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Original article

Factors affecting length of productive life and lifetime production traits in a commercial swine herd in Northern Thailand

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ABSTRACT

The length of productive life (LPL) and lifetime production traits are economically important in commercial swine production systems. This study investigated factors that may influence the LPL and lifetime production traits of sows in a commercial swine population in Thailand. The dataset consisted of information from 2768 sows that had their first farrowing from 1989 to 2012. Three breed groups of sows were represented: 122 Duroc, 1944 Landrace and 702 Yorkshire. The traits analyzed were the LPL, lifetime piglets born alive (LBA), lifetime piglets weaned (LPW), lifetime piglets birth weight (LBW) and lifetime piglets weaning weight (LWW). The model consisted of year-season of first farrowing, breed group and age at first farrowing as fixed effects and the residual as a random effect. Year-season of first farrowing was an important source of variation for all traits ($p < 0.0001$). Yorkshire sows had the longest LPL ($p < 0.05$) and the highest LPW ($p < 0.05$) of all sow breed groups, whereas Duroc sows had the lowest least squares means for all traits. Landrace and Yorkshire sows had similar LBA, LBW and LWW. Thus, Yorkshire sows had the highest production efficiency (the longest LPL and highest LPW) of the three breed groups in this population. Age at first farrowing was negatively associated with LPL, LBA, LPW, LBW and LWW. The favorable association between age at first farrowing with LPL and LPW could be used to increase the efficiency of swine production in this population.

Introduction

Duroc, Landrace and Yorkshire sows are important breeds for producing crossbred gilts to supply commercial swine operations in Thailand where the replacement rate in a commercial swine herd ranges from 25 to 50% per year (Keonouchanh, 2002; Engblom et al., 2007). Usual reasons for removing sows from the herd are reproductive problems, old age and disease (Stalder et al., 2004). Approximately 15%–20% of the sows are culled after the first parity and more than 50% are culled before their fifth parity (Lucia et al., 2000; Engblom et al., 2007). Unfortunately, high replacement rates increase costs of production. The current level of economic competition in Thailand has stimulated swine producers to aim at having large numbers of sows with high production and reproduction efficiency. Thus, selection of sows for production efficiency is important for commercial swine enterprises because it is positively associated with herd productivity and profitability.

The length of productive life (LPL; the number of days between sow age at first farrowing and sow age at weaning of her last farrowing) and lifetime production traits (the sum of all individual measurements of each trait during the lifetime of a sow) are very important for the profitability of swine production systems because of their association with stayability, productivity and the cost of production. Increasing a sow's LPL results in higher sow lifetime productivity and lower gilt replacement costs. Shorter sow LPL values result in lower sow lifetime productivity and higher replacement costs. Thus, if commercial swine producers could control the proportion of sows in the herd with long LPL, their operations would be more competitive and profitable.

The LPL of sows depend on a variety of genetic and environmental factors (for example, sow biology, breed composition, season, management, housing, nutrition, age at first farrowing; Koketsu et al., 1999; Tummaruk et al., 2000; Yazdi et al., 2000a; Engblom et al., 2008; Serenius et al., 2008). In particular, younger

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ages at first farrowing were found to be favorable to the LPL (Engblom et al., 2008; Serenius et al., 2008) and to lifetime production traits (Koketsu et al., 1999; Yazdi et al., 2000a). To improve the LPL and associated lifetime production traits, producers will need to know the factors (genetic and non-genetic) that significantly affect LPL traits in their population. Thus, the objective of this study was to characterize factors affecting the LPL and lifetime production traits of sows raised in a commercial swine population under tropical conditions in Northern Thailand.

Materials and methods

Data, animals and traits

Data were collected from a commercial swine population in Northern Thailand (Chiang Mai province). The dataset consisted of production records from 122 Duroc, 1944 Landrace and 702 Yorkshire sows that had their first farrowing from July 1989 to December 2012. Records consisted of sow identification number, sire, dam, breed group, parity, birth date, farrowing date, weaning date, age at first farrowing (AFF), length of productive life (LPL), lifetime piglets born alive (LBA), lifetime piglets weaned (LPW), lifetime piglets birth weight (LBW) and lifetime piglets weaning weight (LWW). Contemporary groups were defined as year-season of first farrowing. The LPL was defined as the number of days between the age of a sow at first farrowing and the age at weaning of her last farrowing.

Only sows that had their first parity record, known farrowing date for each parity and no missing parities were considered for analysis. Cross-fostering and incomplete records were eliminated from the dataset. All sows had completed their productive life and had been removed from the production system. Sows with extreme values for age at first farrowing (250 d or less and 520 d or more) were removed from the dataset. Seasons were classified as winter (November to February), summer (March to June) and rainy (July to October). The number and percentage of records per parity were: 1 (267 records; 9.65%), 2 (349 records; 12.61%), 3 (291 records; 10.51%), 4 (231 records; 8.35%), 5 (279 records; 10.08%), 6 (299 records; 10.80%), 7 (415 records; 14.99%), 8 (303 records; 10.95%), 9 (202 records; 7.30%) and 10 (132 records; 4.77%). Age at first farrowing of sows ranged from 272 d to 519 d.

