length, and shank circumference. These dimensions may vary depending on age. The objective of the study is to identify the most predictive linear body measurements (LBMs) for body weight in three genotypes of chickens breeds in Zimbabwe

Materials and Methods

Ethical approval

The study was approved by the Zimbabwe Open University Animal Research Ethics Committee (Projects 2023).

Location of the study

The study was conducted at the Matopos Research Station (20 0 23' S, 310 °30' E), which is situated approximately 30 km southwest of Bulawayo, Zimbabwe. The setting is 800 m above sea level and receives an irregular annual rainfall of only 450 mm annually (Homann *et al*, 2007). The temperatures during the summer are quite high, with the average maxima and the lowest temperatures of the warmest months being 21.6 and 11.40C, respectively. There is a chance of severe drought in the area (Hagreveas *et al* 2004). The most prevalent form of flora is the sweet veld, and its browsing and annual grass species have relatively excellent nutritional values (Ward *et al*, 1979). If rangelands are properly managed, they should be able to provide goats and other animals with nourishment (Van Rooyen *et al* 2007). Nevertheless, a sizable percentage of rangeland has been degraded, resulting in low biomass, and consequently, a restricted supply of poor-quality feed resources, especially during the dry season (Hlatshwayo, 2007). Day *et al* (2003) and Gambiza and Nyama (2000) provided in-depth descriptions of the research area's climate and plant types, respectively.

Statistical Analysis

The analysis of quantitative data was done through the use of the statistical package called the Statistical Package for Social Scientists (SPSS) version 16. Inorder to maximise data potential linear regression assumptions were checked. It was observed that the residuals of the measurement were symmetric. This implies that the errors are normally distributed. Also, no correlation was observed between the residuals. The data also indicates that the independent variables NL, BC, BL, SL and SC are not correlated. Finally, a linear and additive relationship between BWT (dependent variable) and independent variables was observed. The nonlinear regression results basing on coefficients of determination (R^2) and mean squared error (MSE) criterions are used to determine the best SASSO chicken management system for different mathematical growth models.

Experimental Animals

Body weight and linear body traits measure in the study

A total of 397 mature hens [(155 Australorp; 154 Boschveld; 88 Sasso] were studied for body weight and linear body measurements. Linear body measurements included Neck

Length (NL), Body Circumference, Body Length (BL), and Shank Length (SL).

Body weights and linear body measurements were independently recorded. Physical characteristics were measured using a measuring tape calibrated in centimeters (cm), while body weight was determined using a balance weighing scale. Following the guidelines outlined by Olawunmi *et al* (2008), the body weight and the linear body measurements were head length (HL), beak length (BL), body length (BL), wing length (WL), shank length (SL), shank circumference (SC), and height(H). One person measured each trait to prevent any discrepancies.

Data analysis

The Statistical Package for Social Sciences (SPSS) (2006) software was employed to compute parametric statistics to compare differences among the characteristics of the three chicken breeds. In this work, model assumptions were checked. Multivariate Normality was checked and the results indicated that the residuals are normally distributed. The variance of error terms (residuals) should be consistent across all levels of the independent variables. Homoscedasticity was checked through drawing a scatterplot of residuals versus predicted values which did not display any discernible pattern. Models for predicting body weight based on linear body parameters were developed and correlation, multiple regression, and path coefficient analyses were performed. Path analysis can handle more complicated models with several independent and dependent variables as the case of this work. Path analysis is a more adaptable and effective approach than regression analysis, especially when dealing with multiple variables. A simple correlation was used to determine the association between BW and linear body measurements. Multiple regression was used to establish a formula to predict BWT using linear body measurements. The following multiple linear regression was adopted:

$Y = a+b_1 X_1 +b_2 X_2 +b_3 X_3 +b_4 X_4 +b_5 X_5$

where Y = dependent variable (BWT),

a = intercept,

$b_1 – b_5$ = coefficient of regression, and

$X_1 – X_5$ = independent variables (biometric traits).

