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Post Weaning Morphology and Growth traits of Nigerian Indigenous Pig and Crossbred Pigs

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ABSTRACT
This study evaluated morphological, growth and leukocyte traits of NIP and its hybrid at post-weaning ages of 9, 17 and 25 weeks. Body weight and morphometric measurements of 132 progenies consisting of 36 NIP and 96 hybrids from crossbreeding between NIP and Large White were taken at post weaning ages of 9, 17 and 25 weeks to obtain comparative growth performance. Body measurement included Body weight (BW), Snout length (SL), Snout circumference (SC), Ear length (EL), Head length (HL), Body length (BL), Body height (BH), Rump circumference (RC) and Tail length (TL). Data collected was subjected to Analysis of Variance (ANOVA) while the means were separated using Duncan's Multiple Range Test. Correlation analysis of the growth indices was done using Pearson's correlation. The results showed the effect of sex was only significant on BL ($P<0.05$). The value (49.38+ 0.69) for BL of female hybrid was longer at 9weeks of age. While at 17 and 25 weeks of age, male hybrid was longer with 57.00±1.59cm and 65.00±2.55cm respectively. At 9 and 17 week of age, the NIP female BL was longer with value of 48.33±0.80cm and 57.00±0.52cm respectively but overtaken by male (62.67±1.80cm) at 25 weeks of age. The correlation matrix for body weight against linear body measurements in post-weaned pure NIP and crossbreds indicated that all the parameters could be used to select for body weight. The hybrid body weight was highly correlated with all morphometric parameters SL, SC, NC, EL, BL, HL, HG, BH, RC and TL with values 0.67, 0.67, 0.78, 0.50, 0.74, 0.91, 0.88, 0.77, 0.85 and 0.84 respectively. \The NIP body weight (BW) had high correlation with all morphometric parameters SL, SC, NC, EL, BL, HL, HG, BH, RC and TL with values 0.77, 0.75, 0.81, 0.77, 0.74, 0.76, 0.83, 0.77, 0.76 and 0.40. From this study, it can be concluded that at the post-weaning ages of 9, 17, 25 weeks, the hybrid performed better than the NIP.
Keywords: Growth traits, morphometric traits, Nigerian Indigenous Pig, Crossbred Pigs

INTRODUCTION

NIP is a small size animal with adult reaching 100kg, but rarely weighs more than 60kg at twelve month of age even under favorable rearing conditions (Ikanni and Dafwang, 1998). They have small and short legs with unimproved conformation of a large head, well developed fore-quarters and relative small hind quarter that makes them mobile and gives them ability to forage and root (Holness, 1991). The female NIP mature sexually at an early age, showing first sign of oestrus at 3 months of age (Chiboka, 1981). They also show good mothering ability which results in low piglet mortality. They are adapted to traditional rearing system and performed better than exotic pigs in extreme nutritional condition (Ilori, 1974).

The morphological descriptions of an animal can be used to evaluate breeding goals, to assess type and function and to estimate the individual animal's value as potential breeding stock (Mwacharo *et al.*, 2005). It is difficult to design appropriate breeding programs for breeds that have not been adequately characterized either phenotypically or genetically. Phenotypic characteristics are important in breed identification and classification in ways that farming communities can relate to. Linear body

measurements can be used to interpret growth and production factors, to describe size inheritance and types of breeds or strains, and to estimate weight in animals (Zulu, 2008).

The objectives of this study is to evaluate morphology, growth and leukocyte traits of NIP and its hybrid at post-weaning ages of 9, 17 and 25 weeks and to determine correlation coefficients of morphological traits with live weight at these ages

MATERIALS AND METHODS

Growth data was recorded at 9 weeks, 17 weeks and 25 weeks post-weaning age of 132 weaners consisting of 96 hybrids (50% Large White X 50% NIP) and 36 pure NIP between 2008-2010. The body parameters taken were Body weight (WT), Ear length (EL), Body length (BL), Body height (BH), Heart girth (HG), Neck circumference (NC), Rump circumference (RC) and Tail length (TL). Height at withers or body height (BH), (Distance between the most cranial palpable spinosus and the ground), Body length (cm), (Distance from the head of the humerus to the distal end of the pubic bone), Heart girth (cm) (Measured as the circumference of the chest region), Neck circumference (NC) (Measured as the neck circumference), Rump Circumference (the circumference of the loin region), Tail length (cm) (measured as distance from distal end of the pubic bone to the tip of the tail end).

Data Analysis

Morphometric measurements obtained were subjected to statistical analysis using General Linear Model procedure of SAS (1999). The multiple regression between the live weight and morphometric traits were determined using SAS (1999).