Nutrition and management

All gilts and sows received the same management, feeding and health care in an open-house system with foggers (gilts and non-lactating sows) or dippers (nursing sows) that were activated when the ambient temperature rose above 33 °C. Breeder boars were kept in a close-house system with an evaporative cooling system. Breeder sows were fed 2.50 kg feed/d (16% crude protein and 3200 to 3500 kcal/kg feed) divided into two feeding times (0700 hours and 1300 hours). Farrowing and nursing sows were fed 5.0–6.0 kg feed/d (16–17% crude protein and 4600 kcal/kg feed) split into four feeding times (0700 hours, 1000 hours, 1300 hours and 1500 hours).

Replacement gilts were selected based on their own phenotype, pedigree and estimated breeding value for production traits (total number of piglets born, number of piglets born alive, litter birth weight, number of piglets weaned and litter weaning weight) and growth traits (average daily gain, hip width, shoulder width, body length and number of nipples). Gilts were inseminated for the first time at age 8 to 9 mth or 140 kg of body weight. After mating, sows were moved to a farrowing building and kept in individual farrowing pens from mating until approximately 1 wk before parturition. Piglets were weaned at age 26–30 d (approximately 7 kg weight). When selected gilts and sows showed estrus, they were inseminated with semen from a boar chosen according to the same selection criteria used for gilts. Gilts and sows were inseminated twice with the same boar (12 h after detection of estrus and 12 h after the first insemination).

Statistical analysis

A fixed linear model was used to determine the importance of genetic and environmental factors affecting the LPL, LBA, LPW, LBW and LWW. The model included the fixed effects of first farrowing year-season, breed group (Duroc, Landrace and Yorkshire) and age at first farrowing as a covariate and residual as a random effect. Random residual effects were assumed to have mean equal to zero, common variance and be uncorrelated. The model can be described by Equation (1):

$$y_{ijk} = \mu + FYS_i + BG_j + b_1AFF + e_{ijk} \quad (1)$$

where y_{ijk} is a phenotypic observation for the LPL, LBA, LPW, LBW and LWW, μ is the population mean, FYS_i is the ith first farrowing year-season (i = 1 to 70), BG_j is the jth breed group of sow (j = 1 to 3; 1 = Duroc, 2 = Landrace and 3 = Yorkshire), AFF is the age at first farrowing in days, b_1 is the linear regression coefficient of the LPL, LBA, LPW, LBW and LWW on AFF and e_{ijk} is the random residual. The e_{ijk} were assumed to have mean zero and common variance σ_e^2. The expected value of y_{ijk} was equal to $\mu + FYS_i + BG_j + b_1AFF$, and the variance of y_{ijk} was equal to σ_e^2 for all y_{ijk}. Descriptive statistics (mean, SD, minimum, maximum) for the complete dataset were obtained using the MEANS procedure of the Statistical Analysis System (SAS, 2003). Least squares estimates of effects in the model were computed using the GLM procedure of SAS. Significant differences were considered at $\alpha = 0.05$. Least square means (LSM) for first farrowing year-seasons and breed groups were compared using a t test adjusted with a Bonferroni correction.

Results and discussion

The numbers of records, mean, SD, minimum and maximum values for each trait (LPL, LBA, LPW, LBW and LWW) in the complete dataset are presented in Table 1. The mean LPL for sows in this commercial population was shorter than those reported for two farms in Northeastern Thailand (807.59–883.58 d for farm 1 and 804.93–832.87 days for farm 2; Keonouchanh, 2002).

First farrowing year-season

The effect of first farrowing year-season was important for all traits ($p < 0.0001$). The LSM ranged from 144.96 ± 45.21 d (2012-rainy) to 1038.80 ± 149.41 d (1996-winter) for LPL, from 14.09 ± 3.25 piglets (2012-rainy) to 70.74 ± 11.81 piglets (1997-rainy) for LBA, from 11.80 ± 2.92 piglets (2012-rainy) to 64.90 ± 10.60 piglets (1997-rainy) for LPW, from 24.27 ± 5.17 kg (2012-rainy) to 104.92 ± 5.37 kg (2009-rainy) for LBW and from 88.51 ± 22.15 kg (2012-rainy) to 431.21 ± 22.75 kg (2009-rainy). Thus, variation in environmental conditions (climate, management, nutrition and health care) in this commercial farm during the years of this study markedly affected the least squares estimates of first farrowing year-season effects for all traits in this study.

These findings were in agreement with a previous study in Northeastern Thailand, where first farrowing year-season also significantly influenced LPL and lifetime sow productivity (Keonouchanh, 2002). Tummaruk et al. (2004) found that Landrace and Yorkshire sows that farrowed in the rainy season (August and September) tended to have a lower total number of piglets born and