

Short communication

Variation in individual piglet birth weights in a Large White × Landrace sow herd

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Abstract

Within-litter birth weight variation in pigs is increasingly becoming important in influencing the profitability of pig enterprises. The objective of the study was to characterize within-litter birth weight variation in piglets from Large White × Landrace sows. The study was conducted using records from 1 768 litters collected between January 1998 and September 2010 from a pig herd in South Africa. The number of piglets born alive (NBA) ranged from three to 18. The mean within-litter birth weight coefficient of variation (CVBWT) was 17.6% and ranged from 0.47% to 50.7%. The distribution of CVBWT in the herd was positively skewed. CVBWT increased as NBA increased. Multiparous sows farrowed litters with higher CVBWT than gilts. To enhance profitability of pig enterprises, the selection for increased NBA should be followed by selection for decreased CVBWT.

Keywords: Coefficient of variation, litter weight at birth, number of piglets born alive, parity

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Number of piglets born alive (NBA) has been a major component of sow productivity, and genetic improvement programmes linked to it have been given priority (Kim *et al.*, 2005). The number of teats a sow has limits the number of piglets it can nurture to weaning. When a sow farrows more piglets in a litter than its number of teats, the excess piglets have to be fostered (Canario *et al.*, 2010). To date, sows from most breeds exhibit NBA of over 12 (Umesiobi, 2009). Kim *et al.* (2005) reported average teat numbers of 14 in Large White and Landrace sows. Therefore, the success of continued selection for litter size is likely to be limited by the number of teats.

Since improvement for NBA is approaching its optimum level, the next challenge could be to maximize piglet survival and growth rates. Milligan *et al.* (2002) suggested that one reason for low survival rates and a reduced average litter weight at weaning in large litters is the unfavourable positive correlation between NBA and within-litter birth weight variation. Light piglets have a reduced likelihood of surviving to weaning age and have reduced growth rates and weights at slaughter compared with their litter mates (Wolf *et al.*, 2007). Uniform piglets at birth are likely to produce uniform pigs at weaning and at marketing (Fix *et al.*, 2010). In addition, production of uniform piglets at birth reduces the incidences of foster-mothering, which is commonly practised to reduce variation among litter mates. A study by Straw *et al.* (1998) has shown that cross-fostering is adequate to achieve high survival rates owing to its negative effects such as reduced growth rates. Large weight variation at birth also requires the use of more pens, thereby increasing the cost of housing and cleaning, and complicating management requirements. Within-litter birth weight variation, defined as the distribution of individual weights within a litter, has not been given much attention despite its recognized impact on pig enterprises (Wolf *et al.*, 2007). Factors affecting the variability in piglet birth weights are complex and poorly understood. These factors include nutrition and the age of the sow, breed of boar and genetic selection of gilts (Chimonyo *et al.*, 2006). To improve the homogeneity of litters at birth, the relative importance of these factors needs to be explored. The objective of this study was to characterize

within-litter birth weight variation in pigs, and determine factors that influence birth weight variation. It was hypothesized that non-genetic factors influence within-litter birth weight variation.

Data were collected from a pig herd at the Agricultural Research Council (ARC) farm at Irene, South Africa. The farm is located at 25°34'0" S and 28°22'0" E and lies 1523 m above sea level. An approximate mean annual rainfall of 715 mm is received with mean annual temperature of 17.3 °C. The temperature in the hot humid season (November to January) averages 23 °C, while the cold dry season (May to July) has an average temperature of 15 °C.

Data used in the study included 20 741 piglets from 1 816 litter records produced from January 1998 until September 2010. The records consisted of piglet identity, parity number, farrowing date, farrowing month, farrowing year, NBA and individual piglet birth weights. From these records, mean birth weight (MBWT), litter weight at birth (LWT), within-litter birth weight coefficient of variation (CVBWT), minimum birth weight (MinBWT) and maximum birth weight (MaxBWT) were calculated. Records of litters with piglets fostered in or out were excluded from the analyses. Litters with fewer than three piglets were assumed to have piglets fostered out and were excluded from the analyses. Data from 48 litters were deleted in this way, leaving 1 768 litters available for analyses.