The standardized partial regression coefficient, used as the path coefficient (beta weight), was computed using multiple regression analysis. This value was used as a direct effect of the linear body measurements on the BWT. Path analysis was conducted as described by Mendes *et al* [6]. Briefly, the path analysis was computed as follows:

Pyxi = biSxi/ Sy

where Pyxi is the path analysis coefficient from Xi to Y (i = NL, BC, BL, SL, or SC).

bi = partial regression coefficient,

Sxi = standard deviation (σ) of Xi and Sy = σ of Y.

Remarkably, the path analysis coefficient was tested using the t-statistic in the multiple regression analysis. The indirect influence of linear body measurements on BW through direct effects was calculated as follows:

IEyxi = rxixj/Pyxj

where IEyxi is the direct effect of linear body measurements via a direct effect on body weight.

rxiyj = correlation coefficient (r) between i^{th} and j^{th} linear body measurements; and

Pyxj = path analysis coefficient, which indicates the direct effect of the j^{th} linear body measurement on body weight.

Results and Discussion

Parametric statistics for comparison of differences among three chicken breeds characteristics

A completely randomized design (CRD) was used (Table 1) to compare the differences among the three chicken breeds. Table 1 shows significant differences in BWT, BC, BL, SC, and SC mean for all chicken breeds Australorp, Boschveld, and Sasso, with p-values less than 0.05.

The study found a slight difference in neck length and shank circumference between chicken breeds. Therefore, we can conclude that different chicken breeds have different sizes and body weights. Furthermore, it can be noted from the data that Australorp has more weight and a larger size, followed by Boschveld and Sasso.

Table 1: ANOVA table for three different chicken breeds characteristics

		Sum of Squares	df	Mean Square	F	Sig.
BWT	Between Chicken Breeds	4026027.716	2	2013013.858	15.807	.000
	Within Groups	49537962.975	389	127346.949		
	Total	53563990.691	391			
NL	Between Chicken Breeds	60.394	2	30.197	5.587	.004
	Within Groups	2134.865	395	5.405		
	Total	2195.259	397			
BC	Between Chicken Breeds	408.071	2	204.035	8.238	.000
	Within Groups	9783.557	395	24.768		
	Total	10191.628	397			
BL	Between Chicken Breeds	455.494	2	227.747	6.979	.001
	Within Groups	12890.723	395	32.635		
	Total	13346.217	397			
SL	Between Chicken Breeds	60.259	2	30.130	17.887	.000
	Within Groups	665.362	395	1.684		
	Total	725.621	397			
SC	Between Chicken Breeds	2.755	2	1.378	5.300	.005
	Within Groups	102.660	395	.260		
	Total	105.415	397			

BWT, body weight; BC, body circumference; BL, body length; SL, shank length; SC, shank circumference; NL, neck length.

The bivariate correlation coefficients between bodyweight and linear body measurements

Tables 2–4 highlight the bivariate coefficients demonstrating the association between body weight and all linear body parameters of chicken breeds in Zimbabwe. There was a substantial positive linear association between body weight and morphological features of the Boschveld chicken (Table 2). The strongest associations were found between body weight and shank length (r=0.50) and between body weight and shank circumference (r=0.5).

Because most rural agricultural communities and meat markets in Africa lack access to scales, the use of shank length as a proxy for live body weight in chickens is especially crucial (Mani *et al*, 1991, Nesamvumi *et al*, 2000). Conversely, Sadick *et al* (2020) [16, 21] used the shank circumference to estimate the body weight of chickens. In Nigeria, Patbandha *et al* (2017) [19] observed that the greatest predictor of body weight in the local chicken shank was length, with a coefficient of determination of 80%.

Table 3 indicates that there was a low positive correlation, but not as strong as it would have been for Boschveld chicken morphological features with body weight. The relationship between neck length and body weight was the strongest. This demonstrates how neck length may help farmers, particularly those without weighing scales, estimate the body weight of Boschveld chickens correctly. Significant results (p > 0.01) were observed for several linear body metrics. In conclusion, Table 4 shows a good link between the physical characteristics of Australorp chickens and body weight. When compared to the correlation of Sasso and Boschveld chickens, the connection was somewhat less.

