Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 960

2009

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Recommended Citation

Bergstrom, J R.; Potter, M L.; Henry, Steven C.; Tokach, Michael D.; Nelssen, Jim L.; Goodband, Robert D.; DeRouchey, Joel M.; and Dritz, Steven S. (2009) "Effects of piglet birth weight and litter size on the preweaning growth performance of pigs on a commercial farm," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. https://doi.org/10.4148/2378-5977.6800

Effects of piglet birth weight and litter size on the preweaning growth performance of pigs on a commercial farm

Abstract

A total of 2,204 pigs (PIC 327 sired) were used to evaluate the effects of piglet birth weight and litter size on preweaning piglet performance. At a commercial sow farm, all pigs born alive for 22 consecutive days were identified individually at birth with a numbered ear tag. Each sow was assigned a body condition score (BCS; 1 = very thin to 5 = very fat), and the number of total born, live born, and born dead as well as the individual gender, birth weight, and identification of piglets were recorded within 18 h of parturition and before the movement of pigs to equalize litter size. During lactation, all pigs fostered, removed, or found dead were weighed, and the event was recorded. No litters were provided creep feed or supplements during lactation. Pigs were individually weighed and assigned a BCS (1 = emaciated, 2 = thin, or 3 = full-bodied) at weaning over 6 weaning days during a 19-d period, which resulted in a mean weaning age of 25 d. For data analysis, individual birth weight was used to assign pigs to 4 birth weight categories (â‰¤ 2.3 lb, 2.4 to 3.3 lb, 3.4 to 4.3 lb, and â‰¥ 4.4 lb), and the number of total born in each pigâ€™s litter of origin was used to assign pigs to 3 total born categories (â‰¤ 11, 12 to 14, and â‰¥ 15). As expected, birth weight was greater (P < 0.0001) for pigs of heavier birth weight categories. Pigs of heavier birth weight categories were associated (P < 0.02) with a decreased number of total and live born. Also, preweaning ADG, weaning weight, weaning BCS, and preweaning mortality were improved (P < 0.0001) for pigs of heavier birth weight categories. Birth weight decreased (P < 0.04) for pigs of greater total born categories, and an increased sow BCS was associated (P < 0.0001) with total born category â‰¥ 15. As expected, the litter total born, as well as live born and number born dead, increased (P < 0.0001) with greater total born categories. Preweaning ADG (0.51, 0.50, and 0.50 lb/d, respectively) and weaning weight (16.3, 15.9, and 15.8 lb, respectively) were modestly improved (P < 0.04) for pigs from the smallest total born category compared with the 2 larger categories. These data indicate that low-birth-weight pigs had poorer preweaning growth performance and survivability. Although larger litters resulted in a greater number of low-birth-weight pigs, the number of heavier pigs also increased. In addition to increasing litter size, maximizing reproductive and economic efficiency of swine requires identifying methods to improve birth weight and performance of the lightest pigs born.; Swine Day, Manhattan, KS, November 19, 2009

Keywords

Swine day, 2009; Kansas Agricultural Experiment Station contribution; no. 10-014-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1020; Birth weight; Litter size; Swine

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Effects of Piglet Birth Weight and Litter Size on the Preweaning Growth Performance of Pigs on a Commercial Farm[1]

