PREDICTION OF LIVE BODY WEIGHT FROM LINEAR BODY MEASUREMENTS IN AFRICAN GIANT RATS *(CRICETOMYS GAMBIANUS*) IN GHANA

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ABSTRACT

This study was conducted to determine the best predictor of body weight from body measurements in African giant rats (Criscetomys gambianus) in Ghana. Forty (20 bucks and 20 does) African giant rats aged between 2 and 4 months were kept for six months. The body weight and six linear body measurements in both sexes which included body length (BL), heart girth (HG), neck circumference (NC), height at withers (HW), tail length (TL), and head length (HL) were measured and recorded on the last day of the experiment. The data collected were analysed using a t-test to compare the means between the parameters measured in both sexes and pearson's correlation was used to establish the relationship of the parameters in the three categories (males, females, and pooled data for both sexes). The body weight was regressed on the body measurements separately for males, females and pooled data for both sexes. The results indicated that body weight and body measurements were significantly higher in males than in females. All parameters assessed showed a strong positive correlation in the males than in females and pooled data for both sexes. Using the backward stepwise procedure for the linear regression models, it was observed that the best fit model for estimating male body weight was from HG and TL, females from HG, NC, and TL and pooled data for both sexes from HG, HW, NC, and TL. Higher values of adjusted coefficient of determination observed in the males from the linear regression models suggested that body measurements predict body weight more accurately in the male African giant rats than in females and pooled data for both sexes. It was concluded that farmers could rely on heart girth alone or combination of body measurements to accurately predict the body weight of the African giant rats.

Keywords: *African giant rats, adjusted coefficient of determination, body weight, correlation, linear regression model, and linear body measurements***.**

INTRODUCTION

The African giant rat (*Cricetomys gambianus*) is by size one of Africa's largest rodents and has proven to be important because of its scientific attributes such as the detection of landmines (Poling *et al.*, 2011), and also in the medical diagnosis of pulmonary tuberculosis (Poling *et al*., 2010), disease vectors (Durnez *et al*., 2008), potential pest species status (Engeman *et al.,* 2007) among others. The meat has become a delicacy for Ghana's rural and urban folks. Although the African giant rat domestication is not as successful as the grasscutter in Ghana (Hagan *et al*., 2016), it appears to be emerging as a new farming business in rural, and urban communities for the young and old particularly, in southern Ghana. Body weight as an important economic trait, if measured accurately, could aid in the selection of animals, and enhance livestock breeding and production (Sam *et al*., 2023). Mostly in Ghana, African giant rats are sold and bought based on physical appearance. In this way of marketing the African giant rats, the farmers may not get the actual price of their animals and the major part of the profit could be earned by other actors in the trade. Most local farmers do not use conventional weighing scales to determine the body weights of their animals due to their inability to purchase them. However, there is a need to look at other economically important traits such as morphological traits to help poor farmers predict body weight accurately in the absence of weighing scales to maximise profit. Since morphological traits are crucial in the forecasting of quantitative characteristics of meat and helpful in developing suitable selection criteria in a breeding programme (Kumar *et al*., 2017), breeders need to understand the association between body weight and linear body measurements to be able to arrange their breeding programme to increase production and profits. In areas where conventional weighing scales are not easily accessible, morphological traits could be used to estimate the body weights of animals (Amraei *et al*., 2017). Hence, the study was conducted to ascertain whether linear body measurements such as body length (BL), head length (HL), heart girth (HG), height at withers (HW), tail length (TL), and neck circumference (NC) could be used as an alternative by farmers in the absence of conventional weighing scales to predict the body weight of the African giant rats accurately.