The relationship between neck length and body weight was the strongest. The findings of this study on the positive relationship between body weight and morphometric features are consistent with previous research on quails (Ojo *et al* 2013), pigeons (Hassan and Adamu, 1997), chickens (Ibe and Nwakalor, 1987; Adeniji and Ayorinde, 1990), and ducks (Raji *et al* 2009). However, there was little relationship between body circumference and body weight. This suggests that the body diameter of an Australorp chicken is not suitable for estimating body weight. Thus, it may be said that there exists a positive linear relationship between morphological qualities and many varieties of chicken. When weighing scales are insufficient, the correlation can be used to forecast and estimate live body weight using body measurements. The use of LBMs has led to improved accuracy in estimating body weight, the development of genotype-specific prediction models, and enhanced chicken breeding programs. Body measurements play a crucial role in determining the selection of elite animals for breeding (Washaya *et al* 2022) [25].

The direct and indirect effect direct and indirect effect of linear body measurements on bodyweight

The direct and indirect effects of linear body measurements on the body weight of Australorp chickens are shown in Table 5. This study found the strongest correlation coefficient (r = 0.40; p = 0.01) between body weight and BL, with the largest direct influence on body weight (0.293) and the largest indirect effect (0.107), which was mostly manifested through neck length. This demonstrates that neck length may be directly selected to predict body weight. Neck length significantly affected body weight directly (0.161) and indirectly (0.199), primarily through body length. However, there was no significant difference in the direct effects of shank and body circumferences (p = 0.02). In conclusion, the most important factors in determining body length were neck length and body length.

The direct and indirect effects of linear body measurements on the body weight of Sasso chickens are shown in Table 6. In this study, the highest correlation coefficient (r = 0.44; p = 0.01) was observed between body weight and shank circumference. The largest direct influence on body weight was 0.48, while its indirect effects (-0.04) were mostly achieved via body length. Shank length had the lowest direct effect on body weight (0.23), whereas neck length had the lowest indirect effect (0.15). Shank circumference has a considerable indirect influence on these factors. In conclusion, body length and shank circumference play significant roles in accurately estimating the body weight of Sasso chickens with a high degree of accuracy.

Table 7 presents data about the direct and indirect effects of linear body measurements on bodyweight in Boschveld chickens. Shank circumference and neck length 0.50 had the strongest connection relationship with bodyweight. In terms of shank circumference, the direct impact on body weight was 0.12, while the indirect impact through neck length was 0.38. Neck length had a direct influence of 0.16, while it’s indirect effects, or 0.34, and were mostly felt by the circumference of the shank. One may observe that the shank length (-0.04) and body circumference (0.08) had no direct effect. With the exception of body length, where direct effects were shown to be less than indirect effects, this indicates that the observed differences may have been mostly caused by other indirect effects. According to a number of writers (Horst, 1998; Abdul-Rahman, 1989; Badubi *et al*, 2006), a chicken's phenotypic appearance in the tropics is greatly influenced by its surroundings. Body weight prediction is crucial in poultry breeding as it allows breeders to select birds with desirable growth traits, thereby enhancing breeding programs (Melesse *et al* 2021; Assan, 2015; FAO, 2012) [14, 11]. Linear body measurement traits are utilized in animal breeding to estimate body weight for livestock farmers who lack a weighing scale (Parte *et al* 2024; Weimer, *et al* 2020) [18, 26].

Table 2: Bivariate Pearson correlation coefficients among traits in Boschveld chicken in Zimbabwe

Trait	BWT	BC	BL	SL	SC	NC
BWT	1					
BC	0.21	1				
BL	0.37	-0.32	1			
SL	0.43	0.16	0.31	1		
SC	0.50	0.17	0.12	0.44	1	
NL	0.50	0.24	0.40	0.46	0.50	1

BWT: body weight; BC: body circumference; BL: body length; SL: shank length; SC: shank circumference; NL: neck length; **. This correlation was significant (P<0.01).