RESULTS AND DISCUSSION

The effect of genotype and age on morphometric parameters of the hybrid and NIP are presented in Table 1 respectively. The results show the means of weight and morphometric traits of hybrid at 9, 17 and 25 weeks respectively as follows; WT (8.33±0.18kg, 14.73±0.42cm, 21.83±0.73cm); SC (12.59±0.23cm, 14.97±0.26, 14.97±0.11), NC (36.09±054cm, 43.00±0.59cm, 48.28±0.72cm); EL (8.83±0.14cm, 11.03±0.20cm, 11.46±0.22cm); HL (20.53±0.19cm, 24.44±0.22cm, 27.16±0.31cm) BH (38.22±0.38cm, 46.22±0.80cm, 52.19±0.92cm); TL (16.16±0.26cm, 19.50 ±0.34cm, 20.75±0.35cm). The mean of weight and morphometric traits for NIP at 9, 17 and 25 weeks respectively are as follows; WT(7.67±0.37kg, 13.13±0.42kg,19.96±0.68kg);NC(33.58±0.42cm,40.75±1.22cm,46.67±1.36cm);HL(22.00±0.28cm, 24.57±0.18cm, 26.92±0.81cm); BH(35.33±1.05cm, 43.92±1.63cm, 50.67±1.54cm); TL (19.50±0.33cm, 19.67±0.28cm, 19.25±0.46cm). The effect of genotype and age was significant ($P<0.05$) on morphometric parameters NC, HL BH and TL at 9 weeks of age, on WT and EL at 17 weeks and at 25 weeks on SC and TL. The graphical presentation of the effect of genotype and age on morphometric parameters of the hybrid and NIP is shown in Figure 4.1. The morphometric parameters of NIP and hybrid as expected increased as the age increased (Figure 1).

The effect of age and sex of hybrid on the morphological parameters at 9, 17 and 25 weeks is presented in Table 2 respectively. The values for weight of male hybrid and other parameters (SC, EL, NC, BL, HL, HG, RC and TL) were higher at 9 weeks of age with values of 8.82±0.21kg, 13.27±0.33cm, 8.86±0.17cm, 37.00±0.75cm, 47.09±1.25cm, 21.36±0.34cm, 46.27±0.54cm, 47.00±1.71cm and 16.91±0.44cm respectively with the exception of SL and BH (6.45±0.21cm and 37.91± 0.56cm) while the females were superior in weight (15.02±0.56kg) at 17 weeks of age but again were overtaken by males (24.16±1.03kg) at 25 weeks of age.

At 9 weeks of age, effect of sex was significant ($P<0.05$) on weight and morphometric parameters SC, BL, HL, RC and TL of hybrid. At 17 weeks of age, there was significant difference ($P<0.05$) on WT, SL, SC, EL, BL, BH and RC of the hybrid while at 25 weeks, there was significant difference ($P<0.05$) on SL, SC, HL, BL RC and TL

The effect of age and sex of NIP on the morphological parameters at 9, 17 and 25 weeks are presented in Table 3 respectively. The values for weight of NIP females at 9, 17 and 25 weeks (7.75±0.44kg, 13.42±0.42kg, 20.92±0.96kg) were higher than that of NIP males of the same age. The BL of females at 9 and 17 weeks (48.33±0.80cm, 57.00±0.52cm) were higher than that of males of the same age. At 25

weeks, the male BL value (62.67±1.80cm) was higher than that of the female. at 25 weeks of age, there was significance value on WT and morphometric parameters such as BL, BH and TL while at 9 and 17 weeks of age there was no significant difference (P>0.05).

The close weights observed at 9,17 and 25 weeks in hybrid (8.33±0.18kg, 14.73±0.42kg, 21.83±0.73kg) and NIP (7.67±0.37kg, 13.13 ± 0.42, 19.96±0.68kg) was in corroboration with the findings of Okeudo *et al*. (2007) where the same live weights were observed between NIP and hybrid up to the age of 17 weeks. The insignificant weights difference observed at 25 weeks of age was in line with Okeudo *et al*. (2006) where weights differences were observed from 15-25weeks of age. The insignificant variation in weight at 9 weeks of age was also in line with Okeudo *et al.* (2006) findings. The live weight reported in this study was higher than the findings of Sonaiya (1981) where he reported live weight of 10kg and 13kg for NIP at 16 and 28 weeks of age. This discrepancy may be as a result of management. The hybrid having higher values in weight at 9, 17 and 25 weeks of age than NIP was in line with the results obtained by Okeudo *et al.* (2006), Adesehinwa *et al*. (2010) and Oluwole *et al.* (2012). The poor performance observed in NIP compared with hybrid in this study, may be as a result of poor feed efficiency reported by Okeudo *et al.*, 2006. This superiority of hybrid over NIP was explained by Okeudo to be apparent from 18 week of age which is an indication of different response to finishing.

The observed morphometric parameters increase with age in this study is in line with the observations of Okon *et al.* (2008), Mutua *et al*. (2011) and Oluwole *et al*. (2012). The lower mean of NIP live weight was in agreement with Adeola (2005) and Holness (1991) that indigenous pigs are smaller in size with shorter legs than exotic pigs. Lekuule and Kyvsgarrd (2003), in addition, emphasized that the smaller size was an indication of the ability of the NIP to survive under harsh conditions which is linked to evolutionary adaptation to a low-input production conditions. The influence of sex on the body weight in this study is in line with Sonaiya (1981) where he reported that over all ages, the females have superior weight than the males. These differences are likely connected with sex hormonal action which leads to differential growth rates. Gatford *et al*. (1998) and Egena *et al*. (2010) also reported that the differences in linear body measurements between sexes were attributed to sex dimorphism. Isaac (2005) reported that sexual dimorphism in bodyweight and size is clearly widespread among many mammalian taxa, with male-biased dimorphism being the more common, but certainly not the exclusive pattern.