MATERIALS AND METHODS

Study Area and Management of Animals

The study was conducted in the department of Animal Science Farm; Akenten Appiah - Minka University of Skills Training and Entrepreneurial Development in the Mampong Ashanti Campus from May 2022 to February 2023. Mampong lies in the transitional zone between the Guinea savannah zone of the northern and the tropical rain forest of southern Ghana along the Kumasi–Ejura road. The municipality is located 40 km North-East of Kumasi and lies between latitude 07°04ˈnorth and longitude 01°24ˈwest with an altitude of 457m above sea level. It has an average annual rainfall of 1224mm with a major rainy season from April to July and a minor rainy season from August to November. The dry season occurs from December to March. The vegetation is transitional savanna woodland. Temperatures are generally high with minimum and maximum values of 22.66°C and 34.26°C recorded in March and December respectively with an average temperature of 23.7°C. Humidity is always around 82.26% (Mampong, 2024). The African giant rats (*Cricetomys gambianus*) aged between 2 and 4 months were purchased from the MoFA Rat Farmers Association in Kumasi. The stock comprised 20 bucks and 20 does with the bucks weighing between 250 to 450g and the does also weighing between 200 to 400g. There were no pedigree records of animals at the time of purchase. The experimental animals had large snouts, grey coats, long tails with white tips, cheek pouches, and fancy facial expressions when feeding as common characteristics. The males and females were housed singly in the cells of their respective hutches. The animals were housed in 3-tier wooden cages, each chamber measuring 70cm x 69cm x 50cm. The 3 -tier cages were placed in a room roofed with corrugated iron sheets. The wooden cages were partitioned by 2mm diameter wire mesh. The sides and floor of the wooden cages were also covered with wire mesh. Wire mesh was also used to line the exposed surfaces of the wood to prevent gnawing. The roof of each wooden tier cage was slanted and lined with corrugated iron sheets to aid in easy cleaning and drainage of waste. Cleaning of the cages and the house were carried out daily. Feed and water troughs were also cleaned daily, and clean water and fresh feeds were provided. Sick animals were isolated and treated. De-worming was done every 3 months using dried pounded papaya seeds or albendazole 25% (Mobedeo Vet, Jodan) mixed with water.

Data Collection

Measurements were taken on body weight, and linear body measurements on the last day of the experiment. The body weight was measured in grams using a 10kg digital hanging scale with 1g sensitivity. A metallic rectangular cage was used to restrict the movement of the animals when weighing to obtain accurate body weights and to avoid injury to the handlers and animals. Linear body measurements were taken and recorded using a graduated plastic 30cm measuring rule for the height while the length and circumferences were measured using flexible calibrated tape in centimeters. The following linear body measurements were taken as described by Annor *et al.* (2011);

i) ***Body Length (BL):*** The distance from the nose's tip to the tail's base.

ii) ***Heart Girth (HG):*** The distance around the heart or the circumference of the heart.

iii) ***Height at withers (HW):*** The distance from a platform or ground where the animal is allowed to stand freely and upright to the most dorsal point of the withers. It is taken behind the forelimb.

iv) ***Head length (HL):*** The distance from the tip of the nose to the 7^{TH} cervical vertebrae of the neck.

v) ***Tail length (TL):*** The distance from the base of the tail to the tip of it.

vi) ***Neck circumference (NC):*** The distance around the mid-region of the neck.

To avoid intra-individual variations, all measurements were taken by the same person

Statistical Analysis

Data on body weight and six linear body measurements obtained from both sexes of the African giant rats were analysed using a t-test, pearson's correlation and linear regression model in GenStat (11^{th} Edition software 2008). The t-test was used to compare the means of body weight and linear body measurements between the male and female African giant rats. Pearson's correlation was used to determine relationship between the parameters measured in the males, females and pooled data for both sexes. The data was fitted into multiple linear regression model using backward stepwise procedure to establish the best fit model in predicting body weight from linear body measurements in males, females and the pooled data for both sexes. Body weight was regressed on the linear body measurements separately for males, females and pooled data for