The distribution of birth weights within the litter was described by several quantities. The arithmetic mean represented the average birth weight. PROC UNIVARIATE (SAS, 2009) was used to examine the distribution of CVBWT and MBWT and frequency distributions. Skewness and kurtosis were derived to describe the deviation of the distribution of CVBWT and MBWT between litters from the (symmetric) normal distribution.

The effect of parity, month of farrowing, year of farrowing, their interactions and relevant covariates on NBA, LWT, MBWT, MinBWT, MaxBWT and CVBWT was determined using generalized linear model procedures for repeated measures (SAS, 2009) to allow for repeated records of the sow. The relationship between CVBWT and NBA was plotted using Proc Gplot (SAS, 2009).

Summary statistics of studied traits are shown in Table 1. A skewness value of zero indicates a normal distribution (Milligan *et al.*, 2002). The negative skewness value for NBA indicated that the majority of the NBA values were above the litter mean. The CVBWT and MBWT were positively skewed.

Table 1 Summary statistics of the number of piglets born alive (NBA), litter weight at birth (LWT), mean birth weight (MBWT), within-litter birth weight coefficient of variation (CVBWT), minimum birth weight within a litter (MinBWT) and maximum birth weight within a litter (MaxBWT) (N = 1 768)

Trait	Mean	Standard deviation	Minimum	Maximum	Skewness	Kurtosis
NBA	10.21	2.74	3.00	18.00	-0.21	-0.08
LWT	15.60	4.63	6.70	36.70	0.20	0.33
MBWT	1.55	0.33	0.54	2.88	0.58	0.83
CVBWT	17.64	6.89	0.47	50.65	0.54	0.53
MinBWT	1.10	0.36	0.20	2.90	0.48	0.58
MaxBWT	1.92	0.37	0.80	3.30	0.73	0.72

CVBWT ranged from 0.47% to 50.7%, reflecting considerable differences among litters over the 13-year period. The range of CVBWT reported in this study was larger than that reported by Wolf *et al.* (2008). This difference could be owing to variations in herd structures and the minimum NBA used for analysis. The CVBWT mean of 17.7% was on the lower end of the typical range of 18% to 25% reported by Le Dividich (1999). The finding that a considerable number of litters had CVBWT higher than the herd's mean CVBWT (Figure 1) implies that there is scope for improvement of within-litter birth weight homogeneity. The reported range and mean for CVBWT was higher than values reported by Wolf *et al.* (2008). This deviation could be ascribed to differences in environmental conditions and herd composition. The observed phenotypic increase in MBWT with year (Figure 2) shows that there was a remarkable improvement in MBWT. The reduction in NBA over the period under study could be owing to the negative correlation between NBA and MBWT. When breeders select for improved MBWT, NBA will be decreased. Year effects on MBWT and NBA can be the result of other factors such as a change in managerial strategies (e.g. differences in quality of feed and feeding regimens) by year and changes in parity distribution within the

herd. Absence of year effects on CVBWT could be evidence that there was no change in within-litter variability in weights during the period under study. This could be because the trait was not being selected for over the period under study.