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Summary

A total of 2,204 pigs (PIC 327 sired) were used to evaluate the effects of piglet birth weight and litter size on preweaning piglet performance. At a commercial sow farm, all pigs born alive for 22 consecutive days were identified individually at birth with a numbered ear tag. Each sow was assigned a body condition score (BCS; 1 = very thin to 5 = very fat), and the number of total born, live born, and born dead as well as the individual gender, birth weight, and identification of piglets were recorded within 18 h of parturition and before the movement of pigs to equalize litter size. During lactation, all pigs fostered, removed, or found dead were weighed, and the event was recorded. No litters were provided creep feed or supplements during lactation. Pigs were individually weighed and assigned a BCS (1 = emaciated, 2 = thin, or 3 = full-bodied) at weaning over 6 weaning days during a 19-d period, which resulted in a mean weaning age of 25 d. For data analysis, individual birth weight was used to assign pigs to 4 birth weight categories (≤ 2.3 lb, 2.4 to 3.3 lb, 3.4 to 4.3 lb, and ≥ 4.4 lb), and the number of total born in each pig's litter of origin was used to assign pigs to 3 total born categories (≤ 11, 12 to 14, and ≥ 15). As expected, birth weight was greater ($P < 0.0001$) for pigs of heavier birth weight categories. Pigs of heavier birth weight categories were associated ($P < 0.02$) with a decreased number of total and live born. Also, preweaning ADG, weaning weight, weaning BCS, and preweaning mortality were improved ($P < 0.0001$) for pigs of heavier birth weight categories. Birth weight decreased ($P < 0.04$) for pigs of greater total born categories, and an increased sow BCS was associated ($P < 0.0001$) with total born category ≥ 15. As expected, the litter total born, as well as live born and number born dead, increased ($P < 0.0001$) with greater total born categories. Preweaning ADG (0.51, 0.50, and 0.50 lb/d, respectively) and weaning weight (16.3, 15.9, and 15.8 lb, respectively) were modestly improved ($P < 0.04$) for pigs from the smallest total born category compared with the 2 larger categories. These data indicate that low-birth-weight pigs had poorer preweaning growth performance and survivability. Although larger litters resulted in a greater number of low-birth-weight pigs, the number of heavier pigs also increased. In addition to increasing litter size, maximizing reproductive and economic efficiency of swine requires identifying methods to improve birth weight and performance of the lightest pigs born.

Key words: birth weight, litter size

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[1] Appreciation is expressed to Keesecker Agri-business, Washington, KS, for providing pigs and facilities involved with this study.

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Introduction

Research by Main et al. (2002[4]) demonstrated that weaning weight and postweaning performance improved linearly with increased weaning age. When these data were modeled to quantify the changes in performance associated with increasing weaning age, Main et al. (2002) found it useful to express these benefits on a change per pound of weaning weight basis. As a result, the importance of weaning age and weaning weight for subsequent performance is well understood. Since that time, many swine production systems have increased their weaning age to improve weaning weight, postweaning growth, efficiency of growth, welfare, and economic return. However, litter size has also increased during this time because of improvements in genetics, sow nutrition and feeding practices, and health management. The increased lactation period may also be contributing to the improved reproductive performance.

Unfortunately, improved ovulation rates and embryonic survival have occurred without any measurable change in the uterine capacity of sows (Foxcroft, 2007[5]). This has resulted in concern that birth weights will be reduced. Although the relationship of birth weight and subsequent growth is fairly well understood, the existing studies have used a relatively small number of pigs. These studies have characterized the effects of birth weight on growth using only 2 or 3 birth weight categories. Also, other economically important traits (such as mortality) that may be influenced by birth weight have not been adequately described. Few studies have evaluated the effects of both litter size and birth weight on the subsequent performance of pigs.

Therefore, our objective was to evaluate the relationship of piglet birth weight and the size of the piglet's litter of origin with subsequent preweaning performance using a large population of pigs on a commercial farm.

Procedures

Procedures used in this experiment were approved by the Kansas State University Institutional Animal Care and Use Committee. The experiment was conducted at a commercial farm in Kansas and used 1,181 pigs (PIC 327 sired) born of first, second, and a few third parity females (Triumph TR24) and 1,023 pigs (PIC 327 sired) born of third parity and older sows (PIC 1050). Throughout the experiment, all litters were penned in individual farrowing crates located over totally slatted floors in environmentally controlled buildings.