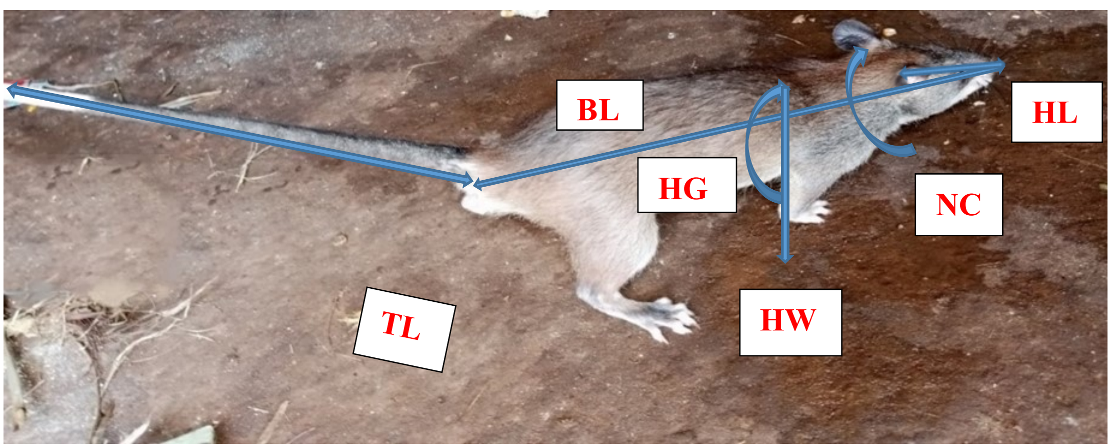

Plate 1: Illustration of how linear body measurements were taken

both sexes. The choice of best fit regression model was established by using the adjusted coefficient of determination (adjusted R^2). Results were considered significant at probability values < 0.05. The simple and multiple linear regression models used are;

$$Y = a + \beta X + e$$

$$Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n + e$$

where;

Y	=	dependent variable (body weight)
X	=	independent variable (linear body measurements),
a	=	intercept,
β	=	regression coefficient of Y on X
n	=	*n*th number of linear body measurements and
e	=	random error term.

According to Chen & Qi (2023), the formula of the adjusted R^2 is given by;

$$Adjusted\ R^2 = 1 - \left[\frac{(1 - R^2)(n-1)}{(n-k-1)} \right]$$

where;

R^2	=	coefficient of determination
n	=	number of observations
k	=	number of linear body measurements or predictors used in the regression model

RESULTS AND DISCUSSION

Table 1 revealed the effect of sex on body weight and linear body measurements in the African giant rats. Body weight and linear body measurements such as body length, tail length, neck circumference, heart girth, height at withers, and head length were significantly higher in males than in females. The significant results obtained in the sex effect on body weight and linear body measurements in African giant rats agrees with the general notion that males have higher mean values in body weight and linear body measurements than females (Tesfay *et al.,* 2017). A similar observation was reported by Olude *et al.* (2015) and Obadiah *et al.* (2015), that the mean values of body weight and linear body measurements were higher in males than in the female African giant rats. However, this current findings disagree with the tail length that recorded no significant differences (P>0.05) by Obadiah et al. (2015), which may be due to the differences in environmental conditions such as nutrition and errors associated with measurements. This significant results conform to earlier research works on different species particularly grasscutters (Hagan *et al.*, 2016; Durowaye *et al.,* 2021), guinea pigs (Abossede *et al*., 2019), crossbred rabbits (Agaviezor *et al*., 2017), sheep (Markos *et al.*, 2023; Sam *et al.,* 2023) and cattle (Vanvanhossou *et al*., 2018). This assertion might be due to the differences in sex hormones such as androgen in males and estrogen in females that are regulated through the differential genetic architecture of the two sexes (Tesfay *et al.,* 2017).

Results on the correlation between body weight and linear body measurements in the male and female African giant rats are shown in Table 2 and that of the pooled data for both sexes are presented in Table 3. The correlation coefficient among linear body measurements was strongly positive and highly significant (P<0.001) with the males having higher values than the females and pooled data for both sexes. Body weight and linear body measurements recorded strong positive values and highly significant differences (P<0.001) with the males outperforming the females. Body weight had the highest correlation coefficient with heart girth in the males, followed by females, and then pooled data for both sexes. The significant results obtained on the phenotypic correlation between body weight and morphometric traits in the African giant rats in this study agree with Obadiah *et al.* (2015), who observed a positive correlation among linear body measurements particularly body length and tail length in the African giant rats.

The significant (P<0.001) strong positive correlation among the traits in the present study im-

Table 1: Effect of sex on body weight and linear body measurements in the African giant rats

Sex	BW/g	BL/cm	HG/cm	HL/cm	HW/cm	NC/cm	TL/cm
Male	1335	46.22	25.36	8.580	10.090	20.480	47.21
Female	1178	44.42	23.32	7.700	9.190	19.890	45.41
Mean	1256	45.32	24.34	8.140	9.640	20.185	46.31
SEM	42.2	1.086	0.944	0.2468	0.2470	0.3745	0.461
P-Value	0.002	0.002	<0.001	<0.001	<0.001	0.002	0.001

BW: body weight, BL: body length, HG: heart girth, HL: head length, HW: height at withers, TL: tail length, NC:neck circumference, SEM: standard error mean, P-Value: probability value, cm: centimetres, g: grams.