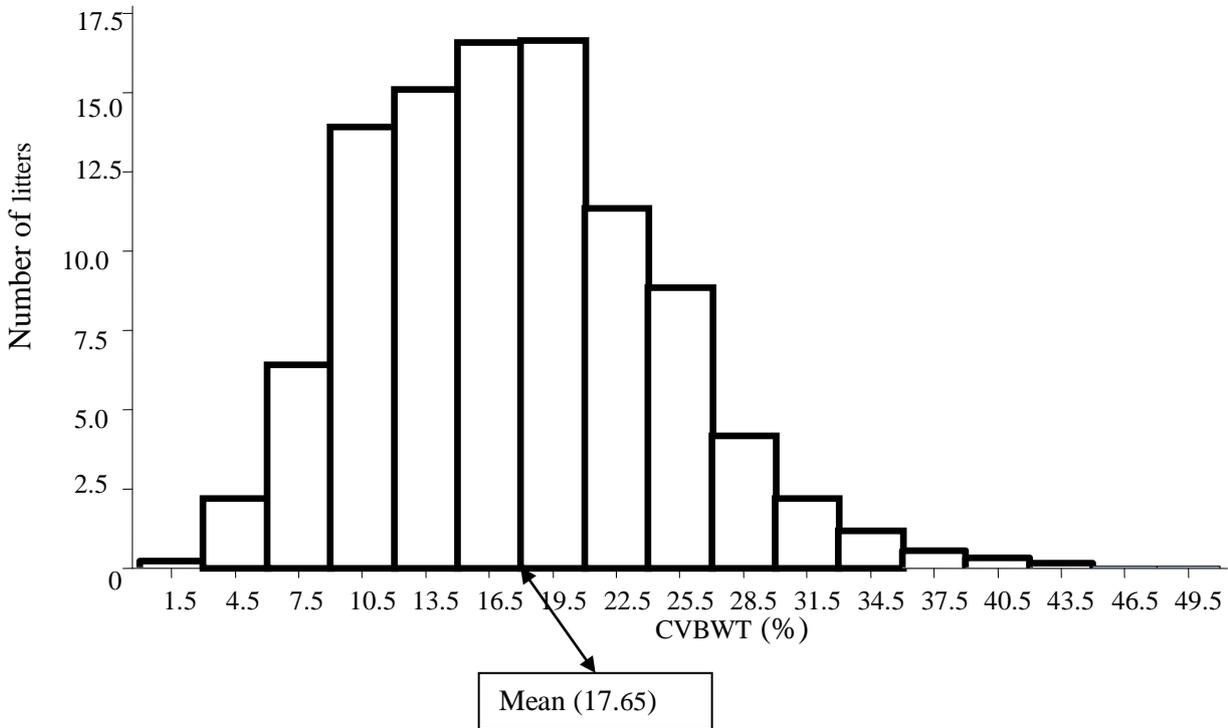


Figure 1 Distribution of the within-litter birth weight coefficient of variation (CVBWT).

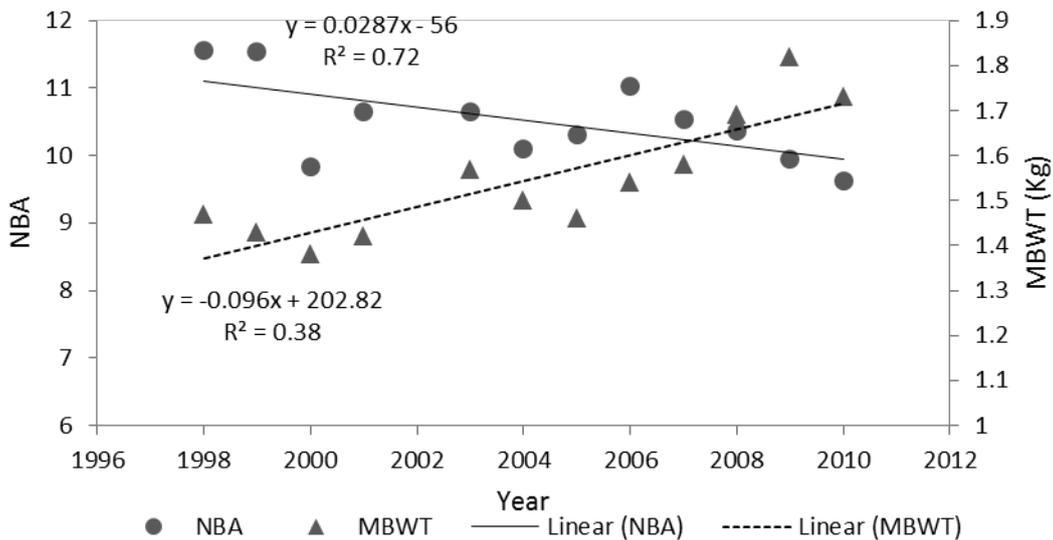


Figure 2 Relationship between year and number of piglets born alive (NBA) and mean birth weight (MBWT) in a Large White x Landrace sow herd.

