Parity differences in reproductive performance and progeny performance

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Introduction

Culling rate and parity structure of a sow herd have long been discussed; however there are still numerous methods and protocols utilized throughout the industry based on a variety of theories. There is no single system that is guaranteed to work in every production system. Understanding the differences in reproductive performance of sows and the performance of their progeny by dam parity is important when making decisions on genetics, management protocols, culling practices and parity structure needed to meet production goals and maximize the return from a system. The objectives of this study were to evaluate differences in reproductive performance of sows, the performance of individual market progeny, and mortality based on dam parity.

Materials and methods

Parity records (n = 24,335) from F1 (Yorkshire x Landrace and Landrace x Yorkshire) females which farrowed from January 2008 through September 2013 were used to evaluate differences in reproductive performance by parity. The average parity of sows in the study was 3.4 ± 2.0, but ranged from parity 1 through parity 11 with an average lactation length of 19.0 ± 2.3 days. Parity differences were estimated for number born alive (NBA), total born (TB), number of pigs nursed after transfer (NAT), average piglet birth weight (ABW), number of pigs weaned (NW), 21-day litter weaning weight (LWW), and wean-to-service interval (WTSI). Prior to evaluation, litter weaning weight was adjusted to a 21-day lactation length and to a litter size of 12 pigs nursed. Parity differences were estimated with mixed models (HPMIXED procedure in SAS 9.3) which included parity group (PG) as a fixed effect. Initial analysis included parity as a fixed effect; however, due to limited observations and no significant statistical differences ($P > 0.05$) in reproductive performance beyond parity 8 the final model included 8 categories for the effect of parity: PG 1, 2, 3, 4, 5, 6, 7, and ≥ 8. Differences were evaluated by comparing by least squares means between each PG.

Data from a commercial testing program, which identifies sires and maternal lines that produce progeny that excel in a commercial environment, was used to evaluate the differences of progeny performance between a dam's PG. Commercial F1 sows were single sire mated to a Duroc sire and all progeny were individually tagged at birth to insure an accurate and complete pedigree. Prior to marketing, each pig was individually performance tested, and since 2011 17,959 fully pedigreed market pigs have been tested. Animals were tested at approximately 169.5 ± 7.8 days of age and weight (245.2 ± 25.8 pounds), backfat depth at the 10^{th} rib (0.74 ± 0.19 inches), and loin depth at the 10^{th} rib (2.25 ± 0.20 inches) were recorded on each animal. Growth was expressed as number of days to reach 250 pounds (DAYS) using regression formulas recommend by the National Swine Improvement Federation. Mixed models (HPMIXED procedure in SAS 9.3) were used to evaluate parity differences in progeny performance by including PG as a fixed effect, and differences in performance were evaluated by comparing least squares means. Due to limited observations after parity 8 and no significant statistical differences ($P > 0.05$) in progeny performance the final model included 8 categories for the effect of PG.

In the commercial testing program mortality was recorded for the individually identified animal and the age of that animal was also recorded. Since the beginning of the commercial testing program 2,681 animals had died prior to a performance test. Seventy-three percent of all mortalities occurred prior to weaning. The effect of sow parity on progeny mortality was evaluated using logistic regression (GLIMMIX procedure in SAS). Survival was evaluated separately as pre-weaning survival and survival to market. Pre-weaning survival and survival to market were classified and evaluated as binary events (0 or 1), survived or did not survive. Parity differences for the likelihood of a pig surviving through weaning and through market were reported as odds ratios.

Results and discussion

One of the most significant debates on longevity and parity structure within a herd is founded on the genetic progress that is made each generation and the improved genetic potential of new gilts entering the herd. It is true that a gilt brought into the herd should have higher genetic potential than the current sow herd due to selection at the nucleus. However, heritability for reproductive traits have been consistently reported as being very low, limiting the amount of genetic gain that can be realized[1]. It is critical to get as much genetic improvement introduced to your sow herd, however only if it does not impede the overall production of the herd.

In the present study, significant differences in reproductive performance, progeny performance, and progeny survival were estimated between each PG. Least squares means for reproductive performance are presented in Table 1.