Table 2: Phenotypic correlation between body weight and morphometric traits (males on top of the diagonal and females below the diagonal) of African giant rats

	BW/g	BL/cm	HG/cm	HL/cm	HW/cm	TL/cm	NC/cm
BW/g	**1**	0.967	0.999	0.992	0.996	0.970	0.952
BL/cm	0.912	**1**	0.964	0.967	0.957	0.984	0.945
HG/cm	0.992	0.896	**1**	0.991	0.996	0.967	0.951
HL/cm	0.984	0.857	0.993	**1**	0.994	0.982	0.960
HW/cm	0.985	0.885	0.995	0.994	**1**	0.970	0.955
TL/cm	0.927	0.994	0.914	0.880	0.906	**1**	0.977
NC/cm	0.811	0.841	0.838	0.817	0.846	0.871	**1**

BW=body weight, BL=body length, HG=heart girth, HL=head length, HW=height at withers, TL=tail length, NC=neck circumference, = highly significant (P<0.001), cm= centimetres, g=grams

Table 3: Phenotypic correlation between body weight and morphometric traits in Pooled data for both sexes of the African giant rats

	BWg	BL/cm	HG/cm	HL/cm	HW/cm	NC/cm	TL/cm
BW/g	1						
BL/cm	0.956	1					
HG/cm	0.990	0.948	1				
HL/cm	0.930	0.899	0.970	1			
HW/cm	0.929	0.897	0.970	0.998	1		
NC/cm	0.850	0.893	0.865	0.841	0.837	1	
TL/cm	0.939	0.988	0.937	0.903	0.899	0.928	1

BW=body weight, BL=body length, HG=heart girth, HL=head length, HW=height at withers, TL=tail length, NC=neck circumference, =highly significant (P<0.001), cm=centimetres, g=grams plies that a selection for one trait could lead to the corresponding improvement of other traits in a breeding programme with the males more likely to respond to selection due to the higher values of the strong positive correlation coefficients than the females and pooled data for both sexes. This current findings conform to earlier studies on different species such as grasscutters (Hagan *et al*., 2016; Osaiyuwu *et al*., 2018; Durowaye *et al.,* 2021), and sheep (Sam *et al*., 2023). However, this present study contradict earlier findings by Adeyinka *et al.* (2006) on goats, Rotimi (2021) on rabbits, and Appau *et al*. (2023) on guinea pigs, who stated that the females had a stronger positive correlation than the male counterparts. The significant findings of this present study of heart girth having the highest positive correlation with body weight agree with earlier studies on different species particularly grasscutters (Hagan *et al*., 2016; Durowaye *et al*., 2021), guinea pigs (Abossede *et al*., 2019), crossbred rabbits (Agaviezor *et al*., 2017), sheep (Markos *et al*., 2023; Sam *et al*., 2023), and cattle (Vanvanhossou *et al*., 2018). However, the current findings disagree with earlier studies by Jayeola *et al.* (2009) on grasscutters who concluded that head length was the trait with the highest positive correlation with body weight, as well as Darfour and Naazie (2010) on the Ashanti black pig who observed that body length had the highest positive correlation with body weight. This disagreement may be attributed to the differences in species.

Results on linear regression models for predicting body weight from linear body measurements in the males, females and pooled data for both sexes of African giant rats are presented in Tables 4, 5, and 6. In the male African giant rats, all the models obtained were seen to be good since about 99.9% of the variations in the body weight could be explained by the linear body measurements in all the models. The linear body measurements that best fit the model were HG and TL (with the lowest standard error value taken into consideration). In the females, the linear body measurements that best fitted the model were HG, NC, and TL accounting for about 98.7% of the variations in the body weight. In pooled data for both sexes, the linear body measurements that best fitted the model were HG, HW, NC, and TL explaining about 99.5% of the variations in the body weight. The significant results from this study indicate that the prediction of body weight from linear body measurements was more accurate for males than in females and pooled data for both sexes which conform with earlier studies on different species

Table 4 : Stepwise linear regression models for predicting body weight from linear body measurements in the male African giant rats

