Effects of Sire Breed on the Subsequent Reproductive Performances of Landrace Sows

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ABSTRACT : Reproductive traits of sows are determined chiefly by the genetic background of the dam herself. Whether the breed of the serviced boars also contributes is not yet clear. A total of 8,946 litters of Landrace (L) sows from 68 farms were examined. Of these, 876, 1,260, and 6,810 litters were produced from natural mating with L, Yorkshire (Y), and Duroc (D) breeds, respectively. The birth litter size (BLS), weaning litter size (WLS), live born piglets (LBP), and survival rate % (SR), of every litter were recorded. A general linear-model procedure was followed to estimate the effects of boars' breed (B), parity (P) and B×P interaction on the reproductive traits of the sows. Results show that BLS, WLS, and LBP were all significantly ($p<0.001$) affected by B and P. SR% was significantly influenced by B but not by P. L sows crossbred with Y or purebred with L produced litters with higher BLS, WLS, and LBP values than those bred with D. Pure L breeding yielded litters with lower SR% than did crossbreeding with D, while the difference between SR% due to LY and that due to LD crossbreeding was not significant. The interaction of B with P was significant with respect to BLS, WLS, and LBP ($p<0.001$), but not SR%. No significant B effect on reproductive traits was measured in sows at their first parity; but at latter parities, LL or LY produced litters with similarly high BLS, WLS and LBP, which values were all significantly greater than those of LD litters. The breed of boar evidently affected the subsequent reproductive performance of L sows and this effect may be further manipulated by the parity effect. Breed differences in semen quality and the success of fetus development with different interactions of the genetic background with the uterus function of the sow that may contribute to these effects are discussed. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 4 : 489-493)***

Key Words : Sow, Sire Effects, Parity, Litter Size, Survival Rate

INTRODUCTION

The reproductive performance of sows is usually indicated by a number of traits including birth litter size (BLS), live born pigs (LBP), weaning litter size (WLS), and survival rate (SR). These traits vary with the genetic background of the dam and environmental factors such as management and season (Cheon et al., 2002). Interactions between these factors are also significant (Hill and Webb, 1982; Tomes and Nelsen, 1982; Yen et al., 1987; Koketsu et al., 1997). For example, sows bred in the hot season have fertility inferior to those bred in other seasons (Boender, 1966; Wettemann and Bazer, 1985; Clark et al., 1989). Furthermore, the physiological status, for example parity, also markedly affects those traits (Xue et al., 1997; Wang and Lee, 1999; Tantasuparuk et al., 2000). Sows are known to have better fertility at parity between two and six than those at parity either below two or over six (Clark et al., 1989; Koketsu et al., 1997; Tummaruk et al., 2001).

The genetic background of the serviced boar should also contribute to the variation of the reproductive traits of the sows. Not only does the success of fertilization depend equally on the quality of boar's semen and the ovarian integrity, but also the sire's genetic background affects embryo mortality and fetal development (Swierstra and Dyck, 1976; Hill and Webb, 1982; Van der Lende et al., 1994). This effect may persist even through the lactation period (Strang, 1970), since well-developed piglets with higher birth weights tend to acquire more milk and therefore have a higher survival rate during nursing. The breed of boar is known to affect significantly all semen measures (Kennedy and Wilkins, 1984; Kuo et al., 1997), and within a breed, the reproductive performance of a sow is affected by the boar (Swierstra and Dyck, 1976; Van der Lende et al., 1994; Kim et al., 2002). Limited data, however, are available on the effect of the breed of the serviced boar on the sow's reproductive performance. Landrace (L) sows are usually sired with L or Yorkshire (Y) boars, to produce breeding stocks of LL (purebred L) or LY (crossbred) gilts used to replace the dam for later breeding. L sows are also bred with Duroc (D) boars to produce LD market hogs. This study then was conducted to evaluate the effects of boar breed (B), sow's parity (P), and their interaction (B×P) on the reproductive traits of L sows.

MATERIALS AND METHODS

A program that involved 2,000 L sows from 68 farrow-to-finish farms was conducted over two years. The criteria for the selection of L sows included not only general appearance but, more importantly, background references

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including breed identities, birth and previous farrowing dates and parity number. Those references were checked before the study to ensure all the information was valid. No enforced mating program was involved and selected sows were mated according to the needs of the farm as long as the serviced boars were any registered pure breeds of D, Y, or L. Reproductive parameters including the birth litter size (BLS), the number of live born piglets (LBP), the weaning litter size (WLS), and the percentage survival rate (SR%), were recorded for every selected sow.