Table 3: Bivariate Pearson correlation coefficients among traits in Sasso chicken in Zimbabwe

Trait	BWT	BC	BL	SL	SC	NC
BWT	1					
BC	0.34	1				
BL	0.43	0.13	1			
SL	0.38	0.43	0.38	1		
SC	0.44	0.50	0.53	0.61	1	
NL	0.56	0.48	0.45	0.52	0.62	1

BWT: body weight; BC: body circumference; BL: body length; SL: shank length; SC: shank circumference; NL: neck length.

Table 4: Bivariate Pearson correlation coefficients among traits in Australorp chicken in Zimbabwe

Trait	BWT	BC	BL	SL	SC	NC
BWT	1					
BC	0.14	1				
BL	0.40	-0.16	1			
SL	0.17	0.27	0.44	1		
SC	0.31	0.15	0.31	0.37	1	
NL	0.36	0.30	0.27	0.21	0.41	1

BWT, body weight; BC, body circumference; BL, body length; SL, shank length; SC, shank circumference; NL, neck length

Table 5: Direct and indirect effects of morphological traits on the bodyweight in Australorp chicken in Zimbabwe

TRAIT	Correlation Coefficient with BWT	Direct Effects		Indirect Effects				Total
		-	BC	BL	SL	SC	NL	
BC	0.14	0.02	-	-0.07	0.03	0.05	0.11	0.12
BL	0.40	0.293	-0.03	-	-0.003	0.06	0.08	0.107
SL	0.17	-0.22	0.03	0.18	-	0.11	0.07	0.39
SC	0.31	0.07	0.01	0.10	0.02	-	0.11	0.24
NL	0.36	0.161	0.009	0.09	0.02	0.08	-	0.199

BWT = body weight; BC= circumference; BL = body length; SL= shank length; SC= shank circumference; NL= neck length;
** P < 0.01 ** P < 0.05 NS= Non-Significant

Table 6: Direct and indirect effects of morphological traits on the bodyweight in Sasso chicken in Zimbabwe

TRAIT	Correlation Coefficient with BWT	Direct Effects		Indirect Effects				Total
			BC	BL	SL	SC	NL	
BC	0.34	0.39	-	-0.01	-0.02	0.02	-0.04	-0.05
BL	0.43	0.409	0.001	-	-0.08	0.01	0.09	0.021
SL	0.38	0.23	-0.03	0.08	-	0.01	0.09	0.15
SC	0.44	0.48	-0.03	0.05	-0.04	-	-0.02	-0.04
NL	0.36	0.325	0.005	0.061	-0.03	-0.001	-	0.035

BWT = body weight; BC= circumference; BL = body length; SL= shank length; SC= shank circumference; NL= neck length;
** P < 0.01 ** P < 0.05 NS= Non-Significant

Table 7: Direct and indirect effects of morphological traits on the bodyweight in Boschveld chicken in Zimbabwe

Trait	Correlation Coefficient with BWT	Direct Effects		Indirect Effects				Total
			BC	BL	SL	SC	NL	
BC	0.21	0.08	-	-0.15	0.07	0.09	0.12	0.13
BL	0.37	0.25	-0.12	-	0.11	0.06	0.07	0.12
SL	0.43	-0.04	0.03	0.08	-	0.17	0.19	0.47
SC	0.50	0.12	0.02	0.04	0.12	-	0.18	0.38
NL	0.50	0.16	0.02	0.04	0.12	0.16	-	0.34

BWT = body weight; BC= circumference; BL = body length; SL= shank length; SC= shank circumference; NL= neck length;
** P < 0.01 ** P < 0.05 NS= Non-Significant

Simple and multiple regression equation for predicting body weight from linear body measurements

In poultry breeding, accurately predicting body weight is essential. This capability enables breeders to identify birds with favorable growth characteristics, ultimately improving the effectiveness of their breeding initiatives (Assan, 2015). The prediction equations relating the body weight and linear body measurements in the three chickens are shown in Table 8. The values of coefficient of determination (%R) were low in all genotypes ranged from 0.03 – 0.15, 0.05 - 0.27 and 0.02 -0.34 in Australorp, Boschveld and Sasso respectively. Moderate %R was found for Boschveld (0.27 for NL and 0.25, SC) and Sasso (0.34 for NL and 0.22 for BC). This implies that NL could be the best predictor of the body weight in Boschveld and Sasso chickens. In some linear body parameters, the negative intercept of body weight on regression lines suggests that body weight began at a known period and at a very high value, much above zero. It is implied that no linear body parameter could be utilized to forecast the body weight of AC= Australorp, BC= Boschveld, and SC= Sasso in this population, because all other linear body characteristics in all the strains investigated returned a %R value below 50%. The likelihood of significant human error in morphometric trait assessments was higher.

