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Using first and second parity number born alive information to estimate later reproductive performance in sows

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ABSTRACT

The study objectives were to compare the lifetime performance of sows based on number of piglets born alive (**NBA**) and NBA across parities, according to 3 NBA classifications in first and second parity. The data used for this study were collected from 2001 to 2014 at 17 farms owned by the same company. Farms were located in the Mid-West region of the United States. A total of 502,491 records accounting for the lifetime performance of 105,719 sows were used in this analysis. Data included both purebred and crossbred sow information. Sows were classified into 3 NBA categories (e.g., low, medium, and high) according to the 25th percentiles of NBA in parity 1 and parity 2. Parity 1 classifications: low < 10 NBA, medium 10–12 NBA, high > 12 NBA. Parity 2 classifications: low < 11 NBA, medium 11–13 NBA, high > 13 NBA. Mixed model analyses were applied to the data. Sows in the low first and second parity NBA classification had an average of 1–1.8 less NBA per parity in parities 3 through 7, when compared with sows in the medium and high NBA classifications, respectively ($P < 0.05$). Conversely, sows classified as high NBA in parity 1 and parity 2 had greater NBA in all subsequent parities as well as total lifetime NBA when compared with sows classified as low or medium NBA ($P < 0.05$). The effect that parity 2 classification has on estimated later parity performance is dependent on parity 1 classification (P-interaction < 0.05). The interaction between classification was also seen when predicting total lifetime NBA. As parity 1 classification increased, the difference between estimates of high versus low parity 2 NBA classification sows became smaller. For example, with the removal parity of 7, the difference between a high versus low classified sow in parity 2, both with a parity one classification of low, was 10.3 lifetime NBA. The difference between high versus low parity 2 classified sows that were both high in parity one was 8.6 lifetime NBA. It was shown that parity 1 and 2 classification only had a small effect on the parity of removal. Overall, it was demonstrated that the use of first and second parity performance, based on number born alive, can be used effectively to predict subsequent parity and lifetime performance which can aid in selection and culling decisions early in the sow's life.

1. Introduction

The ability to assess sow performance at first and second parity is necessary when making selection and culling decisions for the breeding herd, as early performance of the sow has been shown to be indicative of later lifetime performance and sow retention in the breeding herd (Andersson et al., 2016; Hoving et al., 2011; Iida and Koketsu, 2015; Sasaki and Koketsu, 2008). For example, sows with 9–16 total piglets born in parity 1, are more likely to stay in the breeding herd until at least their 4th parity in comparison to sows who had less than 8 or greater than 17 piglets in their first parity (Andersson et al., 2016). The classification of parity 1 and parity 2 dams as low, medium, or high for reproductive traits can give producers a consistent means to predict later parity performance for sows (Hoving et al., 2011; Iida and Koketsu, 2015; Sasaki and Koketsu, 2008) even though the repeatability of number of piglets born alive (NBA) is considered to be low (Dube et al., 2012). There are additional factors that may influence first parity performance beyond the sow's genetic potential that are not as prevalent in later parities, such as an increased sensitivity to seasonal effects (Tummaruk et al., 2010). Adding additional performance records, such as parity 2 records, improves the accuracy of the prediction for future parities (Mrode, 2014).

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Studies conducted in Europe and Japan have shown that sows with a high number born alive in parity 1 have subsequent litters with a higher than average number born alive as well (Iida and Koketsu, 2015; Iida et al., 2015; Sasaki and Koketsu, 2008). This can be directly tied to sow longevity and retention in the herd as it has been shown that high lifetime performance is associated with superior sow longevity (Sasaki and Koketsu, 2008). It has also been demonstrated that sow retention in the breeding herd can be increased by selecting for highly prolific sows (Serenius, 2004), and the early indicator trait of number born alive within each parity was specifically shown to be useful when predicting sow longevity (Engblom et al., 2015).

Therefore, the objectives of this study were to compare the lifetime performance of sows and number of piglets born alive across parities, according to 3 NBA classifications in parity 1 and 2.

2. Methods and materials

Animal Care and Use Committee approval was not obtained for this study because the data used for this analysis were obtained from a private company's existing database.

2.1. Performance data and data exclusion criteria

Data editing and categorization was conducted in R (R Core Team, 2015). Data were collected over a 13-year span (2001–2014) at 17 farms located in the Mid-West region in the United States. Both purebred and crossbred sows were included in the dataset, the purebred sows were primarily comprised of maternal lines, and the crossbred sows were F1 maternal breed crosses. Sows were housed in gestation stalls and gestating gilts were housed in groups. The average farm size was 4400 sows, with in the smallest farm totaling 1800 sows, and the largest farm containing 6000 sows. Data editing was performed to ensure data were within normal physiological ranges and free from recording errors. Outlier records were removed and any sow that did not have complete lifetime performance records was not included in the analysis. Individual records were considered outliers and removed from the data set if they were ± 3 standard deviations from the mean for any of the following traits at each parity: NBA, number of piglets weaned, total piglets born, number of stillborn piglets, wean to first service interval, and weaning age. Records greater than parity 10 were removed due to the small number of records in those high parities. The Shapiro test was used on the model residual information as well as the examination of the normal plot to evaluate the dataset for normal distribution. The final data set included 502,491 records accounting for lifetime performance of 105,719 sows.