Table 1. Least squares means for reproductive performance by parity in PureTek Generator sows

	Parity Group[x]							
Trait[y]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
N	5,340	4,555	3,904	3,343	2,859	2,324	1,372	638
NBA	11.70 ± 0.04[a]	11.85 ± 0.04[b]	12.49 ± 0.05[c]	12.90 ± 0.05[d,e]	12.93 ± 0.05[e]	12.78 ± 0.06[d]	12.43 ± 0.08[c]	11.80 ± 0.12[a,b]
TB	12.16 ± 0.04[a]	12.32 ± 0.04[b]	12.97 ± 0.05[d]	13.50 ± 0.05[f]	13.66 ± 0.05[g]	13.63 ± 0.06[g]	13.30 ± 0.08[e]	12.85 ± 0.12[c]
NAT	12.71 ± 0.02[d]	12.85 ± 0.02[e]	12.82 ± 0.02[e]	12.73 ± 0.03[d]	12.61 ± 0.03[c]	12.59 ± 0.03[c]	12.42 ± 0.04[b]	12.26 ± 0.06[a]
ABW	3.29 ± 0.01[a]	3.62 ± 0.01[g]	3.63 ± 0.01[g]	3.56 ± 0.01[f]	3.48 ± 0.01[e]	3.44 ± 0.01[d]	3.39 ± 0.01[c]	3.35 ± 0.01[b]
NW	11.72 ± 0.02[f]	11.82 ± 0.03[g]	11.71 ± 0.03[f]	11.63 ± 0.03[e]	11.50 ± 0.03[d]	11.42 ± 0.03[c]	11.30 ± 0.04[b]	11.05 ± 0.05[a]
LWW	161.6 ± 0.3[a]	176.3 ± 0.4[f]	175.5 ± 0.4[f]	173.9 ± 0.4[e]	171.9 ± 0.5[d]	169.0 ± 0.5[c]	168.9 ± 0.6[c]	164.1 ± 1.0[b]
WTSI	8.0 ± 0.9[c]	6.3 ± 0.9[b]	5.1 ± 0.9[a]	4.8 ± 0.9[a]	4.7 ± 0.9[a]	4.5 ± 0.9[a]	4.5 ± 0.9[a]	4.5 ± 0.9[a]

[a-g] Least squares means, within a row, with different superscripts were significantly different (*P* < 0.05).

[x] Parity group: Due to limited observations from sows of parity 8 or greater, those were consolidated into one parity group (8). Parity groups 1 through 7 are equivalent to their observed parity.

[y] N: number of parity records; NBA: number born alive; TB: total born; NAT: number of pigs nursing after transfer; ABW: average piglet birth weight; NW: number weaned; LWW: adjusted 21-day litter weight; WTSI: wean-to-service interval.

Number born alive and TB were smallest in first parity sows and steadily increased through PG 5 and then slowly started to decline. Twenty-one day litter weaning weight was also significantly lower in PG 1 sows, and was nearly 15 pounds heavier in PG 2 sows and over 10 pounds heavier in PG 5 sows. Wean-to-service interval was highest in PG 1 sows and significantly decreased as PG increased. The reduction in WTSI of nearly two days between PG 1 and PG 2 sows was the largest change and once sows reach PG 3 or older WTSI was up to 3.5 days shorter than it was in PG 1 sows, reducing farrowing interval and maximizing litters/sow/year. Sows are continually maturing throughout their productive life and do not reach mature size until parity 6 thus it makes sense that as sows continue to mature their productivity continues to increase and peak performance will occur later in a sow's lifetime[2].

Number weaned was higher in the first 3 PGs, but was a function of the farm's cross-fostering program which allotted more pigs to be fostered to younger sows (PG1 through PG4) than older animals. The ability of sows in the population used in this study to wean a high number of pigs is consistent throughout a sow's lifetime, but is highly dependent on the number pigs the sow is allowed to nurse.

Average birth weight was lightest in PG 1 sows and was highest in PG 2 and PG 3 sows. There was a slight reduction in ABW as sows continued to mature, but ABW was still significantly higher than PG 1 sows in each PG through PG 8. Piglet birth weight is vital to future performance of that pig and a reduction in individual piglet birth weight has been associated with poorer pig quality, higher mortality rates, fewer full value pigs at market, fatter, and lighter muscled pigs at market[3]. Retaining mature sows should significantly boost reproductive performance and produce more quality pigs for a system.