All pigs born alive for 22 consecutive days were identified individually at birth with a numbered ear tag. Each sow was assigned a body condition score (BCS; 1 = very thin to 5 = very fat), and the number of total born, live born, and born dead was recorded. Also, the individual gender, birth weight, and identification of piglets were recorded within 18 h of parturition and before the movement of pigs to equalize litters. Afterward, litters born within the same day were equalized and processed following the farm's normal procedures to optimize sow and piglet health and welfare. During lactation, all pigs fostered, removed, or found dead were weighed, and the event was recorded. No litters were provided creep feed or supplements during lactation. The

[4] Main et al., Swine Day 2002, Report of Progress 897, pp. 1-19.

[5] Foxcroft, G. R. 2007. Pre-natal programming of variation in postnatal performance – How and when? Adv. Pork Prod. 18:167-189.

pigs were individually weighed and assigned a BCS (1 = emaciated, 2 = thin, or 3 = full-bodied) at weaning over 6 occasions during a 19-d period, which resulted in a mean weaning age of 25 d.

For data analysis, individual birth weight was used to assign pigs to 4 birth weight categories (≤ 2.3 lb, 2.4 to 3.3 lb, 3.4 to 4.3 lb, and ≥ 4.4 lb), and the number of total born in each pig's litter of origin was used to assign pigs to 3 total born categories (≤ 11, 12 to 14, and ≥ 15). Because of a change in maternal genetics delivered to the farm, the parity and genetic background (PIC 1050 and Triumph TR24) of sows were confounded. Therefore, the effects of sow parity and genetic background on piglet performance were not evaluated. Parity was used as a random effect in the data analysis. Data were analyzed as a 4 × 3 factorial design using the PROC MIXED procedure of SAS (SAS Institute Inc., Cary, NC). Weaning age was used as a covariate for the analysis of preweaning growth. Individual pig was the experimental unit for the analysis of response criteria.

Results

Meaningful interactions were not observed during the study. As expected, birth weight was greater ($P < 0.001$) for pigs of heavier birth weight categories (Table 1). As birth weight category increased, the number of total born and live born decreased ($P < 0.02$). Preweaning ADG (0.38 lb/d for ≤ 2.3 lb birth weight to 0.59 lb/d for ≥ 4.4 lb birth weight), weaning weight (11.6 lb to 19.5 lb), weaning BCS (2.69 to 2.93), and preweaning mortality (24.2% to 4.6%) were improved ($P < 0.0001$) for pigs of heavier birth weight categories.

The birth weight of pigs from the smallest total born category (≤ 11) was greater ($P < 0.04$) than that of pigs from the largest total born category (≥ 15; Table 2). Sows of the largest total born category had an increased ($P < 0.0001$) BCS after parturition compared with the other two categories. As expected, the litter total born, as well as live born and number born dead, increased ($P < 0.0001$) with greater total born categories. Also, preweaning ADG and weaning weight were greatest ($P < 0.04$) for pigs from the smallest total born category (≤ 11) compared with the 2 larger categories. Preweaning mortality tended ($P < 0.07$) to be greatest for pigs from the 12 to 14 total born category.

Discussion

Several studies have reported an improved growth rate of heavier birth weight pigs (Powell and Aberle, 1980[6]; Wolter et al., 2002[7]; Bee, 2004[8]; Bérard et al., 2008[9]). However, these studies have generally compared 2 or 3 birth weight categories using a relatively small population, and none have adequately described the effect of birth

[6] Powell, S. E., and E. D. Aberle. 1980. Effects of birth weight on growth and carcass composition of swine. J. Anim. Sci. 50:860-868.

[7] Wolter, B. F., M. Ellis, B. P. Corrigan, and J. M. DeDecker. 2002. The effect of birth weight and feeding supplemental milk replacer to piglets during lactation on preweaning and postweaning growth performance and carcass characteristics. J. Anim. Sci. 80:301-308.

[8] Bee, G. 2004. Effect of early gestation feeding, birth weight, and gender of progeny on muscle fiber characteristics of pigs at slaughter. J. Anim. Sci. 82:826-836.