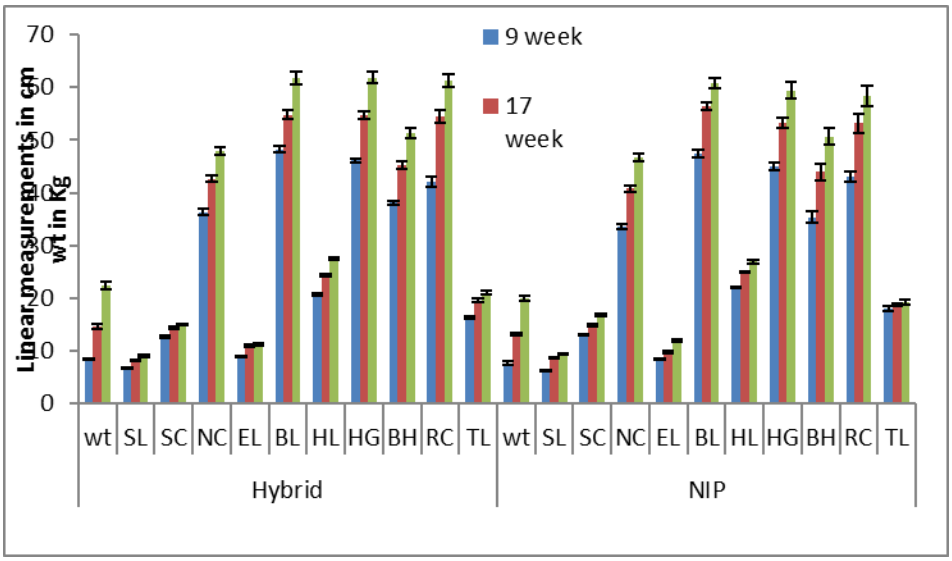


Figure 1: Morphological traits for NIP and hybrids at 9, 17 and 25 weeks of age.

BW-Body weight, BL Body Length, EL-Ear length, HL- Head Length, HG- Heart girth, NC- Neck circumference, SL- Snout Length, SC- Snout circumference, TL – Tail length, RC- Rump circumference, BL- Body length, BH-Body height (Height at wither), LBM- Linear body measurement.

Table 1: Effect of genotype and age on the morphometric parameters of hybrids and NIP, (P<0.05).

Breed	Age	Variables	Hybrid (n=96)	NIP (n=36)
Hybrid	9wks	WT	8.33 ± 0.18kg	7.67±0.37kg
		SL	6.66± 0.11cm	6.25±0.25cm
		SC	12.59±0.23cm	13.00±0.33cm
		* **NC**	**36.09±0.54cm^{a}**	**33.58±0.42cm^{b}**
		EL	8.83±0.14cm	8.50±0.15 cm
		BL	48.59 ±0.64cm	47.42±1.54cm
		* **HL**	**20.53±0.19cm^{b}**	**22.00±0.28cm^{a}**
		HG	46.03±0.42cm	44.92±0.77cm
		***BH**	**38.22 ±0.38cm^{a}**	**35.33 ±1.05cm^{b}**
		RC	43.34 ±1.05cm	43.39± 1.16cm
		***TL**	**16.16±0.26cm^{b}**	**19.50±0.33cm^{a}**
	17wks	* **WT**	**14.73±0.42kg^{a}**	**13.13 ± 0.42^{b} kg**
		SL	8.34±0.12cm	8.75±0.28cm
		SC	14.23±0.26cm	14.83± 0.27cm
		NC	43.00±0.59cm	40.75±1.22cm
		* **EL**	**11.03±0.20cm^{a}**	**9.67± 0.26cm^{b}**
		BL	54.13±0.88cm	56.33 ±1.16cm
		HL	24.44±0.22cm	24.57±0.18cm
		HG	54.69±0.76cm	56.25±0.97cm
		BH	46.22±0.80cm	43.92±1.63cm
		RC	53.38±1.16cm	53.58±1.72cm
		TL	19.50±0.34cm	19.67±0.28cm
	25wks	WT	21.83±0.73kg	19.96±0.68kg
		SL	9.16 ±0.16cm	9.33±0.14cm
		***SC**	**14.97±0.11cm^{b}**	**16.83±0.60cm^{a}**
		NC	48.28±0.72cm	46.67±1.36cm
		EL	11.64±0.22cm	12.00± 0.55cm
		BL	60.72±1.14cm	60.75± 1.23cm
		HL	27.16±0.31cm	26.92± 0.81cm
		HG	61.53±1.02cm	59.42±0.56cm
		BH	52.19 ±0.92cm	50.67 ±1.54cm
		RC	60.59±1.17cm	58.42±1.94cm
		* **TL**	**20.75±0.30cm^{a}**	**19.25±0.46cm^{b}**

^{a,b,} Mean values for each trait with different superscript letters, were different (P<0.05). *Level of significance *(P<0.05)*

BW-Body weight, BL Body Length, EL-Ear length, HL- Head Length, HG- Heart girth, NC- Neck circumference, SL- Snout Length, SC- Snout \circumference, TL – Tail length, RC- Rump circumference, BL- Body length, BH-Body height ,NIP-Nigerian Indigenous pig,

Table 2: Effect of age and sex on morphological parameters of hybrid at 9, 17 and 25 weeks of age.