2.2. Categorization according to NBA in parity 1 and parity 2

Sows were classified into low, medium, and high NBA categories according to the NBA in parity 1 and parity 2. Sows were classified in these groups based on the lower and upper NBA 25th percentiles (Iida and Koketsu, 2015; Sasaki and Koketsu, 2008;). For parity 1, the low NBA group was classified as less than 10 piglets born alive, medium NBA was classified as 10 through 12 piglets born alive, and high NBA was classified as greater than 12 piglets born alive. The subsequent percentage of sows per group was 23.7%, 43.6%, and 32.6% respectively. The same procedure was used to classify sows in parity 2 according to NBA. The low NBA group was classified as less than 11 piglets born alive, the medium NBA group equated to 11 through 13 piglets born alive, and the high NBA group, greater than 13 piglets born alive. The respective percentages of sows in these groups were as follows, 29.9%, 42.8%, and 27.2%.

2.3. Statistical analysis

Statistical analyses were conducted using ASReml software (Gilmore et al., 2009). Three separate models were used.

Model 1: Model 1 was used to estimate NBA by parity, for parities 3 through 10. Parity 1 high (P1H), medium (P1M), and low (P1L) classifications were used as the fixed effect called P1HML, and parity 2 high (P2H), medium (P2M) and low (P2L) classifications were used as the fixed effect called P2HML. Other fixed effects included year at farrowing, parity, breed, wean to first service interval, farm, and the interaction of first and second parity classification. Wean to first service interval represents the time from when the sow's previous litter is weaned to the time of first service for her next litter. For example, if there was a 6 days window between weaning her third parity litter and being bred for her fourth parity, the wean to first service interval for her fourth parity is 6 days. All fixed effects were found to be significant sources of variation in the model ($P < 0.05$). Random effects included in the model were contemporary group (farm by year by season) as well as sow to account for the repeated records per sow. Season for which farrowing took place is defined by splitting the year into four seasons with Spring represented by March 1 to May 31, Summer represented by June 1 to August 31, Fall represented by September 1 to November 30, and Winter represented by December 1 to February 28. The random effects were removed from the model temporarily in order to calculate the adjusted model R2 value as a means to show if the effect of NBA classification improved the model more than what would be expected by chance. The correlation between NBA in first and second parity using the Pearson method was calculated.

Model 2: Model 2 was the model for total NBA throughout a sow's productive lifetime with ending parities of 3 through 10. Number of piglets born alive was summed across each sows lifetime to her end parity (3 through 10) and was used as the response variable in the model. Each sow only appeared in the analysis once as the response variable of total NBA was a lifetime measurement. This model was used to estimate lifetime total NBA at different cull parties as a means to show the difference between low and high producing sows in both parity 1 and 2. The analysis was conducted by parity of cull, with the fixed effects of breed, P1HML, P2HML, farm, and year of first parity were used. All fixed effects were significant sources of variation in the model ($P < 0.05$).

Model 3: Model 3 was used to model the effect of P1HML and P2HML on the parity a sow was removed from the herd. The response variable was the removal parity and the fixed effects used in the model included breed, farm, year of first parity, and the interaction between P1HML and P2HML. All effects were significant sources of variation in the model ($P < 0.05$).

3. Results and discussion

The threshold system used in this study has successfully been used in European herds to estimate later reproductive performance (Iida et al., 2015). The classifications used in this analysis estimated least squares means (**LSM**) by parity as well as lifetime average NBA and the values presented are specific to this system's sow herd.

For the base model used to evaluate NBA, fixed effects included parity, year, breed, farm, and wean to first service interval. The adjusted R-squared value was 0.04. By including P1HML into the model the adjusted R-squared increased to 0.16. By adding both P1HML and P2HML the adjusted R-squared value further increased to 0.22. With the addition of both P1HML and P2HML a difference of 0.18 can be realized in the adjusted R-squared value for the model used to predict NBA in parities 3 through 10. This indicated that including P1HML and P2HML improves that model more than what could be expected by chance or by only including P1HML.

Table 1 shows the percentage of sows that changed or remained in the same NBA classification between first and second parity. The percentage of sows that shared the same classification in first and second parity was approximately 40%, indicating that approximately 60% of sows did not share the same classification between parity 1 and