Preventive Veterinary Medicine 121 (2015) 108–114

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Number of pigs born alive in parity 1 sows associated with lifetime performance and removal hazard in high- or low-performing herds in Japan

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ARTICLE INFO

Article history:
Received 30 January 2015
Received in revised form 11 June 2015
Accepted 11 June 2015

Keywords:
Cohort study
Fertile sows
Hazard model
Multivariate model
Repeated measures

ABSTRACT

Reproductive performance, lifetime performance and removal hazard were studied in commercial herds in order to detect prolific sows at an early-stage. Reproductive performance measurements that we assessed were number of pigs born alive (PBA) per litter, weaning-to-first-mating interval and farrowing rate (FR). Lifetime performance measurements included lifetime average PBA and lifetime average nonproductive days. In total, 213,514 parity records and 47,024 lifetime records of 96 herds were included. Sows were categorized into three groups based on the lower and upper 25th percentiles of PBA in parity 1:8 pigs or fewer, 9–12 pigs and 13 pigs or more. The herds were classified into high- and low-performing herds on the basis of the 50th percentile of pigs weaned per mated female per year. To compare the measurements between the sow groups taking account for the herd productivity groups, multivariate and single response models were applied to reproductive performance from first-farrowing and lifetime performance, respectively. A hazard model was fitted to survival data. Sows having 13 or more PBA in parity 1 had 1.0–1.4 more PBA per litter in all subsequent parities ($P<0.05$), 1.2–1.5% higher FR in parities 2–4 ($P<0.05$) and 3.4–3.7 higher lifetime average PBA than sows having 8 or lower PBA ($P<0.01$). However, there were no differences between the sow groups for weaning-to-first-mating interval in any parity ($P>0.05$). There were two-way interactions between the sow and herd groups for FR in parity 2 ($P=0.01$) and lifetime average nonproductive days ($P=0.046$). In low-performing herds, sows having 13 or more PBA in parity 1 had 3.9% higher FR at their next farrowings than sows having 8 or fewer PBA ($P<0.05$), although no such difference was found for high-performing herds ($P>0.05$). Sows in the low-performing herds with 13 or more PBA in parity 1 also had 2.3 fewer lifetime average nonproductive days than sows having 8 or fewer PBA ($P=0.01$), although again no similar difference was found for high-performing herds ($P=0.96$). The removal hazards for sows having 13 or more PBA in parity 1 were lower than those for sows having 8 or fewer PBA ($P<0.01$), with no difference in hazards between the herd groups ($P=0.62$). In conclusion, PBA in parity 1 may help predict a prolific sow or low PBA sow.

1. Introduction

Over the last two decades selective breeding has substantially improved reproductive performance of sows (Tarrés et al., 2006). However, there is still relatively large variation in reproductive performance between sows within and between herds (Iida et al., 2014). Thus, when producers need to make decisions about keeping or culling sows, it would be useful if they could predict at an early-stage which sows will have high reproductive performance across parity and have high longevity.

The number of pigs born alive (PBA) in parity 1 is an important reproductive predictor; recent American and EU studies have shown that sows with high PBA in parity 1 continued to have high PBA in subsequent parities, and consequently had high lifetime PBA (Pinilla et al., 2014; Iida et al., 2015). High lifetime performance of sows is also associated with high longevity (Sasaki et al., 2008). Therefore, these results suggest that sow lifetime performance, removal hazard and removal patterns could be predicted by differences in PBA in parity 1. Furthermore, lifetime performance and sow removal are also associated with herd reproductive productivity (Sasaki and Koketsu, 2011), because high-performing herds typically have better management systems and practices with improved genetics than low-performing herds. However, no study has examined how herd groups based on herd productiv-

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http://dx.doi.org/10.1016/j.prevetmed.2015.06.012
0167-5877/

ity interact with sows having high or low PBA in parity 1 for reproductive performance across parity, lifetime performance and removal hazard. Equally, no studies have quantified the relative importance of PBA in parity 1 and herd productivity groups for lifetime measurements, which can be estimated by the proportions of the variance explained by those variables out of the total variance (Larriestra et al., 2005). Therefore, the objectives of the present study were 1) to compare reproductive performance across parity, lifetime performance, removal hazard and patterns in three sow groups, categorized by PBA in parity 1, and two herd productivity groups, and 2) to examine relative importance of the sow and herd groups for lifetime performance using the proportions of the variance explained by these groups.

2. Materials and methods

2.1. Herds

Pig producers in the 108 Japanese breeding herds that use the PigCHAMP recording system (PigCHAMP, Ames, IA, USA) were requested to mail their data files to Meiji University in 2011. By August 31, 2011, data files were received from 101 breeding herds (93.5%). Of the 101 herds, five were excluded from the present study: two were producing only purebred pigs and three did not record birth dates of females.