Age	Traits	Female	Male
9 weeks	***WT**	**8.07±0.24kg^{b}**	**8.82±0.21kg^{a}**
	SL	6.76±0.12cm	6.45±0.21cm
	***SC**	**12.24±0.28cm^{b}**	**13.27±0.33cm^{a}**
	NC	35.63±0.71cm	37.00±0.75cm
	EL	8.81±0.19cm	8.86±0.17cm
	***BL**	**49.38±0.69cm ^{a}**	**47.09±1.25cm^{b}**
	***HL**	**20.10±0.17cm^{b}**	**21.36±0.34cm^{a}**
	HG	45.90±0.58cm	46.27±0.54cm
	BH	38.38±0.51cm	37.91±0.56cm
	***RC**	**41.43±1.14cm^{b}**	**47.00±1.71cm^{a}**
	***TL**	**15.76±0.24cm^{b}**	**16.91±0.44cm^{a}**
17 weeks	WT	15.02±0.56kg ^{a}	14.18±0.40kg^{b}
	***SL**	**8.52±0.13cm^{a}**	**8.00±0.19cm^{b}**
	*SC	13.86±0.22cm^{b}	15.00±0.57cm^{a}
	NC	43.81±0.65cm	41.45±1.07cm
	***EL**	**11.33±0.25cm^{a}**	**10.45±1.25cm^{b}**
	***BL**	**52.62±0.91cm^{b}**	**57.00±1.59cm^{a}**
	HL	24.52±0.26cm	24.27±0.41cm
	HG	54.57±0.98cm	54.91±1.23cm
	***BH**	**48.38±0.59cm^{a}**	**42.09±1.37cm^{b}**
	*RC	51.67±1.30cm^{b}	56.64±2.02cm^{a}
	TL	19.33±0.42cm	19.82±0.60cm
25 weeks	***WT**	**20.60±0.84kg^{b}**	**24.16±1.03kg^{a}**
	***SL**	**9.52±0.16cm^{a}**	**8.45±0.25cm^{b}**
	***SC**	**14.71±0.10cm^{b}**	**15.45±0.16 cm^{a}**
	NC	49.00±0.66cm	49.91±1.63cm
	***EL**	**12.00±0.23cm^{a}**	**10.55±0.28cm^{b}**
	***BL**	**58.48±0.81cm^{b}**	**65.00±2.55cm^{a}**
	***HL**	**26.38±0.30cm^{b}**	**28.64±0.41cm^{a}**
	HG	60.81±0.87cm	62.91±2.50cm
	***BH**	**54.00±0.95 cm^{a}**	**48.73±1.54**cm^{b}
	***RC**	**59.14±1.27cm^{b}**	**63.36±2.25cm^{a}**
	*TL	**20.19±0.36cm^{b}**	**21.82±0.40cm^{a}**

^{a,b,} Mean values for each trait with different superscript letters, were different *Level of significance *(P<0.05)*

BW-Body weight, BL Body Length, EL-Ear length, HL- Head Length, HG- Heart girth, NC- Neck circumference, SL- Snout Length, SC- Snout \circumference, TL – Tail length, RC- Rump circumference, BL- Body length, BH-Body height ,NIP-Nigerian Indigenous pig,

Table 3: Effect of age and sex on morphological parameters of NIP at 9, 17 and 25 weeks of age.

Breed	Age	Traits	Female	Male
	9 weeks	WT	7.75±0.44kg	7.58±0.6kg
		SL	6.33±0.21cm	6.17±0.48cm
		SC	12.83±0.54cm	13.17±0.40cm
		NC	33.17±0.54cm	34.00±0.63cm
		EL	8.67±0.21cm	8.33±0.21cm
		BL	48.33±0.80cm	46.50±3.06cm
		HL	21.83±0.17cm	22.17±0.54cm
		HG	45.83±0.48cm	44.00±1.44cm
		BH	34.83±0.60cm	35.83±2.09cm
		RC	43.67±1.61cm	42.33±1.36cm
		TL	17.83±0.40cm	18.17±0.79cm
	17 weeks	WT	13.42±0.42kg	12.83±0.75kg
		SL	8.67±0.42cm	8.83±0.40cm
		SC	14.83±0.48cm	14.83±0.31cm
		NC	40.50±1.43cm	41.00±2.11cm
		EL	9.67±0.33cm	9.62±0.42cm
		BL	57.00±0.52cm	55.67±2.33cm
		HL	24.67±0.56cm	25.17±0.40cm
		HG	53.50±0.92cm	53.00±1.81cm
		BH	43.17±1.68cm	44.67±2.93cm
		RC	54.00±2.46cm	53.17±2.61cm
		TL	18.5±0.22 cm	18.67±0.28cm
	25 weeks	***WT**	**20.92±0.96kg [a]**	**19.00±0.87kg[b]**
		SL	9.33±0.21cm	9.33±0.21cm
		SC	17.00±0.97cm	16.67±0.80cm
		NC	45.83±1.87cm	47.50±2.66cm
		EL	11.83±0.70cm	12.17±0.91cm
		***BL**	**58.83±1.40cm[b]**	**62.67±1.80cm[a]**
		HL	26.83±1.30cm	27.00±1.10cm
		HG	59.50±2.49cm	59.33±2.12cm
		***BH**	**48.83±1.38cm[b]**	**52.50±2.68cm[a]**
		RC	58.33±1.91cm	56.50±1.91cm
		***TL**	**18.50±0.34cm[b]**	**20.00±0.78cm[a]**