The farms involved all applied standard practices of husbandry. Sows were checked for heat twice a day, and were naturally serviced by boars whenever estrous symptoms were observed. Sows were transferred to individual crates after pregnancy was verified and transferred to farrowing crates on Day (D) 110 of pregnancy. Shortly after farrowing, the total numbers of piglets born and stillborn were recorded. All piglets were given extra heat throughout the study and their ears were notched and teeth clipped on the first day after birth. Iron-dextran was injected on D3 and creep feed was offered on D14. On D28, piglets were weaned and the body weights and numbers of surviving piglets were recorded.

Pregnant sows were fed 1.0 kg of feed that contained 13% crude protein (CP), twice a day, during the last month of gestation, feeding levels were increased to 1.1 kg (CP=13%), twice a day. During lactation, the sows were fed a 16% CP diet, 4.0 kg per day, plus 0.25 kg per piglet. Any symptoms of illness, including a reduced appetite of a sow or an alimentary disorder of her litter, caused data pertaining to that litter to be excluded from the final analysis.

A general linear-model (GLM) procedure was used to estimate the effects of boar breed (B), parity (P) and B×P on the reproductive traits of the sows, as follows:

$$Y_{ijklm} = \mu + B_i + P_j + (B \times P)_{ij} + \varepsilon_{ijk}$$

where Y_{ijk} represents any observation; B_i represents the effects of the breed of the sire; P_j represents the effects of the dam's parity; $B \times P_{ij}$ represents the joint effects of the sire's breed and the dam's parity; andε_{ijk} is the random residual effect.

RESULTS

A total of 8,946 liters were examined of which, 876 were pure L breeding (LL); and 1,260 and 6,810 were crossbred from L sows and Y boars (LY) and D boars (LD) respectively. GLM analysis showed that the breed (B) of serviced boars significantly affected the BLS, LBP, and WLS, mortality, and SR% of the L sows (Table 1). Notably, all corresponding traits measured for LL and LY were similar, except in that LY showed a significantly higher WLS. The significant effect of the breed of serviced boar originated from significantly lower BLS, LBP, WLS and mortality of LD than of LL or LY. The lower mortality of LD gave a markedly higher SR% than that of LL but not of LY. The results reveal that LD crossbreeding resulted in 0.56 and 0.48 fewer live born piglets or 0.30 and 0.37 fewer weaning pigs than LL and LY, respectively.

Table 1. Reproductive performance of Landrace sows bred with boars of different breeds

Reproductive traits	Boar breeds (B)		
	Landrace	Yorkshire	Duroc
Litter recorded	876	1,260	6,810
Birth litter size	10.77±0.08[a]	10.73±0.06[a]	10.21±0.03[b]
Live born piglets	9.93±0.07[a]	9.85±0.05[a]	9.37±0.02[b]
Stillbirth (no.)	0.85±0.04	0.87±0.04	0.84±0.02
Live born (%)	92.64±0.37	92.55±0.31	92.59±0.13
Stillbirth (%)	7.36±0.37	7.45±0.31	7.41±0.13
Weaning litter size	8.57±0.06[b]	8.64±0.05[a]	8.27±0.02[c]
Mortality (no.)	1.35±0.05[a]	1.21±0.04[a]	1.10±0.02[b]
Survival rate (%)	87.65±0.45[b]	88.97±0.37[ab]	89.36±0.16[a]

Mean±S.E.
Data in the same row but with different superscripts differ significantly ($p<0.001$).

Parity also significantly affected BLS, LBP and WLS, but not stillbirth (no. and %), live born % or mortality in L sows (Table 2). Reproductive performance of the L sows improved as parity proceeded. This improvement was indicated by a steady increase in BLS from 10.22 to 10.89 from first to 5th or 6th parity. LBP increased from 9.31 at first parity to 9.99 at 3rd or 4th and slightly decreased at 5th or 6th parity. A similar increase was also observed in WLS, reaching a maximum at 3rd or 4th parity and slightly decreasing at 5th or 6th parity.