[9] Bérard, J., M. Kreuzer, and G. Bee. 2008. Effect of litter size and birth weight on growth, carcass and pork quality, and their relationship to postmortem proteolysis. J. Anim. Sci. 86:2357-2368.

weight on preweaning performance. Bérard et al. (2008) did not observe any differences in the preweaning growth of low-birth-weight, average-birth-weight, and heavy-birth-weight pigs. However, there were only 20 pigs in each of their birth weight categories. Wolter et al. (2002) did not observe any differences in preweaning growth of light- and heavy-birth-weight pigs, but preweaning mortality tended ($P = 0.10$) to be lower for heavy-birth-weight pigs. They started with 192 piglets in each of 2 weight categories, but categorizing pigs into a heavy half and light half is not adequate for understanding the relative differences in performance between the extremes. Bee (2004) observed differences in the preweaning growth performance of light- and heavy-birth-weight pigs but reported the performance of the lightest barrow and gilt (not less than 2.2 lb) and the heaviest barrow and gilt from 16 litters. This excluded any bias from categorizing pigs with birth weights similar to the mean. However, Bee (2004) did not have enough pigs to evaluate mortality differences.

Recent increases in litter size have raised concern over the impact that the increase may have on piglet birth weight and performance. However, there is little data available that adequately describes these relationships and their effects on subsequent performance. Only Bérard et al. (2008) has reported on the effect of both birth weight and litter size on piglet growth performance. Similar to the present experiment, they reported that the birth weight of pigs from large litters (≥ 14) was less than that of pigs from small litters (≤ 10). Although Bérard et al. (2008) did not observe significant differences in preweaning ADG among the low-, average-, and heavy-birth-weight pigs, the low-birth-weight pigs had numerically lower ADG and maintained a significantly lighter BW than heavy-birth-weight pigs at weaning (35 d of age). Average-birth-weight pigs had an intermediate BW at weaning. Unlike the current experiment, Bérard et al. (2008) did not observe any differences in preweaning ADG and weaning weight for pigs originating from small and large litters. Their estimates were based on the means of 3 pigs from each of 20 litters: the lightest pig, a single average-weight pig, and the heaviest pig. Therefore, their estimates for the 2 litter size categories did not include all pigs in the litter. In the present study, the greater number of low-birth-weight pigs from larger litters was responsible for the reduced performance, but these litters also produced more pigs that were heavier than 2.3 lb and 3.3 lb (Figures 1 and 2). Therefore, growth differences among the litter size categories were relatively small.

In conclusion, these data indicate that low-birth-weight pigs, especially those weighing 2.3 lb or less at birth, had poorer growth performance and higher mortality preweaning. Although larger litters had a greater number of low-birth-weight pigs, these litters also produced a greater number of live pigs with a birth weight greater than 2.3 lb. Litters with 15 or more total born produced the greatest number of live pigs that were heavier than 3.3 lb at birth. In addition to increasing litter size, maximizing the reproductive and economic efficiency of swine requires identifying methods to improve birth weight and performance of the lightest pigs born.

Table 1. Effect of piglet birth weight on preweaning growth performance[1]

Item	Birth weight category, lb[2]				SEM	Probability, $P <$
	≤ 2.3	2.4 to 3.3	3.4 to 4.3	≥ 4.4		
Pigs, no.	243	796	857	308		
Live born, %	11.0	36.1	38.9	14.0		
Birth weight, lb	1.92[a]	2.92[b]	3.78[c]	4.72[d]	0.02	0.0001
Sow BCS post-farrowing[3]	3.0	3.0	3.0	3.1	0.1	---[4]
Litter total born	13.3[a]	13.1[ab]	13.0[b]	12.6[c]	0.1	0.0001
Litter live born	12.1[a]	11.9[a]	11.9[a]	11.6[b]	0.1	0.02
Litter born dead	1.1	1.2	1.1	1.0	0.1	---
Preweaning ADG, lb	0.38[a]	0.49[b]	0.55[c]	0.59[d]	0.01	0.0001
Weaning wt, lb	11.6[a]	15.3[b]	17.5[c]	19.5[d]	0.2	0.0001
Pig BCS at weaning[5]	2.69[a]	2.87[b]	2.89[bc]	2.93[c]	0.02	0.0001
Preweaning mortality, %	24.2[a]	9.7[b]	5.0[c]	4.6[c]	1.6	0.0001