[a,b,] Mean values for each trait with different superscript letters, were different *Level of significance *(P<0.05)*

BW-Body weight, BL Body Length, EL-Ear length, HL- Head Length, HG- Heart girth, NC- Neck circumference, SL- Snout Length, SC- Snout circumference, TL – Tail length, RC- Rump circumference, BL- Body length, BH-Body height ,NIP-Nigerian Indigenous pig,

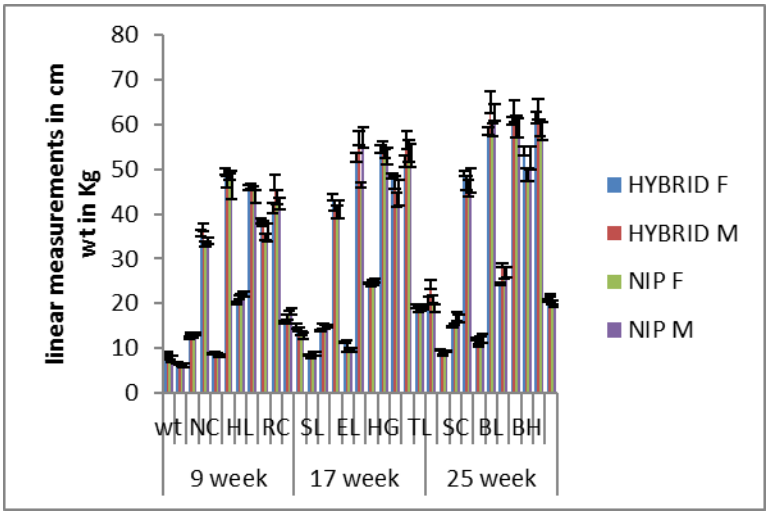


Figure 2: Effect of genotype and sex on the morphological traits at different age.

Wt-Body weight, BL Body Length, EL-Ear length, HL- Head Lenght, HG- Heart girth, NC- Neck circumference, SL- Snout Length, SC- Snout circumference, TL – Tail length, RC- Rump circumference, BL- Body length, BH-Body height (Heigth at wither), LBM- Linear body measurement.H-Hybrid, NIP-Nigeran indigenous pig.

The Pearson's correlation coefficients of bodyweight and linear body measurements of hybrids and NIP were presented in Table 4 and 5. The hybrid body weight was highly correlated with all morphometric parameters SL, SC, NC, EL, BL, HL, HG, BH, RC and TL with values 0.67, .67, 0.78, 0.50, 0.74, 0.91, 0.88, 0.77, 0.85 and 0.84 respectively as shown in Table 4. HL had highest correlation with BW while EL had the lowest value. The correlation values among other morphometric parameters excluding body weight range from 0.33 to 0.86 where BH and SL had highest correlation value of 0.86.

The NIP body weight (BW) had high correlation with all morphometric parameters SL, SC, NC, EL, BL, HL, HG, BH, RC and TL with values 0.77, 0.75, 0.81, 0.77, 0.74, 0.76, 0.83, 0.77, 0.76 and 0.40 where it ranges from 0.40 to 0.83, as shown in Table 5. HG had the highest correlation value with BW while TL had the lowest value. The correlation values among other morphometric parameters excluding body weight range from 0.00 to 0.95, where BH and NC had the highest correlation value of 0.95.

The regression graph for hybrid and NIP live weight and morphometric traits were graphically presented in Figure 3.1a to .3.4b. Figure 3.1a to 3.3b show hybrid regression graph for live weight and morphometric traits HG, BL, BH, HL, RC and NC with R^2 values ranging from 0.54 to 0.84 while Figure 3.4 shows NIP regression graph for live weight and morphometric trait HG with R^2 value 0.69. These graphs show that increase in body weight will increase these morphometric traits and thereby can be used to predict the body weight of the pigs.

Phenotypic correlations between bodyweight and morphometric traits were medially associated and positive for NIP with a range of 0.40 to 0.83 and hybrid with range of 0.30 to 0.91 respectively. The present estimates were comparable to the range of values recorded for pigs in an earlier research by Adeola (2009). The strong relationship existing between body weight and body measurements suggested that either or a combination of these traits could be used to estimate live weight in both NIP and hybrid in the situation where scales are not available. The association may also be useful as selection criterion since positive correlations of traits suggest that the traits may be under the same genetic influences.

