



Litter size, parity and sex effects on weaning and post weaning growth of pigs

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Abstract

Pig breeding has been mostly affected by number of piglets that survived to market age with regards to their productivity and fitness traits. This study investigated the influence of sex, parity and litter size on three growth performance characteristics (weaning weight, total weight gain and average daily gain of piglets) at the weaning and post-weaning period of piglets. The 43 piglets investigated are from the cross of Camborough and Landrace breeds, comprising 25 male and 18 female piglets, from three different parities and five unique litter sizes. Measurements of body weight of the piglets were taken immediately at weaning and consistently for additional 12 weeks on a regular weekly basis. The piglets were tagged with an ID and restrained for the measurement, which was recorded against each piglet ID. All measurements were done with a digital hanging balance sensitive to 0.00g, whereby the piglets were placed in bags and hung for weighing. Data collected were recorded on excel worksheets and validated for precision and accuracy. Preliminary descriptive statistics was done to check the data for normality, and indices (total weight gain and average daily gain) were computed from the measured weekly values. The values ranged between 3.55kg-8.35kg, 6.90kg-18.45kg and 0.08kg-0.22kg respectively for weaning weight, total weight gain and average daily gain. Sex did not exert significant ($P>0.05$) influence on any of the three characteristics studied, while parity only significantly ($P<0.05$) impacted weaning weight but did not influence the other two parameters (total weight gain and average daily gain). However, litter size significantly affected the three parameters investigated with the largest influence recorded on weaning weight (61.1%). The relationship between weaning weight and subsequent weekly weights were mostly positive (direct) and significant, with the exception of Week 1 post weaning that was negative. The study revealed that piglets from small to moderate litter sizes tend to have higher post weaning weights.

Keywords: Growth parameters, Sex, Parity, Litter Size, Piglets.

Introduction

Pig enterprise has been reported to be a profitable enterprise due to its shorter generation interval, ease of breeding and rearing and ability to produce large offspring per farrowing, thus it should be encouraged and embarked upon (Ajala and Adesehinwa, 2008; Meissner *et al.*, 2013; Adjei *et al.*, 2015; Ouma *et al.*, 2015; Obayelu *et al.*, 2017), since it can contribute positively to the empowerment of women and enhance their equal

participation in local markets especially at the smallholder level.

Due to increasing human population and demand for meat, pork production has scaled up by developing pig value chain which has gradually been established over time. However, the cultural, traditional or religious sentiments against pork has been a major challenge in its acceptability as an alternate form of meat in some parts of Nigeria (Nwachukwu and Udegbunam, 2020).

Litter size is an important factor influencing the economic outcome, as a higher number of born piglets gives an opportunity to a higher number of pigs sent to slaughter (Andersson *et al.*, 2016; Kridli *et al.*, 2016). Sows' ability to produce large litters has shaped modern piglet production, with the main production target, is to increase the number of piglets born in each litter in order to improve the production efficiency (Knecht *et al.*, 2015).

However, the problems of high piglet mortality, and sow's removal rates seem to have concomitantly increased during the same period that litter sizes have increased (Baumgartner, 2011), simply because large litters at birth have been found to be associated with slow growth rates, high level of losses due to pre-weaning mortality and has not translated to large litters at weaning.

Low average birth weights associated with large litters also result in slow growth rates and low survivability has been recorded at the pre-weaning, growing and finishing phases (Zindove *et al.*, 2013). Consequently, this study therefore aims to investigate and assess the effect of parity and litter size on post-weaning growth parameters of pigs.

Materials and Methods

Experimental site: This study was conducted at a well-established private piggery farm located at Ilara in Epe-Lagos State at latitude 6.53° N, longitude 4.06° E and altitude of 48.99m above sea level.

Experimental unit: A total number of 43 weaners consisting 25 male and 18 female piglets from three different parities (1, 2 and 3), and five litter sizes (4, 7, 9, 11 and 12), comprising piglets of Camborough (CB) x Landrace (LR) cross were evaluated. The piglets were individually

tagged and appropriately labelled with unique identifier depicting their sex and ID. Body weight was taken using a digital hanging balance sensitive to 0.00g. Weighing was done on a weekly basis and monitored for 13 weeks post weaning. Details of the weighing were immediately recorded against the ID of the piglet.