Table 2 shows that there is a positive correlation between NBA and CVBWT. This observation supports reports by Canario *et al.* (2010), who suggested that variation in birth weight of litter mates could be owing to differences in litter size and uterine capacity, size of the placenta and interactions among these factors. The NBA for gilts was lower ($P < 0.05$) than that for multiparous sows, except for those greater than parity 6 (Table 3). This finding agrees with results of Fernandez *et al.* (2008).

Table 2 Pearson's correlations among number of piglets born alive (NBA), litter weight at birth (LWT); within-litter birth weight coefficient of variation (CVBWT), minimum birth weight within a litter (MinBWT), maximum birth weight within a litter (MaxBWT) and mean birth weight (MBWT) (N = 1 768)

Variable	NBA	MinB	MaxB	MBWT	LWT
CVBWT	0.30**	-0.69**	0.05	-0.31**	0.06*
NBA		-0.44**	-0.09**	-0.26**	0.73**
MinBWT			0.53**	0.78**	0.11*
MaxBWT				0.89**	0.52*
MBWT					0.44**

* $P < 0.05$; ** $P < 0.01$.**Table 3** Least square means (\pm SE) for the effects of sow parity on number of piglets born alive (NBA), litter weight at birth (LWT), mean birth weight (MBWT), maximum birth weight within a litter (MaxBWT), and within-litter birth weight coefficient of variation (CVBWT)

Parity	n	NBA	LWT	MBWT	MaxBWT	CVBWT
1	684	9.8 ^a \pm 0.58	15.7 ^a \pm 0.95	1.61 ^a \pm 0.064	1.86 ^a \pm 0.014	16.90 ^a \pm 0.265
2	367	10.6 ^{bc} \pm 0.59	17.4 ^{bc} \pm 0.97	1.66 ^b \pm 0.066	1.92 ^b \pm 0.019	17.13 ^{ab} \pm 0.358
3	232	10.8 ^{bcd} \pm 0.60	17.9 ^c \pm 0.98	1.68 ^b \pm 0.067	1.98 ^b \pm 0.024	18.06 ^{bc} \pm 0.451
4	158	11.3 ^d \pm 0.62	18.3 ^c \pm 1.01	1.65 ^{ab} \pm 0.069	1.97 ^b \pm 0.029	18.88 ^{cd} \pm 0.544
5	102	11.1 ^{cd} \pm 0.64	18.2 ^c \pm 1.05	1.66 ^{ab} \pm 0.072	1.20 ^b \pm 0.036	19.70 ^{cd} \pm 0.677
6	61	11.0 ^{bcd} \pm 0.67	17.3 ^{bc} \pm 1.10	1.62 ^{ab} \pm 0.075	1.94 ^b \pm 0.047	19.54 ^{cd} \pm 0.876
7	66	10.1 ^{ab} \pm 0.66	16.3 ^{ab} \pm 1.08	1.63 ^{ab} \pm 0.074	1.98 ^b \pm 0.045	20.57 ^d \pm 0.842

Values within a column with different superscripts differ ($P < 0.05$).