The values for correlation of body weights and linear body measurements of NIP and hybrid obtained from this study agreed with earlier report of Adeola (2009) but not for the mean body weights and linear body measurements because of differences in age of animal used. From this study the heart girth (with R^2 =0.69) fitted best in the regression model (WT=0.62HG-19.20) which can be used in predicting NIP body weight. This result is in agreement with the submission of Adeola (2009) in predicting NIP body weight,

Salubo *et al.* (2006) in predicting boars' weight, Groesbeck *et al.* (2002) in Kansas State University for growing-finishing pigs and that of Tegbe and Olorunju (1998). For the hybrids, the morphometric parameters such as neck circumference, body length, head length, heart girth, body height and rump circumference can be used to predict the body weight. The head length and heart girth with $R^2 = 0.84$ and 0.78 fitted best to predict the weight with equation WT= 1.86HL-29.80 and WT= 0.71HG-23.28. The derived equations for both NIP and hybrid can be used for the estimation of their live weight where there is no weighing scale. Some of these parameters can be used by the farmers to determine the live weight of pigs when administering drugs. The increase in body length is due to skeletal growth, while increases in girth are due to muscle development plus accumulation of adipose tissue (Mutua *et al.*, 2011). Also these morphometric parameters are closely related to body weight of growing animals as reported by Murillo *et al*. (2004).

In conclusion, the hybrid performed better than the NIP in growth at 9, 17 and 25 weeks of age.

The correlation matrix for body weight against linear body measurements in post-weaned pure NIP and hybrids indicates that some of the parameters such as HG, RC, TL can be used to select for body weight. The linear equation generated by body weight on snout length, snout circumference, body length, neck circumference, ear length, head length, body height, rump circumference, heart girth and tail length could be used by resource poor pig farmers in the estimation of body weight of post weaned crossbreds for drug use.

Table 4 Phenotypic Correlations coefficients of bodyweight and linear Body Measurements of hybrids.

	BWT	SL	SC	NC	EL	BL	HL	HG	BH	RC	TL
BWT	1.00	0.67	0.67	0.78	0.50	0.74	0.91	0.88	0.77	0.85	0.84
SL		1.00	0.44	0.70	0.77	0.43	0.65	0.61	0.86	0.50	0.60
SC			1.00	0.60	0.42	0.59	0.75	0.66	0.44	0.77	0.74
NC				1.00	0.66	0.56	0.76	0.77	0.80	0.69	0.66
EL					1.00	***0.33**	0.54	0.50	067	0.38	0.50
BL						1.00	0.68	0.79	0.43	0.66	0.60
HL							1.00	0.84	0.72	0.85	0.84
HG								1.00	0.71	0.82	0.80
BH									1.00	0.61	0.66
RC										1.00	0.83
TL											1.00

*-Level of significance ($P<0.05$)

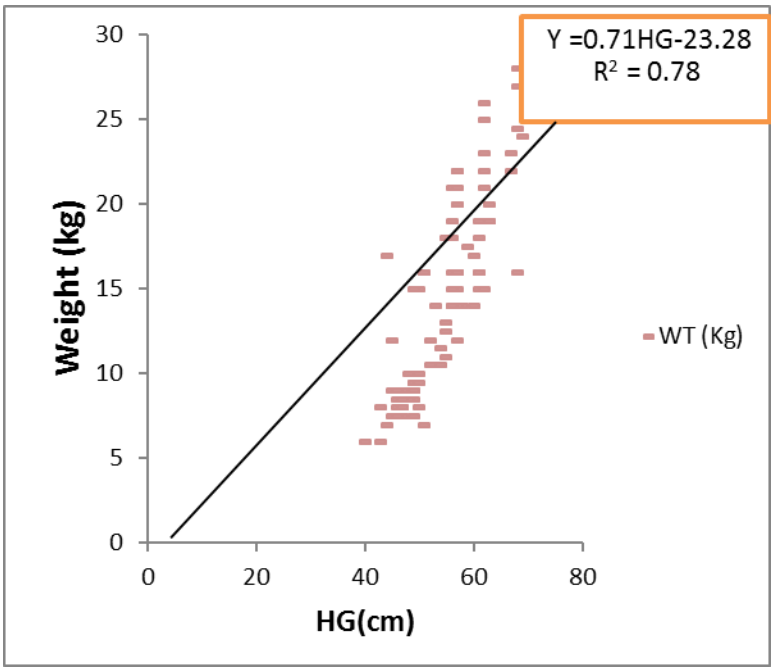
BW-Body weight, BL Body Length, EL-Ear length, HL- Head Length, HG- Heart girth, NC- Neck circumference, SL- Snout Length, SC- Snout circumference, TL – Tail length, RC- Rump circumference, BL- Body length, BH-Body height (Height at wither), LBM- Linear body measurement.

Table 5: Phenotypic correlations coefficients of body weight and linear body measurements of NIP