Traits/ Predictors	Prediction Equations	Adjusted R^2	SE	PV
HG, BL, HL, HW, NC and TL	BW = - 1290.36 + 93.72HG – 1.98BL – 44.18HL + 37.96HW – 30.63NC + 20.40TL	0.999	3.44	< 0.001
HG, HL, HW, NC, and TL	BW = - 1320.26 + 91.54HG – 39.94HL + 42.53HW – 26.35NC + 16.67TL	0.999	2.99	< 0.001
HG, HL, NC and TL	BW = - 1245.92 + 97.62HG – 14.94HL – 19.99NC + 13.62TL	0.999	2.85	< 0.001
HG, NC and TL	BW = – 1239.87 + 95.24HG – 18.43NC + 11.37TL	0.999	2.63	< 0.001
HG and TL	BW = – 1420.31 + 94.95HG + 7.36TL	0.999	2.56	< 0.001
HG	BW = – 1201.84 + 100.03HG	0.999	2.78	< 0.001

BW= body weight, HG= heartgirth, BL= body length, HL= head length, HW= height at withers, NC= neck circumference, TL= tail length, SE= standard errors, PV= probability values, R^2= coefficient of determination

Table 5 : Stepwise linear regression models for predicting body weight from linear body measurements in the female African giant rats

Traits/Predictors	Prediction Equations	Adjusted R^2	SE	PV
HG, BL, HL, HW, NC and TL	BW = -1111.75 + 72.54HG – 9.45BL + 107.11HL – 60.88HW – 25.80NC + 27.87TL	0.976	19.46	0.003
HG, HL, HW, NC and TL	BW = -1166.16 + 68.39HG + 118.02HL – 55.85HW – 23.867NC + 18.24TL	0.981	17.01	< 0.001
HG, HL, NC and TL	BW = -1290.45 + 62.87HG + 90.08HL – 25.36NC + 17.90TL	0.985	15.34	< 0.001
HG, NC and TL	BW = -1136.09 +91.47HG – 24.83NC + 14.86TL	0.987	14.48	< 0.001
HG and TL	BW = -1262.74 + 87.90HG + 8.60TL	0.983	16.47	< 0.001
HG	BW = -1135.83 + 99.22HG	0.982	16.78	< 0.001

BW= body weight, HG= heartgirth, BL= body length, HL= head length, HW= height at withers, NC= neck circumference, TL= tail length, SE= standard errors, PV= probability values, R^2= coefficient of determination

Table 6 : Stepwise linear regression models for predicting body weight from linear body measurements in the pooled data for both sexes of the African giant rats

Traits/Predictors	Prediction Equations	Adjusted R^2	SE	PV
HG, BL, HL, HW, NC and TL	BW = -782.37 + 125.55HG – 5.76BL – 26.31HL – 92.68HW – 25.17NC + 18.56TL	0.994	10.88	< 0.001
HG, BL, HW, NC and TL	BW = -754.76 + 124.25HG – 3.80BL - 115.94HW – 24.49NC + 16.65TL	0.995	10.53	< 0.001
HG, HW, NC and TL	BW = -770.77 + 123.15HG – 114.52HW – 23.02NC + 12.93TL	0.995	10.21	< 0.001
HG, HW and TL	BW = -884.90 + 123.50HG – 115.67HW + 5.41TL	0.994	11.64	< 0.001
HG and HW	BW = -756.60 + 130.77HG – 121.36HW	0.993	11.83	< 0.001
HG	BW = -863.24 + 87.23HG	0.977	21.99	< 0.001

BW= body weight, HG= heartgirth, BL= body length, HL= head length, HW= height at withers, NC= neck circumference, TL= tail length, SE= standard errors, PV= probability values, R^2= coefficient of determination

particularly grasscutters (Hagan *et al*., 2016; Durowaye *et al*., 2021), and sheep (Sam *et al.,* 2023). According to Sam *et al.* (2023), the variations in the males and females may be due to the differences in fat accumulation in the two sexes. It was observed that the heart girth alone could be used to estimate the body weight accurately in the males, females and pooled data for both sexes. In males, the HG alone could account for 99.9% of the variations in body weight. Also, about 98.2% of the variations in body weight could be explained by the HG in the females. In pooled data for both sexes, the HG could singly account for 97.7% of the variations in the body weight. This indicates that in the absence of a conventional weighing scale, the heart girth alone could be effectively used to estimate body weight accurately in African giant rats. This significant results agrees with earlier studies by Kumar *et al.* (2017) and Sam *et al.* (2023) on sheep, Durowaye *et al*. (2021) on grasscutters. This assertion of heart girth as the best predictor of body weight is attributed to the presence of muscle and bone around the thoracic area as compared to other linear body measurements (Abdulwaheed & Adama, 2012). The current findings however disagree with earlier studies by Darfour & Naazie (2010) on the Ashanti black pig who observed that body length was the best predictor of body weight, as well as Jayeola *et al.* (2009), whose studies on grasscutters indicated that head length was the best trait to singly predict body weight accurately. This disagreement may be attributed to the differences in species and environmental variations such as feeding and errors associated with measurements.