[1] A total of 2,204 pigs were used to evaluate the effect of piglet birth weight on preweaning performance. Pigs were weaned at approximately 25 d of age, and weaning age was used as a covariate in data analysis.
[2] Results are reported as least squares means.
[3] Sow body condition score (1 = very thin to 5 = very fat, with 3 being ideal).
[4] Probability, $P > 0.10$.
[5] Pig body condition score (1 = emaciated, 2 = thin, and 3 = full-bodied).
[abcd] Within a row, means without a common superscript differ ($P < 0.05$).

Table 2. Effect of litter size on piglet growth performance preweaning[1]

Item	Total born category[2] ≤ 11		12 to 14		≥ 15		SEM	Probability, P <
Litters, no.	73		77		45			
Pigs, no.	644		903		657			
Birth weight, lb	3.36^{a}		3.34^{ab}		3.31^{b}		0.02	0.04
Sow BCS post-farrowing[3]	2.96^{a}		3.01^{a}		3.10^{b}		0.05	0.0001
Litter total born	9.4^{a}		13.0^{b}		16.6^{c}		0.1	0.0001
Litter live born	8.8^{a}		12.0^{b}		14.8^{c}		0.1	0.0001
By birth weight category	% of litter	no./litter	% of litter	no./litter	% of litter	no./litter		
≤ 2.3 lb	8	0.7	11	1.3	13	1.9		
2.4 to 3.3 lb	26	2.3	41	4.9	40	6.0		
3.4 to 4.3 lb	39	3.4	37	4.4	41	6.1		
≥ 4.4 lb	27	2.4	11	1.3	6	0.9		
Litter born dead	0.6^{a}		1.0^{b}		1.8^{c}		0.1	0.0001
Preweaning ADG, lb	0.51^{a}		0.50^{b}		0.50^{b}		0.01	0.04
Weaning wt, lb	16.3^{a}		15.9^{b}		15.8^{b}		0.2	0.03
Pig BCS at weaning[4]	2.86		2.84		2.85		0.02	---[5]
Preweaning mortality, %	8.6^{a}		12.6^{b}		11.5^{ab}		1.6	0.07

[1] A total of 2,204 pigs were used to evaluate the effect of the size of the litter of origin on preweaning performance of pigs. Pigs were weaned at approximately 25 d of age, and weaning age was used as a covariate in data analysis.
[2] Results are reported as least squares means.
[3] Sow body condition score (1 = very thin to 5 = very fat, with 3 being ideal).
[4] Pig body condition score (1 = emaciated, 2 = thin, and 3 = full-bodied).
[5] Probability, $P > 0.10$.
[abc] Within a row, means without a common superscript differ ($P < 0.05$).