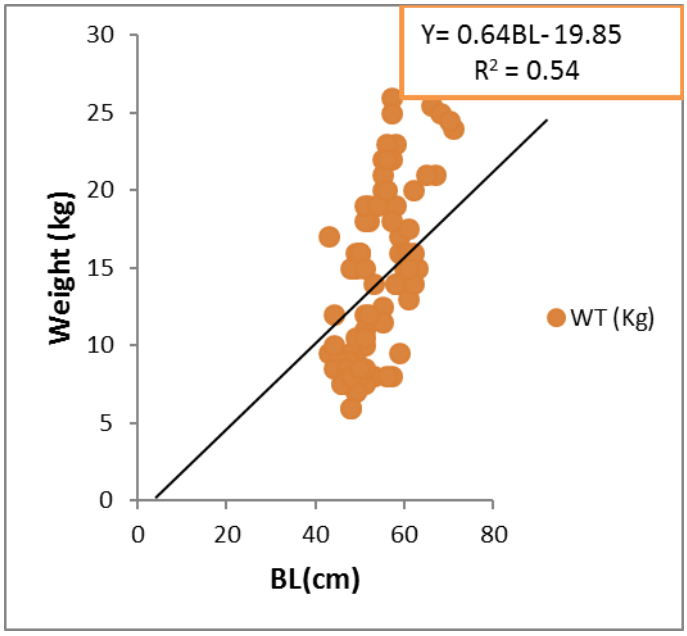
	BWT	SL	SC	NC	EL	BL	HL	HG	BH	RC	TL
BWT	1.00	0.77	0.75	0.81	0.77	0.74	0.76	0.83	0.77	0.76	0.40
SL		1.00	***0.55**	0.88	0.64	0.89	0.70	0.88	0.90	0.71	0.53
SC			1.00	0.61	0.83	0.46	0.85	0.66	***0.58**	0.80	0.00
NC				1.00	0.63	0.85	0.74	0.93	0.95	0.76	0.60
EL					1.00	0.59	0.88	0.70	0.62	0.74	0.16
BL						1.00	0.62	0.85	0.86	0.72	0.64
HL							1.00	0.81	0.72	0.81	0.30
HG								1.00	0.91	0.81	0.29
BH									1.00	0.71	0.57
RC										1.00	0.24
TL											1.00

*Level of significance ($P<0.05$)

BW-Body weight, BL Body Length, EL-Ear length, HL- Head Length, HG- Heart girth, NC- Neck circumference, SL- Snout Length, SC- Snout circumference, TL – Tail length, RC- Rump circumference, BL- Body length, BH-Body height (Height at wither), LBM- Linear body measurement.



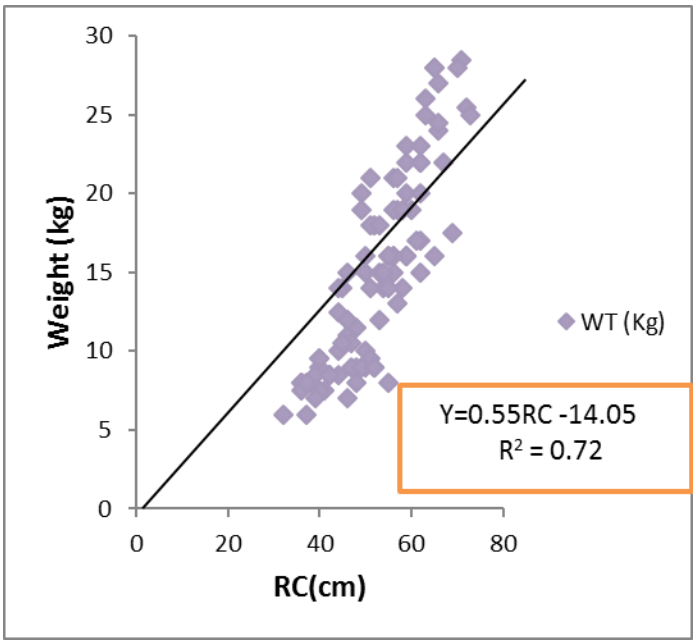
(a)



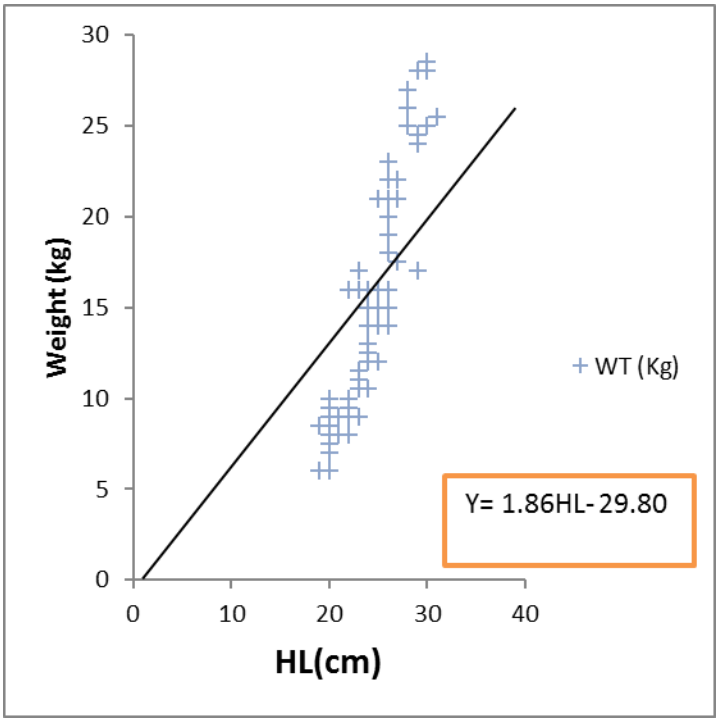
(b)

Figures 3.1a and b: The regression graph for weight against (a) heart girth and (b) body length of hybrid

