Original research article

Reproductive Performance of Purebred and Crossbred Landrace and Large White Sows Raised under Thai Commercial Swine Herd

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Received 10 December 2016; Received in revised form 18 January 2017
Accepted 26 January 2017; Available online 30 June 2017

ABSTRACT

The reproductive data of a total of 27,783 sows from Landrace (L) of 2,016 heads (7,080 records), Large White (W) of 1,573 heads (6,016 records), and the crossbred sows between L x W of 1,581 heads (6,273 records) and W x L of 2,146 heads (8,414 records) were studied to investigate the influence of breed on reproductive performance of sows, including total piglets born (TPB), number of piglets born alive (NBA), stillbirth piglets (STB), mummified piglets (MUM), average birth weight (ABW) and average weaning weight (AWW). Breed, parity and year × season at farrowing were considered as fixed effects in a statistical model. Least Squares Means (LSM) for each subclass of breed were estimated and the different values of LSM were compared using the t-test method. The results found that breed, parity and year × season at farrowing significantly affected reproductive performance of sows in all studied traits ($p < 0.01$). The crossbred sows (L x W and W x L) had higher LSM for TPB, NBA, ABW and AWW than purebred sows (L and W) and had less STB than purebred sows ($p < 0.05$). For MUM, a small but significant difference was found in each breed (0.23 ± 0.01 to 0.32 ± 0.01 heads). The crossbred W x L had the highest LSM for TPB, NBA and AWW which implied that crossbred sow production using Landrace sows as dam line tends to have more piglets per litter and have higher weaning weight than Large White.

Keywords: Breed; Crossbred sow; Heterosis; Litter size; Piglet loss

Introduction

Reproduction of sows is one of the important indicators of profits of commercial swine farms. As the production cost has continued to rise, one way to help the commercial swine farms is to develop sustainability through increased potential of sows. The representative trait for reproductive performance of sows is the sum total of piglets born, number of live born piglets, number of weaned piglets, birth weight and weaning weight, as well as piglet loss traits such as number of stillbirth piglets and mummified piglets [1]. The breeds of sows are important factors that directly affect reproductive behavior, in addition to the other environmental factors such as parity, season at farrowing, gilt management, feed, lactation length and boar fertility [2-6]. Thus, the suitable selection program and mating strategy are necessary for improving reproduction of sows.

For many years, research has been conducted to investigate the efficiency of

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production of sows in several breeds, especially Landrace, Large White, Duroc, Hampshire and Pietrain under management of international farms both in tropical and winter zones [4, 6-9]. Landrace and Large White are chosen to produce fattening piglets the most. Currently, a crossing system is being applied to increase reproductive efficiency of sows in general swine farms, with the advantage of heterosis derived from crossing between breeds [10].

However, potential of sows may be different depending on condition and management of farms, as heterosis percentile may vary depending on the genetic differences between breeds. Therefore, the objective of this study was to compare the reproductive efficiency of sows between purebred Landrace, Large White and two other crossbred sows (Landrace x Large White and Large White x Landrace) under the tropical zone weather of Thailand. The results may be useful for selection and mating plans in order to produce great sows with high reproductive performance.

Materials and methods

Animal and management

A total of 7,315 sows (27,783 records) were used for this study, including purebred Landrace (L) of 2,016 heads (7,080 records), Large White (W) of 1,572 heads (6,016 records), crossbred L × W of 1,581 heads (6,273 records) and W × L of 2,146 heads (8,414 records). All sows were reared under the open house system of a commercial swine farm in Nakhon Ratchasima Province located in the northeastern region of Thailand and were fed under the same management throughout the study period.