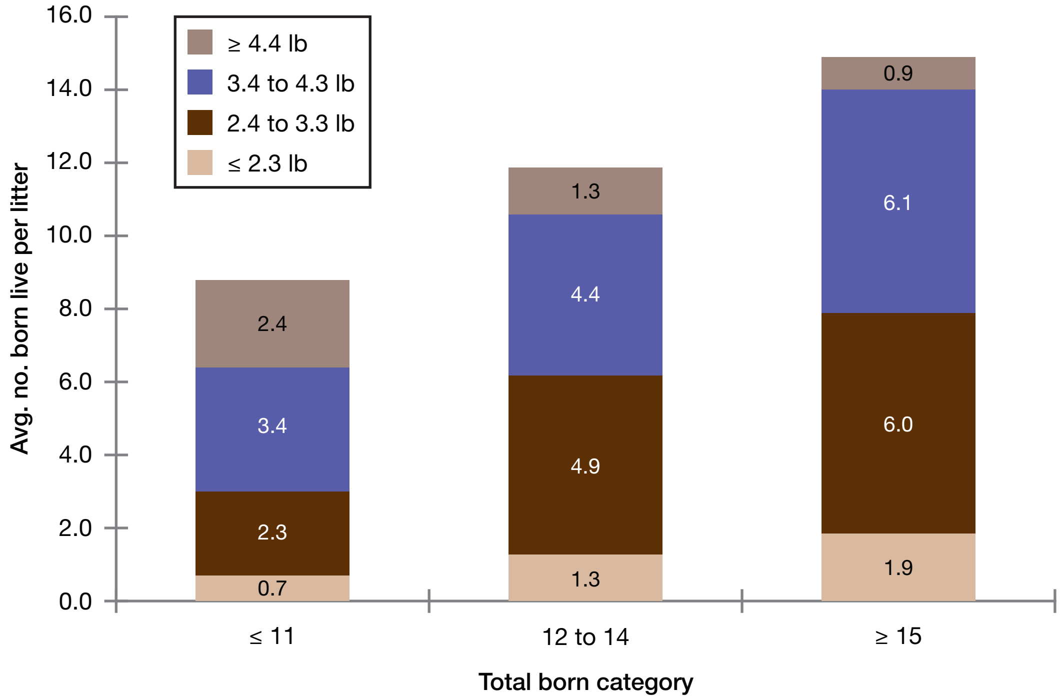

Figure 1. Relationship between total born and number of live pigs born within each birth weight category.

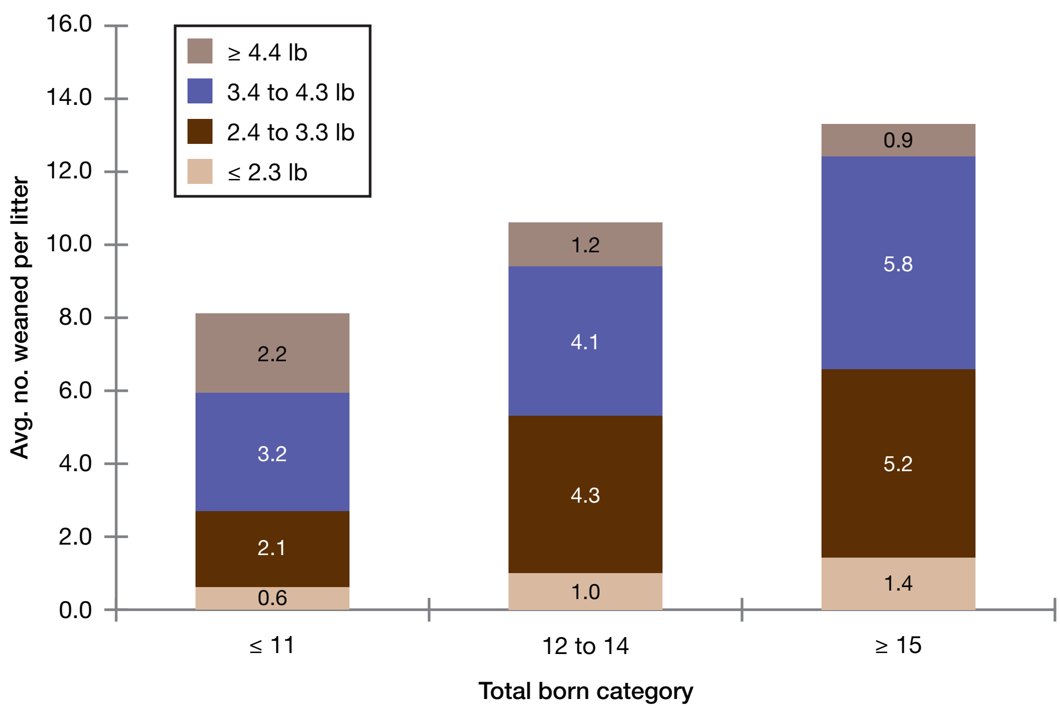

Figure 2. Relationship between total born and number of pigs weaned from each birth weight category.