CONCLUSION

There was sexual dimorphism in the African giant rats as evidenced by the better morphometric traits (body length, tail length, head length, height at withers, heart girth, and neck circumference) and body weight in males compared to the females at 2 to 4 months old in captivity. A selection program to improve body weight will produce a positively correlated response in all the linear body measurements. Prediction of body weight from linear body measurements using simple and multiple linear regression models was possible with the males seen as the best with higher adjusted coefficient of determination values than the females. Thus heart girth alone was seen as the best predictor of body weight in the African giant rats. In the absence of conventional weighing scales, farmers could rely on the combination of morphometric traits such as heart girth, body length, tail length, neck circumference, head length, and height at withers to accurately predict body weight of the African giant rats. These research findings could be used as selection criteria for a breeding programme aimed at improving production and profit margins of the African giant rat farmers in Ghana.

REFERENCES

Abdulwaheed, B., & Adama, T. (2012). Studies on Body Weight and Linear Body Measurements of Castrates and Non-Castrate Savannah Brown Goats. *Asian Journal of Animal Sciences*, *6*, 140–146. https://doi.org/10.3923/ajas.2012.140.146

Abossede, M. L. F., Alex, G. Z., Vidjinnangni, F. G. N. D., & Mahule, S. H.-A. (2019). Determination of body weight from morphometric characteristics of guinea pigs (Cavia porcellus) reared in southern Benin. *International Journal of Livestock Production*, *10*(1), 9–13. https://doi.org/10.5897/IJLP2018.0541

Adeyinka, I. A. & Mohammed I.D. (2006). Relationship of Liveweight and Linear Body Measurement in Two Breeds of Goat of Northern Nigeria. *Journal of Animal and Veterinary Advances, 5(11).*, 891–893.

Agaviezor, B., Ologbose, F., & Ajayi, F. (2017). Effect of Breeds, Sex and Age on Interrelationship between Body Weight and Linear Body Measurement in Rabbits. *Journal of Fisheries & Livestock Production*, *05*(3), 1000250. https://doi.org/10.4172/2332-2608.1000250

Amraei, S., Abdanan Mehdizadeh, S., & Salari, S. (2017). Broiler weight estimation based on machine vision and artificial neural network. *British Poultry Science*, *58*(2), 200–205.

Annor S.Y, Ahunu B.K, Aboagye G.S, Amponsem K.B, Fordjour K.T.D, & Cassady J.P. (2011). *The genetics of morphological traits in the grasscutter.Livestock Research for Rural Development. 23(8)*, 23167.

Appau, D. O., Duodu, A., Bonsu, F. R. K., Kwenin, W. K. J., Atta Poku, P. S., Amadu, B., & Husein, S. M. A. (2023). Phenotypic characterization of linear body measurements of Guinea pigs (Cavia porcellus) in the middle belt of Ghana. *International Journal of Environmental & Agriculture Research*, *9*(1), 01–10. https://doi.org/10.5281/zenodo.7654160

Chen, Q., & Qi, J. (2023). How much should we trust R2 and adjusted R2: Evidence from regressions in top economics journals and Monte Carlo simulations. *Journal of Applied Economics*, *26*(1), 2207326. https://doi.org/10.1080/15140326.2023.2207326

Darfour-Oduro, K. A. & Naazie, A. (2010). Predictive abilities of two linear body measurements of liveweight of the Ashanti Black Pig. *Ghanaian Journal of Animal Science*, *5*, 49–59.

Durnez, L., Eddyani, M., Mgode, G., Katakweba, A., Katholi, C., Machang'u, R., Kazwala, R., Portaels, F., & Leirs, H. (2008). First Detection of Mycobacteria in African Rodents and Insectivores, Using Stratified Pool Screening. *Applied and Environmental Microbiology*, *74*, 768–773. https://doi. org/10.1128/AEM.01193-07

Durowaye, A., Salako, A., Osaiyuwu, O., & Fijabi, O. (2021). Relationship among Liveweight and Body Dimensions of the Greater Cane Rat (Thrynomys swinderianus). *Asian Journal of Research in Animal and Veterinary Sciences*, *8(4)*, 1–9.