Sows were fed twice a day (14% crude protein, 3,300 kcal ME/kg) at the amount of 4 to 5 kg/sow. After artificial insemination and sows were pregnant, the quantity of feed was changed depending on the stages of gestation. At 1 to 21 days post breeding, sows were fed with 1.8 to 2.3 kg/sow/day. At 22 to 84 days post breeding, feed was increased to 2.5 to 3 kg/sow/day, and in the last stage of pregnancy (85 to 110 days post breeding), 3 ± 0.5 kg/day of feed was served to the sows. A week prior to farrowing, the pregnant sows were moved to farrowing pens. During this period, feed was changed for lactating sows to include 16% crude protein (3,300 kcal ME/kg) and sows were fed 3 to 4 times per day. At the farrowing date, sows were not fed or fed 0.5 kg/sow/day. After being weaned, sows were fed with 5.5 ± 0.5 kg/sow/day and clean water.

Data collecting

Pedigree and individual reproductive performance of sows were collected during the period of January 2010 to November 2015. Pedigree data consist of animal ID, sire ID, dam ID, date of birth, and breed. For reproductive performance of sows, data included mating date, farrowing date, parity, number of total piglets born (TPB), number of piglets born alive (NBA), stillbirth piglets (STB), mummified piglets (MUM), average birth weight (ABW) and average weaning weight (AWW) at 3 weeks.

Statistical analysis

The complete dataset (27,783 records) was used to study data distribution and estimate descriptive statistics for reproduction traits using the Univariate and Means procedure of the statistical analysis system [11]. From data analysis, this population had approximately 4 parities. The average total piglets per litter and number of piglets born alive were 12.00 and 10.57 heads, respectively. At birth, piglets had an average body weight of 1.58 kg and 6.32 kg after weaned. Occurrences of stillbirth and mummified piglets were 5.45 and 2.45%, respectively (Table 1).

Table 1. Descriptive statistics (head/sow) for reproduction traits of sows in studied population.

Trait	Mean	Standard deviation	Minimum	Maximum
Number of total piglets born	12.00	2.99	1.00	24.00
Number of piglets born alive	10.57	2.61	1.00	21.00
Stillbirth piglets	0.65	1.07	0.00	11.00
Mummified piglets	0.29	0.73	0.00	14.00
Average birth weight (kg/piglet)	1.58	0.24	0.69	4.25
Average weaning weight (kg/piglet)	6.32	1.02	2.00	14.17

Breed of sows was tested to investigate the significant effect on reproductive traits at a reliability level of 0.05 using the general linear model which considered breed (L, W, L × W and W × L), parity (1, 2, 3, 4, 5, 6, 7, 8 and ≥ 9) and farrowing year × season as fixed effects and errors from other factors as random effects.

Year and season of sow farrowing was set as a contemporary group. There were 3 seasons according to the weather in Thailand, including hot (March to June), rainy (July to October) and cold (November to February). Least Squares Means (LSM) in each subclass of factors were estimated and compared by the t-test method using the GLM procedure of SAS [11]. Then heterosis percentage in crossbred sows was computed using the equation as follows:

$$\% \text{ Heterosis} = ((X - Y)/Y) \times 100$$

where, X is LSM for studied traits in crossbred sows and Y is LSM for studied traits in parent breed of crossbred sows on average.

Results and Discussion

Breed, parity and year × season at farrowing significantly affected all reproductive traits ($p < 0.01$). Sows in each breed had different reproductive efficiency as shown in Table 2. Crossbred W × L had the highest LSM for TPB (12.17 ± 0.05 heads), NBA (10.62 ± 0.04 heads) and AWW (6.33 ± 0.02 kg). Besides, LSM for ABW (1.61 ± 0.01 kg) of crossbred W × L was not significantly different from crossbred L × W (1.62 ± 0.01 kg) which had the highest ABW in this population. For piglet loss traits, sows in each breed had LSM for STB and MUM ranging from 0.65 ± 0.02 to 0.86 ± 0.02 and 0.23 ± 0.01 to 0.32 ± 0.01 heads, respectively. STB mostly occurred in purebred Landrace while MUM was mostly found in crossbred W × L.