As shown in Table 9, the R^2 (0.47) value for Boschveld chickens was approximately 0.5. This suggests that neck length, body circumference, body length, and shank length may be used to predict the overall variance in body weight. Additionally, supporting this is a p-value of 0.000, which is lower than the typical benchmark significance value of 0.05. Furthermore, the Australorp chicken model illustrates that body weight cannot be accurately predicted based solely on independent factors (coefficient of determination = 2.626). The p-value indicates that the model is sufficiently successful in identifying the relationship. In conclusion, the model derived for Sasso chickens has the ability to accurately forecast body weight based on the p-value. It is important to note that the p-value and coefficient of determination are overall measures of strength of association between body weight and independent variables and do not reflect the extent to which any particular independent variable is associated with body weight, as shown in table 8. Generally, it can be deduced from the table that the Boschveld chicken model is the most effective for predicting body weight. Shank diameter and length were the most accurate indicators of body weight in white leghorn chickens in Iraq, according to Abdel-Latif (2019) [1], with coefficients of determination of 66% and 80%, respectively. It should be mentioned that there was a positive linear correlation with other body parameters. Nonetheless, the data indicated an inverse relationship between body circumference and length.

Table 8: The regression equation of BWT on morphometric traits for three chicken genotypes in Zimbabwe

Genotype	Regression Equation	R^2 (%)	SE	P-Value
Australorp	BWT=766.020 + 60.487NL	0.14	320.03	***
	BWT=21.679 + 0.687BC	0.09	4.58	***
	BWT=711.569 + 24.523BL	0.15	317.79	***
	BWT=1428.429 + 40.300SL	0.03	340.03	**
	BWT=987.184 + 203.210SC	0.10	327.33	***
Boschveld	BWT=550.828 + 73.298NL	0.27	288.84	***
	BWT=1147.019 + 15.646BC	0.05	329.18	***
	BWT=833.944 +20.527BL	0.13	313.93	***
	BWT=725.854 + 137.349SL	0.19	303.86	***
	BWT=346.560 +351.987SC	0.25	291.77	***
Sasso	BWT=209.919 +85.209NL	0.34	309.73	***
	BWT=14.611 + 1.010BC	0.22	5.134	***
	BWT=24.414 + 0.137BL	0.02	5.765	NS
	BWT=20.358 + 1.619SL	019	5.247	***
	BWT=342.788 + 311.535SC	0.19	344.49	***

BWT = body weight; BC= circumference; BL = body length; SL= shank length; SC= shank circumference; NL= neck length; *** P < 0.01; ** P < 0.05; NS= Non-Significant.

Table 9: The multiple regression equation of BWT on morphometric traits for three chicken genotypes in Zimbabwe

Genotype	Multiple linear regression equation	R^2	SE	value
Boschveld	BWT=-953.2+36NL+15.1BC+19.6BL+16.6SL+191.2SC	0.466	249.1	0.000
Australorp	BWT=-231.9+28.7NL+11.4BC+24.7BL-34.7SL+96.8SC	0.262	301.2	0.000
Sasso	BWT=-154.7+39.7NL+12.1BC+18.7BL-23.8SL+28.1SC	0.245	370.2	0.001

BWT = body weight, BC= circumference, BL = body length, SL= shank length, SC= shank circumference, NL= neck length, *** P < 0.01, ** P < 0.05, NS= Non-Significant.