Progeny performance was also significantly affected by the dam's PG (Table 2). Pigs farrowed by PG 1 dams were fatter and lighter muscled than pigs farrowed by PG 2 through PG 6 dams. Pigs farrowed by PG 1 dams also took significantly longer to reach 250 pounds than progeny of PG 2 through PG 7 dams. Pigs farrowed by PG 1 dams have lighter birth weights, which have generally been associated with poorer performance through market, but pigs that are farrowed by PG 1 dams also have reduced immunity levels which make them more susceptible to disease which can negatively affect performance[4]. The difference in performance and health status of these pigs has been the foundation for parity segregation. However, logistics of parity segregation are not always possible thus increasing the benefits of retaining mature sows in the herd when possible.

Table 2. Least squares means for grow-finish performance of commercial progeny by dam parity

	Parity Group[x]							
Trait[y]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
N	2,826	3,102	3,099	2,654	2,405	1,728	1,146	999
BF	0.75 ± 0.02[c]	0.74 ± 0.02[b,c]	0.72 ± 0.02[a]	0.72 ± 0.02[a]	0.72 ± 0.02[a]	0.74 ± 0.02[b]	0.74 ± 0.02[b,c]	0.74 ± 0.02[b,c]
LD	2.25 ± 0.02[a]	2.27 ± 0.02[b]	2.28 ± 0.02[c]	2.29 ± 0.02[c]	2.28 ± 0.02[b,c]	2.28 ± 0.02[c]	2.26 ± 0.02[a,b,c]	2.25 ± 0.02[a,b]
DAYS	177.2 ± 1.8[d]	171.6 ± 1.8[a]	173.4 ± 1.8[b]	172.6 ± 1.8[a,b]	173.4 ± 1.9[b]	175.2 ± 1.9[c]	175.4 ± 1.9[c]	177.5 ± 1.9[d]

[a-d] Least squares means, within a row, with different superscripts were significantly different (*P* < 0.05).
[x] Parity group: Due to limited observations of progeny from sows of parity 8 or greater, those were consolidated into one parity group (8). Parity groups 1 through 7 are equivalent to their observed parity.
[y] N: number of progeny records; BF: backfat depth measured at the 10th rib (inches); LD: loin depth measured at the 10th rib (inches); DAYS: Number of days needed to reach 250 pounds.

In the present study, pre-weaning survival and survival through marketing were evaluated as binary traits and the likelihood of an animal surviving each phase of production are reported as odds ratios. Odds of a pig surviving to weaning were 1.41, 1.21, 1.18, and 1.12 times higher ($P < 0.05$) for pigs farrowed by PG 2, 3, 4, and 5 dams, respectively, than pigs sired by PG 1 dams. Reasons for mortality were not identified but differences in mortality were likely due to lower birth weight, poorer immunity levels, or the inability of PG 1 sows to provide enough nutrients to their litter. A similar trend was seen in mortality rates post weaning. Odds of a pig farrowed by PG 2, 3, 4, and 5 dams, respectively, surviving to the time of a performance test were 1.39, 1.18, 1.12, and 1.15 higher ($P < 0.05$) compared to pigs farrowed by PG 1 dams.

Summary

The results from the present study have indicated that there is a significant drop in reproductive performance, progeny performance, and survivability of progeny between PG 1 sows and mature sows that are retained in the herd. A gilt generally needs to produce at least three litters before she has out produced her initial cost, but replacement rates have steadily remained around 50 % on an annual basis[5]. Though culling is inevitable and gilts must be introduced into a sow herd, a herd turnover of 50% per year could significantly reduce a system's production. Voluntarily culling sows prior to parity 5 or 6 limits the productivity of the system by culling sows prior to reaching peak performance and replacing them with gilts that have significantly poorer reproductive performance, reduced progeny performance, and progeny with reduced odds of surviving to market. There is balance between genetic progress and system productivity that needs to be evaluated within each system. By maintaining a parity structure that retains mature sows, a system allows sows to reach peak perform. Retaining mature sows also provides the system with an opportunity to reduce the initial investment in replacement gilts, maximize reproductive performance, and maximize throughput across an entire system. Identifying maternal lines with the genetic capacity to remain in the herd, reach peak performance, and maximize a system's performance remains a critical decision for every system.

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