The effect of breed on reproductive performance of sows in this study was fully in agreement with a previous report [12] which explored the significant effect of mating groups between Landrace and Yorkshire on litter size, number of piglets born alive, mummified piglets, stillborn piglets and litter weight born alive ($p < 0.01$). Also, it was in agreement with Knecht et al. who report the finding of significant breed effect on live born piglets, birth weight, and weaning weight of purebred and crossbred sows between Landrace and Large White in Poland [6]. While Tantasuparuk et al., who studied purebred Landrace and Yorkshire sows raised under Thai commercial farm conditions, found that breed difference affected total piglets per litter, number of live born piglets and average piglet birth weight ($p < 0.01$) but there was no significant difference in the number of stillborn piglets per litter [8]. These results confirmed the important role of breed on swine production. Although low heritability for reproduction traits (0.03 to 0.16) was reported in many countries [13-16] which showed a small effect of genetic variation on sow reproduction, it could not be ignored. Thus, breed selection for parent stock is necessary in order to increase the number of piglets per sow per year apart from farm management and environmental control.

Table 2. Least squares means ± standard error for reproductive performance of sow (head/sow) in each breed group.

Traits	**Breed**			
	L	**W**	**L × W**	**W × L**
Number of total piglets born	11.66 ± 0.05^{c}	11.58 ± 0.05^{c}	12.03 ± 0.05^{b}	12.17 ± 0.05^{a}
Number of piglets born alive	10.14 ± 0.04^{b}	10.03 ± 0.04^{c}	10.56 ± 0.04^{a}	10.62 ± 0.04^{a}
Stillbirth piglets	0.86 ± 0.02^{a}	0.85 ± 0.02^{a}	0.65 ± 0.02^{c}	0.69 ± 0.02^{b}
Mummified piglets	0.29 ± 0.01^{b}	0.23 ± 0.01^{c}	0.29 ± 0.01^{ab}	0.32 ± 0.01^{a}
Average birth weight (kg/piglet)	1.55 ± 0.01^{b}	1.53 ± 0.01^{c}	1.62 ± 0.01^{a}	1.61 ± 0.01^{a}
Average weaning weight (kg/piglet)	6.24 ± 0.02^{c}	5.99 ± 0.02^{d}	6.29 ± 0.02^{b}	6.33 ± 0.02^{a}

$^{a, b, c, d}$ least square means within the same row with different superscripts differ ($p < 0.05$).

Considering reproductive efficiency of purebred sows, Landrace had higher productivity potential than Large White with a significant difference for NBA, ABW and AWW ($p < 0.05$). Even though Landrace sows had more STB and MUM than Large White, it did not affect NBA which is one of best indicators for the potential of sows as Landrace had more total piglets born than Large White. However, these results showed that sows with large litter size tend to have more piglet loss at birth. For the best outcome, breeding programs should not focus only on litter size of sows. According to Table 2, Landrace had higher LSM for NBA than Large White at about 0.11 piglets per litter. These results were also found in a previous report [8], but there was a greater difference between Landrace and Yorkshire. Both breeds had about 0.50 heads of live born piglets per litter different from each other and their birth weight was 0.13 kg different on average. While our results found only 0.02 kg difference in average birth weight between Landrace and Large White, a bigger difference of reproductive performance between Landrace and Yorkshire was reported by Kantanamalakul et al. [12] who revealed that Landrace had higher total piglets born and piglets born alive than Yorkshire sows at approximately 1.07 and 0.57 heads, respectively, and there were more mummified piglets in Landrace like our study. On the other hand, purebred Landrace and Yorkshire were not different in the number of total piglets born per litter. Although Yorkshire gilts had a higher ovulation rate than Landrace gilts, the prenatal loss was significantly higher in Yorkshire gilts as well [17].

However, crossbred sows had higher productivity than purebred sows. Both crossbred L × W and W × L had more LSM for TPB, NBA, ABW and AWW than purebred sows (L and W) with significance of ($p < 0.05$). This may be due to the heterosis effect from crossing between different breeds [7, 18]. The values of heterosis range from 2.86 to 5.30% which affected crossbred sows to have higher TPB and NBA than purebred sows at 0.48 and 0.51 piglet per litter, respectively. The results are similar to the research of [19] who found bigger litter size in crossbred sows, which had about 0.25 to 0.50 more piglets per litter than purebred sows. But lower difference in litter traits between purebred and crossbred sows was found in Segura-Correa et al. [20] in Mexico which revealed that crossbred ¾ Landrace × Yorkshire had higher total pigs born at birth and number of pigs born alive than purebred Yorkshire at approximately 0.19 to 0.20 piglet per litter. The outstanding performance of crossbred sows has not been reported in Landrace and Large white or Yorkshire. Reproductive performance has been reported in other breeds such as crossbred sows between Landrace and Hampshire [7], Landrace and Pietrain [4], Large White and Pietrain [21] and Duroc and Pietrain [22].