Model validation

In this work face validity was used to validate the model used in this paper. This is whereby model's results are checked whether they are in line with known to be true results. The model highlights that body weight and linear body measurements showed generally low positive relationship across the three genotypes that were the subject of the study. The results from the model concur with work of Olawumi 2013 which states that animal body weight can be predicted from body dimension. Results from Rance etal 2002 work indicate that live body weight and morphometric measures are corrected which is support by the results from this work. Therefore, our model's results are in agreement with attested results

Conclusion

The study analyzed the measurements of body length, shank circumference, neck length, and body circumference in chicken breeds, with Astrapolope having the highest measurements. The study found that Australorp chickens were more valuable when meat output was considered. The indirect effects in Boschveld chickens were more significant than direct effects, with a maximum correlation value of 0.50 for neck length and shank circumference. Body length and shank circumference were found to play a significant role in accurately forecasting body weight in Sasso chickens, while neck length in Australorp chickens could be directly selected to predict body weight. The study also found a positive correlation between body weight and linear body measurements in three genotypes, suggesting that in situations where weighing scales are not accessible, the correlation can be used to predict and calculate live body weight in Boschveld chickens.

Author Contribution

Experimental design and data analysis– Assan N and Mwareya N. Draft of manuscript–Assan N and Mpofu M; Interpretation of data for the work & Editing the manuscript, Proof reading - Musasira M. and Muteyo E. All authors approved the final manuscript for submission.

Acknowledgment
Authors would like to extend their deepest appreciation to the Matopos Research Station for allowing us to use their goats for data collection.

Disclosure statement:
No potential conflict of interest was reported by the author(s).

Statement of animal rights
The study was approved by the Academic Research Committee of Experimental Animals, Zimbabwe Open University, Harare, Zimbabwe.

Data availability statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.

Funding
No funding was received

Ethical consideration
The authors carefully checked all ethical issues concerning plagiarism, consent to publish, misconduct, data fabrication, falsification, double publication or submission, and redundancy of the manuscript.

Notes on major author
Never Assan is a Full Professor a Fellow of the Zimbabwe Academy of Science (FZAS) with an interest in Livestock Production and Breeding. Program coordinator of the BSc Agriculture Management, Faculty of Agriculture, Department of Agriculture Management at Bulawayo Region of the Zimbabwe Open University. Formerly, a Principal Research Officer at Matopos Research Station spearheading the Indigenous Cattle Genetic Improvement Program. Published 14 books and more than 150 published works on cattle, goat, sheep, & explored Gender, Climate Change & Micro- Livestock Production.
ORCID Never Assan http://orcid.org/0000-0003-3405-8131