WT=weight, BL=body lenght and HG= Heart girth

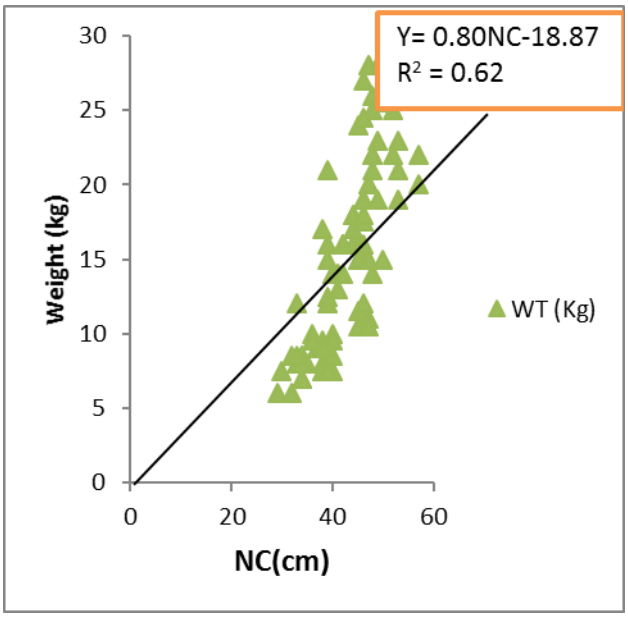


(a)

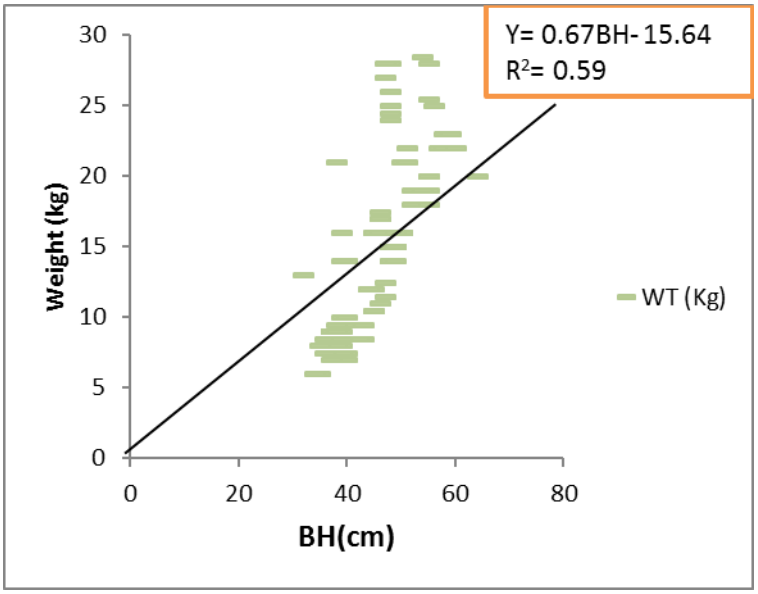


(b)

Figure 3.2 a and b:The regression graph of weight against (a) rump circumference and (b) head length of hybrid
WT=weight, HL=head lenght, RC=Rump circumference



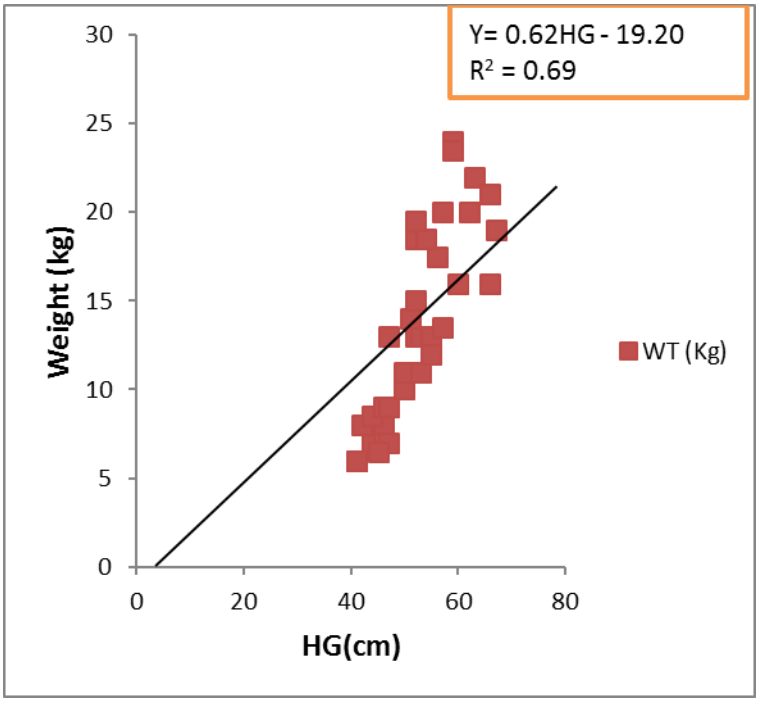
(a)



(b)

Figure 3.3a and b: The regression graph for weight against (a) neck circumference and (b) body height of hybrid.

WT=weight, NC=neck circumference, BH= body height.



(a)

Figure 3.4a: The regression graph for weight against (a) heart girth of NIP.

WT=weight, HG= Heart girth

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