Management practices: Weaners were separated from their dams from four weeks and placed on compounded ration with proximate composition including, crude protein (16.8%), crude Fat (2.5%), crude Fibre (7.4%) and metabolizable energy (3400 kcal/kg). They were managed intensively and penned in groups by litter, and were ear notched for identification purposes at the commencement of the experiment. Weaners were fed ad-libitum diets suitable for the growing and fattening period.

Data collection: Information about the piglets' sex, dam and sire identification number, date of birth along with their respective body weights were taken at weaning. Piglets were restrained to one side of the pen and each piglet was taken and placed in a bucket to weigh, after the scale has been tared to zero with the bucket. The weight was immediately recorded for each piglet and such piglets are released back to the main pen area.

Data handling: Microsoft Excel® worksheet was used to transcribe recorded information for ease of data validation and verification. Data manipulation include construction of logical subclasses to reflect sex and parities of the pigs.

Statistical analyses: After verification and validation of data entered, preliminary exploratory analysis was conducted for each measurement to test data integrity using box plots and normality test for outliers. All statistical analysis was

conducted using Minitab® 17 (2010) Statistical Software.

Descriptive statistics for all weekly measurements was conducted within and across parity and litter sizes. Multiple correlation amongst all the weekly weight gain and weaning weight was computed to measure relationship between the variables in order to also avert multicollinearity in the statistical model.

The experimental design was a completely randomized design and a one-way analysis of variance (ANOVA) using sex, parity and litter size as factors was conducted on all parameters (weaning weight, weekly gain, total gain and average daily gain) studied.

The Statistical model describing the one-way ANOVA was given as $Y_{ij} = \mu + \alpha_i + e_{ij}$ where Y_{ij} is the record of the j^{th} piglet of the i^{th} parity (1, 2, and 3), litter

size (4, 7, 9, 11 and 12) or sex (male and female), μ is the common mean; α_i is the effect of the i^{th} sex, parity or litter size and e_{ij} is the uncontrolled environmental and genetic deviations attributable to the individual piglet. All effects are random, normal, and independent with expectations equal to zero. After a significant ANOVA, further mean comparison procedure were conducted using the Tukey's honestly significant difference to separate the means at probability less than 0.05.

Results and Discussion

The range of values obtained in the study are as presented in Table 1, with overall values ranging between 3.55kg – 8.35kg, 6.90kg – 18.45kg and 0.08kg – 0.22kg respectively for weaning weight, total gain and average daily gain.

Table 1: Range of weaning weight, total weight gain and average daily gain values by sex, parity and litter size

	N	Weaning Weight (kg)	Total Weight Gain (kg)	Average Daily Gain (kg)
Sex				
Male	25	3.60 - 7.50	6.90 - 18.45	0.08 - 0.22
Female	18	3.55 - 8.35	7.40 - 15.70	0.09 - 0.19
Parity				
1	21	3.55 - 8.35	6.95 - 18.45	0.08 - 0.22
2	7	4.60 - 6.60	7.40 - 13.30	0.09 - 0.16
3	15	5.15 - 7.80	6.90 - 15.70	0.08 - 0.19
Litter Size				
4	8	6.50 - 7.80	8.50 - 15.70	0.10 - 0.19
7	7	5.15 - 5.75	6.90 - 13.95	0.08 - 0.17
9	11	4.65 - 8.35	7.55 - 18.45	0.09 - 0.22
11	7	4.60 - 6.60	7.40 - 13.30	0.09 - 0.16
12	10	3.55 - 5.20	6.95 - 11.30	0.08 - 0.14
Overall	43	3.55 - 8.35	6.90 - 18.45	0.08 - 0.22