References
1. Abdel-Latif FH. The linear association between live body weight and some body measurements in some chicken strains. Plant Archives. 2019;19(1):595–9.
2. Alemayehu G, Negasi A. Characterization of scavenging and intensive chicken production system in Lume District, East Showa Zone, Oromia Regional State, Ethiopia. Int J Livest Prod. 2020;11:8–20.
3. Aman G, Bangu B, Bereket Z, Desta G, Abiti T. Production performance of Sasso (distributed by ethio chicken private poultry farms) and Bovans brown chickens breed under village production system in three agro-ecologies of Southern Nations, Nationalities, and Peoples' Regional State (SNNPR), Ethiopia. Int J Livest Prod. 2017;8:145–57.
4. Bekele F, Dnøy TA, Gjøen HM, Kathle J, Girma A. Production performance of dual purpose crosses of two indigenous with two exotic chicken breeds in sub-tropical environment. Int J Poult Sci. 2010;9(7):702–10.
5. Bosch M. Boschveld Village Chicken Management Guide. 1st ed.; 2018.
6. Chineke CA, Agaviezor B, Ikeobi CON, Ologun AG. Some factors affecting body weight and measurements of rabbit at pre and postweaning ages. In: Proceedings of the 27th Annual Conference of the Nigerian Society for Animal Production; 2002. p. 1–3.
7. Dawud I, Gebeyehu G, Wondmeneh E, Avigdor C. Dual-purpose production of genetically different chicken crossbreeds in Ethiopia. 1. Parent stocks' feed intake, body weight, and reproductive performance. Poult Sci. 2019;98(5):3119–29.
8. Dawud ID, Goshu G, Esatu W, Bino G, Abebe T. Comparative study of production and reproductive performance of various strains of chicken parent layers raised in floor pens. Eth J Agric Sci. 2018;28:2415–82.
9. Dzungwe JT, Gwaza DS, Egahi JO. Statistical modeling of body weight and body linear measurements of the French broiler guinea fowl in the humid tropics of Nigeria. Poult Fish Wildl Sci. 2018;6(2):2–5.
10. Dzungwe JT, Kof Tozo K, Chrysostome C. Growth performance, mortality, and carcass yield evaluation of pure and reciprocal crosses between Sasso and Wassache chickens. Trop Anim Health Prod. 2022;54:298. doi:10.1007/s11250-022-03272-x.
11. FAO. Phenotypic characterization of animal genetic resources. FAO Animal Production and Health Guidelines No. 11. Rome: FAO; 2012.
12. Ganner A, Schatzmayr G. Capability of yeast derivatives to adhere enteropathogenic bacteria and to modulate cells of the innate immune system. Appl Microbiol Biotechnol. 2012;95(2):289–97. doi:10.1007/s00253-012-4140-y.
13. Gondwe TNP, Wollny CBA. Comparative productivity of Black Australorp and indigenous chickens under free-ranging village conditions in Malawi. In: Deutscher Tropentag 2003; Göttingen; 2003.
14. Maciejowski J, Zeiba T. Genetics and animal breeding. Amsterdam-Oxford-New York: PWN-Polish Scientific Publishers; 1982.
15. Melkamu BY. The effect of dried blood rumen content mixture (DBRCM) on carcass characteristics of SASSO C44 broiler chicks. Eur Sci J. 2016;12(16):166.
16. Nesamvumi AE, Malaudzi J, Ramanyimi ND, Taylor G. Estimation of body weight in Ngunu-type cattle under communal conditions. S Afr J Anim Sci. 2000;30(suppl).
17. Okoro VMO, Ravhuhali KE, Mapholi TH, Mbajiorgu EF, Mbajiorgu CA. Effect of age on production characteristics of Boschveld indigenous chickens of South Africa reared intensively. S Afr J Anim Sci. 2017;47(2):157–67.
18. Parte P, Sahoo SK, Dubey PP, Kaur S, Mukhopadhyay CS. Effect of genetic groups and gender on body weight and different morphometric traits in poultry. Birds. 2024. doi:10.18805/ag.D-5981.
19. Patbandha TK, Garg DD, Marandi S, Vaghamashi DG, Patil SS. Effect of chick weight and morphometric traits on growth performance of coloured broiler chicken. Anim Sci Adv. 2017;5(6):1278–81.
20. Pinheiro RRS, Watanabe PH, Araújo LRS, *et al* Structured lipids from fish viscera and coconut oils improve weight gain and intestinal morphology of piglets at nursery phase. Trop Anim Health Prod. 2024;56:403. doi:10.1007/s11250-024-04235-0.
21. Sadick AM, Aryee G, Poku PA, Kyere CG. Relationship between body weight and linear body measurements in the Cobb broiler chicken. World J Biol Pharm Health Sci. 2020;4(2):1–6.
22. Semacula J, Lusembo P, Kugonza DR, Mutetikka D, Ssennyonjo J, Mwesigwa M. Estimation of live body weight using zoometrical measurements for improved marketing of indigenous chicken in the Lake Victoria basin of Uganda. 2011.
23. SPSS. Statistical package for social sciences study SPSS for Windows, Version 20. Chicago: SPSS Inc; 2001.
24. Tyasi TL, Mashiloane K, Mokoena K. Human security in the light of the current climate agenda. Sib J Life Sci Agric. 2021;13(1):134–43. doi:10.12731/2658-6649-2021-13-1-134-143.
25. Washaya S, Bvirwa W, Nyamushamba GB. Herd

dynamics, phenotypic characteristics of indigenous beef cattle breeds (Bos indicus) in Gokwe North. Trans R Soc S Afr. 2022;77(2):1–9.

26. Weimer SL, Mauromoustakos A, Karcher DM, Erasmus MA. Differences in performance, body conformation and welfare of conventional and slow-growing broiler chickens raised at 2 stocking densities. Poult Sci. 2020;99(9):4398–407.