Negative and positive heterosis was found in reproductive performance of crossbred sows depending on the studied traits (Table 3).

Table 3. Heterosis percentage for reproductive performance in crossbred sows.

Breed	Traits[1]					
	TB	**NBA**	**STB**	**MUM**	**ABW**	**AWW**
Landrace × Large white	3.53	4.71	-23.98	11.54	5.19	2.86
Large white × Landrace	4.73	5.30	-19.30	23.08	4.55	3.52

[1]TB = number of total piglets born; NBA = number of piglets born alive; STB = stillbirth piglets; MUM = mummified piglets; ABW = average birth weight and AWW = average weaning weight.

Crossbred W × L had higher heterosis than crossbred L × W for TPB, NBA and AWW at approximately 1.20, 0.59 and 0.66%, respectively. This is in contrast to ABW in which crossbred L × W (5.19%) had higher heterosis than crossbred W × L (4.55%). Although heterosis affected crossbred L × W (11.54%) and W × L (23.08%) to have more MUM than the purebred sows, it had no influence on STB especially L × W crossbred with the lowest STB in the population. Levels of heterosis percentage varied depending on genetic difference of the breed used in mating. In this population, positive heterosis was found in all traits except MUM. Heterosis effect led to increased mummified piglets in both crossbred groups. However, this is contrary to the occurrence of STB which was higher in purebred sows. It was in agreement with Kuhaaudomlarp and Imboonta [23] who studied Thai commercial herds and found larger litter size and lower risk of stillbirth piglets in crossbred sows between Landrace and Large White when compared to purebred sows ($p < 0.05$).

According to Table 3, it implies that the mating scheme for crossbreeding using Landrace as the dam line had more potential for total piglets born and number of piglets born alive when compared with using Large White. Even though both breeds had no significant difference in birth weight, the piglets derived from Landrace sows had more weaned weight than those from Large

White sows ($p < 0.05$). This indicated the superior mothering of Landrace sows, which is in agreement with several results in various populations which found a higher productivity of Landrace than Large White [24], Hampshire [7] and Yorkshire [8]. On the other hand, Singtong et al. [25] suggested that Landrace should be used as sire line rather than Yorkshire because the Landrace breed tends to have higher number of piglets born alive and higher birth weight compared with Yorkshire. Moreover, interaction between breed, parity and season at farrowing on birth weight and weaning weight was found by Knecht et al. [6] to affect birth weight and weaning weight of Landrace and Large White sows differently, depending on parity and farrowing season ($p < 0.05$). Different results may be due to population structure, farm management and environmental conditions.

The results could be applied for selection and mating strategy in order to improve sow productivity. However, genes of each breed or individual sow and boar may respond to the environment differently. Therefore, management system, environmental condition and genetic base of herds should be taken into account before applying these results. In addition, breeding programs and environmental improvement should be practiced at the same time for the best performance of sows.

Conclusion

The breed group of sows significantly affected all reproductive traits ($p < 0.01$). The crossbred between Landrace and Large White sows had more productivity than purebred sows, especially TPB, NBA, STB, ABW and AWW ($p < 0.05$). The difference of mating group in crossbred sows influenced reproductive performance. Heterosis percentage for TPB, NBA and AWW in Crossbred W × L were higher than crossbred L × W. Thus, a mating scheme using a Large White boar and a Landrace sow may be help increase piglets per litter and weaning weight in crossbred pigs.

Acknowledgement

The authors are thankful to Laemthong hybrid Co., Ltd. for providing reproductive data in this study.

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