Effect of sex on growth traits

Sex was not significant ($P>0.05$) on weaning weight, total weight gain and average daily gain of piglets (Table 2). This is due to the fact that prior to weaning, the

piglets were with the sow and their growth performances depend more on the mothering ability of the sow rather than the sex of the piglet. Sex no longer becomes an issue immediately after weaning since the male

piglets on the farm are been castrated prior to the post weaning period. These barrows, due to deliberated modification of their physiological status tend not to be different in measured variables as the gilts. Thus, neither the total weight gain nor the average daily gain values differ between the gilts and the barrows. It is also worthy of note that the twelve weekly weight gains monitored in the study were not in any way impacted by the sex of the piglet, even though that the gilts marginally outweighed the barrows in all variables studied, but the difference was not large enough to be statistically significant ($P>0.05$). This better performance of female over male piglets corroborates the work of Baxter *et al* (2012).

Effect of parity on growth traits

Parity was only significant ($P<0.05$) on weaning weight but not on total weight gain and average daily gain (Table 2). The influence of parity alone on weaning weight accounted for 18.79 percent of the total variation observed. There was a 19.85 percent superiority of piglets born at the third parity over piglets from primiparous sows. This observation is in agreement with report of Bergstrom *et al.*, (2011) who reported that reproductive performance generally increases over the first three to four parities, then begins to decline as sows reach the seventh or eighth parity.

Table 2: ANOVA table for effect of sex, parity and litter size on weaning weight, total weight gain and average daily gain

Source	df	Weaning Weight Mean Square	Total Weight Gain Mean Square	Average Daily Gain Mean Square
Sex	1	0.07 ^{ns}	18.86 ^{ns}	0.003 ^{ns}
Error	41	1.23	7.81	0.001
R-Squared (%)		0.13	5.56	5.56
Source	df	Weaning Weight Mean Square	Total Weight Gain Mean Square	Average Daily Gain Mean Square
Parity	2	4.74 [*]	3.64 ^{ns}	0.0005 ^{ns}
Error	40	1.02	8.30	0.0012
R-Squared (%)		18.79	2.14	2.14
Source	df	Weaning Weight Mean Square	Total Weight Gain Mean Square	Average Daily Gain Mean Square
Litter Size	4	7.71 ^{***}	22.22 [*]	0.0032 [*]
Error	38	0.52	6.58	0.0009
R-Squared (%)		61.10	26.21	26.21

*** = $P<0.001$

** = $P<0.01$

* = $P<0.05$

^{ns} = $P>0.05$

The trend in weaning weight consistently increased from first parity and peaked at third parity (Table 3), albeit there was no statistical difference ($P>0.05$) in both the second and third parity values. This observation can be ascribed to the changes in the physiological status and increasing mothering experience of the sows with increasing parturition.

However, parity did not exert significant ($P>0.05$) influence on both post weaning total weight gain and average daily gain. It must be noted that it was only first and third weekly weight gain values that parity exhibited significance but other weekly weight gains remained not impacted by parity of birth.

Effect of litter size on growth traits

Litter size was highly significant ($P < 0.001$) on weaning weight (Table 2). Piglets from smaller litters are better supported nutritionally and physiologically during pregnancy and have higher weight at birth, which has been reported to greatly impact the survival of the piglet and its future growth due to less competition for feeding by the sow unlike larger litters with greater competition for space and food.

Similarly, litter size was significant on both the total weight gain and average daily gain of the piglets through the entire study period (Table 3). This can be ascribed to the positive relationship between birth weight on one hand and weaning weight on the other hand, which further impact the future performance of the animal. Piglets from smaller litter size tend to have higher body weight through the weaning period which also impact its future growth as a result of less competition compared to piglets from large litters.

It is worthy of mention that litter size equally mostly positively impacted the weekly growth rates of the piglets with significant ($P < 0.05$) differences among the different litter sizes at the 3, 4, 6, 7, 8, 9 and 11 weeks. In all, the smaller litters had the greater values, while the larger litters had the lowest.