Gilts and young sows have lower ovulation rates than mature sows (Cole *et al.*, 1994) thus resulting in smaller litter sizes in primiparous sows (Table 3). The reduction in NBA in older sows (with parities greater than 6) can be attributed to high incidences of farrowing problems that lead to higher piglet mortalities, which reduce NBA. Piglets from primiparous sows were more uniform than piglets from older sows, this result being related to the effect of parity on NBA (Milligan *et al.*, 2002). Contrary to the suggestion that the effect of parity on CVBWT is related to a parity effect on NBA, there was no significant difference in CVBWT of first and second parity sows in the present study, despite a significant difference in NBA between the two parities. This would suggest that litter heterogeneity is partly influenced by parity. The dissension can also be because of the exclusion of litters with fewer than three piglets from the analysis. This eliminated mainly first parity sows, since NBA increases with sow parity (Fernandez *et al.*, 2008). Primiparous gilts and sows in their late parities had lower MBWT than sows in parities 2 to 5 (Table 3). This result agrees with findings by Milligan *et al.* (2002). Gilts produce piglets of low birth weights because they are still physiologically immature and hence have to partition nutrients between their own nutrient requirements and those of the fetuses (Campos *et al.*, 2011). Age-associated physiological deterioration in sows in their late parities results in less efficient utilisation of feed to provide nutrition to fetuses resulting in low MBWT (Mungate *et al.*, 1999).

As shown in Table 4, the heaviest litters were born in September and October ($P < 0.05$), while the lightest litters were recorded during the cool-dry months (May to August) ($P < 0.05$). Seasonal variation in MaxBWT and MinBWT can be related to variation of LWT with season, since there is a strong positive correlation between LWT and both MaxBWT and MinBWT. These findings confirm results from other studies that indicate that sows produce not only smaller litters, but also lighter piglets during hot or warm seasons (Tummaruk & Khatiworavage, 2011).

Table 4 Least square means for the effects of farrowing month on litter weight at birth (LWT), minimum birth weight within a litter (MinBWT), and maximum birth weight within a litter (MaxBWT)

Month	n	LWT	MinBWT	MaxBWT
Jan	118	17.6 ^{bc} ± 1.03	1.17 ^b ± 0.081	2.05 ^{bc} ± 0.080
Feb	161	17.5 ^{bc} ± 1.01	1.16 ^b ± 0.079	2.09 ^{cd} ± 0.078
Mar	136	17.6 ^{bc} ± 1.04	1.18 ^b ± 0.081	2.07 ^{bcd} ± 0.080
Apr	143	17.4 ^{ab} ± 1.03	1.12 ^{ab} ± 0.081	2.07 ^{bcd} ± 0.080
May	155	16.4 ^a ± 1.02	1.08 ^a ± 0.080	1.88 ^{ab} ± 0.079
Jun	113	17.1 ^{ab} ± 1.05	1.19 ^b ± 0.082	2.01 ^{abc} ± 0.081
Jul	184	16.4 ^a ± 0.93	1.08 ^a ± 0.078	1.94 ^a ± 0.077
Aug	142	16.9 ^{ab} ± 1.04	1.14 ^{ab} ± 0.081	2.06 ^{abcd} ± 0.080
Sep	169	18.5 ^c ± 1.03	1.16 ^b ± 0.081	2.13 ^d ± 0.080
Oct	133	18.0 ^c ± 1.01	1.14 ^{ab} ± 0.079	2.08 ^{cd} ± 0.079
Nov	131	17.0 ^{ab} ± 1.03	1.10 ^{ab} ± 0.081	2.01 ^{abc} ± 0.080
Dec	195	17.5 ^b ± 1.01	1.17 ^b ± 0.079	2.08 ^{cd} ± 0.078

Values within a column with different superscripts differ significantly ($P < 0.05$).

In conclusion, large NBA was associated with an increased within-litter birth weight variation. Parity also influenced CVBWT, and within-litter birth weight variation was lowest in primiparous sows. Future research in selection programmes should attempt to reduce within-litter birth weight variation in large litters. However, CVBWT is a ratio, and its selection can be complicated owing to antagonistic correlated response in its component traits such as NBA and MBWT. Thus, when selecting for CVBWT, there is need to consider the economic values of selection responses from the component traits and possibly selection index procedures.

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