Engeman, R., Witmer, G. W., Bourassa, J. B., Woolard, J. W., Constantin, B., Hall, P. T., Hardin, S., & Perry, N. D. (2007). The path to eradication of the Gambian giant pouched rat in Florida. *Digital Commons at University of Nebraska-Lincoln*, *11*, 305–311.

Hagan, B. A., Nyameasem, J. K., Asafu-Adjaye, A., & Darfour-Oduro, K. (2016). Predicting live weight of grass cutters using their linear body measurements. *Livestock Research for Rural Development*, *28(8)*, 28143.

Jayeola, O. A., Onadeko, S. A., Ademolu, K. O., & Awofeso, O. M. (2009). Prediction of body weight from body measurements in canerat: Thryonomys swinderianus (Temminck, 1827). *Zoologist (The)*, *7*, 168–175. https://doi.org/10.4314/tzool.v7i1.52079

Kumar, S., Dahiya, S., Dahiya, Z., & Patil, C. (2017). Prediction of body weight from linear body measurements in sheep. *Indian Journal of Animal Research*, *10*, 3360. https://doi.org/10.18805/ijar.B-3360

Mampong. (2024). In *Wikipedia* (p. 1242497972). Encyclopedia. https://en.wikipedia.org/w/index.php?title=Mampong&oldid=1242497972

Markos, D., Masho, W., Baye, M., & Bayou, E. (2023). Morphometric traits and stepwise regression of indigenous sheep in southwestern region, Ethiopia. *Journal of Agriculture and Food Research*, *14*, 100666. https://doi.org/10.1016/j.jafr.2023.100666

Obadiah, B., Dzenda, T., & Happiness, O. I. (2015). Tail allometry of the grasscutter (Thryonomys swinderianus) and African giant pouched rat (Cricetomys gambianus): It's Functional Relevance. *World J Zool*, *10* (2), 112–117.

Olude, A., Idowu, A. O., Mustapha, O., Olopade, J., & Akinloye, A. (2015). Spinal Cord Studies in the African Giant Rat (Cricetomys gambianus, Waterhouse). *Nigerian Journal of Physiological Sciences. 30*, 25–32.

Osaiyuwu, O. H., Akinyemi, M. O., Akindele, O. D., & Ewuola, K. M. (2018). Analysis of sexual dimorphism in morphometric variables of cane rat. *Tropical Animal Production Investigations*, *21(2)*, 44-51.

Poling, A., Weetjens, B., Cox, C., Beyene, N. W., Bach, H., & Sully, A. (2011). Using trained pouched rats to detect land mines. *Journal of Applied Behavior Analysis*, *44* (2), 351. https://doi.org/10.1901/jaba.2011.44-351

Poling, A., Weetjens, B. J., Cox, C., Mgode, G., Jubitana, M., Kazwala, R., Mfinanga, G. S., & Veld, D. H. in 't. (2010). Using Giant African Pouched Rats to Detect Tuberculosis in Human Sputum Samples: 2009 Findings. *The American Journal of Tropical*

Medicine and Hygiene, *83*(6), 1308. https://doi.org/10.4269/ajtmh.2010.10-0180

Rotimi, E. A. (2021). Examination of sexual dimorphism in New-Zealand White × Californian rabbits by morphological traits. *Agricultura Tropica et Subtropica*, *54*(1), 52–56. https://doi.org/10.2478/ats-2021-0006

Sam, I., Usoro, O., & F., U. (2023). Relationship of linear body measurements with live body weight in West African Dwarf sheep raised in Tropical Rainforest of Nigeria. *Journal of Animal Science and Veterinary Medicine*, *8*, 46–51. https://doi.org/10.31248/JASVM2023.365

Tesfay, & et al., M. (2017). Live body weight and linear body measurements of indigenous sheep population in their production system for developing suitable selection criteria in Central Zone of Tigray, Northern Ethiopia. *African Journal of Agricultural Research*, *12*(13), 1087–1095. https://doi.org/10.5897/AJAR2016.11927

Vanvanhossou, S.F.U., Diogo, R.V.C., & Dossa, L. H. (2018). Estimation of live bodyweight from linear body measurements and body condition score in the West African Savannah Shorthorn cattle in North-West Benin. *Cogent Food & Agriculture*, *4*(1), 1549767. https://doi.org/10.1080/23311932.2018.1549767