Relationship between weaning weight and post weaning weekly growth rate

Weaning weight was significantly (albeit at varying levels) correlated to all weekly weight gain, except for weeks 1, 3, 8 and 12 which were not significant. The relationship was mostly direct (positive) with the exception of week 1, and varies between low and medium range.

The study revealed that relationship among the weekly weight gains was mostly not significant ($P > 0.05$), and the coefficient was mostly low. The implication of this is that weekly weight gain is mostly a function of feed availability for the piglets. However, the weaning weight positively correlate to subsequent weight gains.

Table 3: Mean ± S.E. of weaning weight, total weight gain and average daily gain values by sex, parity and litter size

	N	Weaning Weight	Total Weight Gain	Average Daily Gain
Sex				
Male	25	5.66 ± 0.23	10.25 ± 0.62	0.12 ± 0.01
Female	18	5.74 ± 0.24	11.59 ± 0.54	0.14 ± 0.01
Parity				
1	21	5.24 ± 0.26 ^b	10.34 ± 0.73	0.12 ± 0.01
2	7	5.79 ± 0.24 ^{ab}	11.13 ± 0.71	0.13 ± 0.01
3	15	6.28 ± 0.23 ^a	11.25 ± 0.65	0.13 ± 0.01
Litter Size				
4	8	7.01 ± 0.17 ^a	11.93 ± 0.92 ^a	0.14 ± 0.01 ^a
7	7	5.45 ± 0.07 ^{bc}	10.48 ± 0.90 ^{ab}	0.12 ± 0.01 ^{ab}
9	11	5.97 ± 0.34 ^b	12.18 ± 1.08 ^a	0.15 ± 0.01 ^a
11	7	5.79 ± 0.24 ^b	11.13 ± 0.71 ^{ab}	0.13 ± 0.01 ^{ab}
12	10	4.40 ± 0.18 ^c	8.43 ± 0.47 ^b	0.10 ± 0.01 ^b
Overall	43	5.69 ± 0.17	10.81 ± 0.43	0.13 ± 0.01

Means with different superscripts within the same column for each trait and factor are significantly different ($P < 0.05$)

Table 4: Correlation matrix of weaning weight and weekly weight gains

	WWt	Post weaning weekly weight gain											
		Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11	
Wk 1	-0.04												
Wk 2	0.41**	0.14											
Wk 3	0.26	0.06	0.19										
Wk 4	0.38*	0.25	0.13	-0.35*									
Wk 5	0.48***	0.16	0.59***	0.53***	0.01								
Wk 6	0.57***	0.23	0.23	0.16	0.41**	0.22							
Wk 7	0.38*	0.24	0.36*	-0.15	0.24	0.10	0.04						
Wk 7	0.24	0.27	0.17	0.17	0.36*	0.31*	-0.30	0.03					
Wk 9	0.60***	0.20	0.42**	0.11	0.36*	0.23	0.57***	0.26	-0.09				
Wk 10	0.57***	0.29	0.51***	0.33*	0.35*	0.60***	0.37**	0.21	0.52***	0.29			
Wk 11	0.36*	0.07	0.28	-0.03	0.23	0.43**	0.37**	0.05	-0.04	0.35*	0.14		
Wk 12	0.07	0.05	0.05	0.21	-0.03	0.15	-0.01	0.15	0.15	0.02	0.11	-0.11	

WWt = Weaning Weight; *** = P<0.001; ** = P<0.01; * = P<0.05

Conclusions and Recommendations

It was observed from this study that:

- sex was not a significant source of variation in the three parameters (weaning weight, total post weaning gain and average daily gain) investigated, while parity of sow was only significant on weaning weight, with higher values recorded with increasing parity number, but was not significant on the other two parameters studied.
- It was only litter size that was significant on all three parameters investigated reflecting a progressively increase in the parameters with lower litter sizes in an inverse relationship. As litter size increases, so does the weaning weight, total gain and average daily decreases.

Consequently, it is recommended that rather than seek large litter sizes in pigs, it is advisable that moderate litter numbers be encouraged whereby the higher chances of survival and heavier piglets from such parities would offset the economic losses from fewer litter size.

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