The remaining 96 commercial breeding herds (two farrow-to-wean and 94 farrow-to-finish operations) were located throughout Japan from Northern to Southern areas. Ninety of the herds (94.0%) used artificial insemination for both gilts and sows. No group housing or outdoor farrowing was practiced in these herds. Additionally, a previous questionnaire survey reported that 39% of these herds performed farrowing induction, 34% of sows were supervised during the farrowing, and 95% of the herds performed cross-fostering (Ichikawa et al., 2012). Lactation and gestation diets were formulated using imported corn and soybean meal. Females in the herds were mainly crossbreds between Landrace and Large White, which were either purchased replacement gilts from national or international breeding companies, or were replacement gilts home-produced through internal multiplication programs. The breeding stocks in the national breeding companies were originally imported from the USA or Europe during the latter half of the 20th century, and have been improved in Japan.

2.2. Data and exclusion criteria

Data for females entered into the herds from 2005 to 2007 were extracted from the PigCHAMP recording system. This included female data from 2005 to 2010 because females lived for up to 3 years in the herds. The initial dataset contained lifetime records and parity records of 57,790 females. When the data were collected, 1132 (2.0%) of the females had not yet been removed, and so they were excluded. Also, females were excluded if they were removed before first-farrowing (5546 females), or if gilt age at first-mating was less than 160 days or more than 400 days (3166 females; Hoving et al., 2011), weaning-to-first-mating interval (WMI) was over 60 days (862 females; Marois et al., 2000) or there with zero total number of pigs born (60 females). In addition, parity records of sows in parity 7 or higher were omitted (26,879 parity records) because large numbers of sows were voluntarily culled before reaching the seventh parity (Sasaki and Koketsu, 2011) in most of the herds in the present study. Hence, the final data included 47,024 lifetime records and 213,514 parity records of females that had farrowed at least once. Additionally, the following records were regarded as missing values: parity records with no lactation length recorded, those showing 19 or more pigs weaned (mean + 3 × SD; Bloemhof et al., 2013) and showing litter weights at weaning of either less than or equal to 14.7 kg, or greater than or equal to 112.7 kg (mean ± 3 × SD).

2.3. Definitions and categories

The reproductive performance measurements that we examined were PBA per litter, pigs weaned, litter weight at weaning, WMI and first-service farrowing rate (FR). The lifetime performance measurements were lifetime average PBA, lifetime average pigs weaned, lifetime average nonproductive days, removal interval and number of parities at removal. These were defined as follows: lifetime average PBA is the sum of PBA in a sow's lifetime divided by the number of parities at removal; lifetime average pigs weaned is the sum of pigs weaned in a sow's lifetime divided by the number of parities at removal; lifetime average nonproductive days is lifetime nonproductive days divided by the number of parities at removal. Lifetime nonproductive days is the number of days when sows were neither gestating nor lactating from date of first-farrowing to removal date. Removal interval was defined as the number of days between weaning at last parity and removal. In this study, sows with no record of weaning date at last parity were treated as sows with no removal intervals (41 females).

Type of removal included culling, death, euthanasia and transferring a sow to another herd. Also, reasons for culling were categorized into four groups based on a previous study: litter performance, old age, reproductive failure and miscellaneous (Sasaki et al., 2008).

Sows were categorized into three sow groups based on the lower and upper 25th percentiles of PBA in parity 1: the groups were 8 pigs or fewer (PBA8G), 9–12 pigs (PBA9-12G) and 13 pigs or more (PBA13G). Also, herds were classified into two herd productivity groups on the basis of the 50th percentile of pigs weaned per mated female per year (22.5 pigs): high- (mean ± SEM = 24.0 ± 0.13 pigs; maximum = 26.1 pigs) and low-performing herds (mean ± SEM = 20.9 ± 0.18 pigs; minimum = 16.5 pigs). The 50th percentile was chosen in order to ensure that all groups (2 × 3 sow groups in 6 parities) had sufficient numbers of females. Using these two categories, we classified sows in two different ways because PBA is a biological measurement for sow's prolific potential, and pigs weaned per mated female per year is a measurement for herd productivity and management in breeding herds (Sasaki and Koketsu, 2011). Mean herd sizes for high- and low-performing herds were 543 ± 102.1 (range = 49–3618 females) and 324 ± 58.3 females (range = 61–2805 females), respectively. These herd measurements were abstracted from the 96 herd data files, for six 1-year periods from 2005 to 2010.

2.4. Statistical analysis

Descriptive statistics were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA). Comparisons between the sow groups and between the herd groups were performed for PBA in parity 1 in a multivariable model with a random herd effect by using MIXED procedure in SAS.

Multivariate response models were applied to repeated measures data for each female, i.e. reproductive performance data from first-farrowing, using MLwiN version 2.31 (University of Bristol, Bristol, UK). Multivariate normal response models were applied to PBA per litter in parities 2, 3, 4, 5 and 6, pigs weaned and litter weight at weaning in parities 1, 2, 3, 4, 5 and 6. Also, for sows in parities 1, 2, 3, 4, 5 and 6, multivariate Poisson and binary response models were applied to WMI and FR at their next farrowings, respectively. Extra-Poisson and binomial parameters were also introduced into the model to estimate an under or over-dispersion parameter. These models included the following variables as fixed