The interaction of B and P (B×P) was significant in BLS, LBP, and. WLS. No significant difference between LL and LY was evident for all three traits through all six parities. However, the traits of both were significantly higher than those of LD in all parities studied excepted the first one (Figure 1). LD mating, however, also increased production as parity advanced, but not to as much as LL or LY mating; this difference rendered the B×P interaction significant.

DISCUSSION

Numerous studies have shown the effect of breed on both growth and reproduction in pigs (Hill and Webb, 1982; Pepper et al., 1984; Yen et al., 1987; Baas et al., 1992). L and Y breeds have been favorably used as the dam line due to their superior ability to produce larger and heavier litters, while D is a well sire line well-known for its excellent growth rate and feeding efficiency (Yen et al., 1987; Baas et al., 1992). This present study further demonstrates that not only does the maternal background affect reproductive traits

Table 2. Reproductive performance of Landrace sows with different parities

Reproductive traits	Parity (P)				Interaction (B×P)
	1st	2nd	3rd to 4th	5th to 6th	
Litter recorded	1,984	1,868	2,937	2,157	
Birth litter size	10.22±0.07[a]	10.41±0.08[a]	10.76±0.06[b]	10.89±0.06[b]	***
Live born piglets	9.31±0.06[a]	9.67±0.07[bc]	9.99±0.05[d]	9.90±0.05[cd]	***
Stillbirth (no.)	0.91±0.04[a]	0.74±0.04[b]	0.78±0.04[b]	0.98±0.07[a]	***
Live born (%)	91.67±0.35[a]	93.56±0.37[b]	93.48±0.30[b]	91.68±0.31[a]	***
Stillbirth (%)	8.33±0.35[a]	6.44±0.37[b]	6.52±0.30[b]	8.32±0.31[a]	***
Weaning litter size	8.09±0.05[a]	8.47±0.06[b]	8.78±0.04[c]	8.64±0.05[bc]	***
Mortality (no.)	1.22±0.05	1.20±0.05	1.21±0.04	1.26±0.04	NS
Survival rate (%)	88.30±0.43	88.79±0.45	89.11±0.36	88.45±0.38	NS

Mean±S.E.; *** $p<0.001$; NS, nonsignificant.
Data in the same row but with different superscripts differ significantly ($p<0.001$).

but also the servicing boar significantly participates in subsequent reproductive performance, at least in L sows.

A smaller BLS in LD originates from either the production of fewer zygotes or the higher fetal mortality, or both. The fewer zygotes may be due to inferior semen of D boars. However, this negative effect of the D breed of boar on reproductive traits, due to poor semen, is not in accordance with the results of the previous studies by Kennedy and Wilkins (1984) and Kuo et al. (1996). These authors reported that D boars produce less, but more concentrated semen than do Y and L boars, thus D boars produce a similar number of sperm per ejaculation. Besides, the semen traits of these breeds are same. Although studies have shown a positive correlation between the fertilizing capacity of the boar and the average litter size, this result holds only within a breed but not, reportedly, among breeds (Boender, 1966; Swierstra and Dyck, 1976). Therefore, the poor performance in LD is more likely directly associated with the higher fetal mortality or the fewer embryos/fetuses, which result in lower BLS, LBP and WLS. However, L sows may nurse her offspring sufficiently well to offset any difference in the genetic backgrounds of the piglets. Sows bred with D boars can easily maintain their superior capacity to nurse the litters, of which the piglet numbers are already lower than those of LL and LY, resulting in a higher SR%. Seemingly, the status of the piglet at birth, that is BLS, is the major parameter that may also affect the values of two other parameters (WLS and LBP) because BLS, WLS, and LBP are highly correlated. Moreover, BLS mainly depends on the prenatal growth and development of the fetus, and these again are partially controlled by the genetic background of the fetus. In other words, the genetic background of the embryo/fetus is probably the primary and initial event that determines the values of BLS, WLS, and LBP. Further studies are required to clarify the growth and maturity of the crossbred embryos at different stages of gestation in L sows.

Parity is known to significantly influence reproductive traits and sows usually perform better after first two parities, reaching maximum performance at 3rd to 4th parity, gradually declined thereafter (Xue et al., 1997; Koketsu et al., 1997; Wang and Lee, 1999; Tantasuparuk et al., 2000). The present results agree with those of previous reports. The significant effect of the interaction of the sire's breed and the dam's parity is mainly caused by the less prominent effect of parity in sows bred by D boars, while increments between parities 1 and 5 in sows sired by L or Y boars are evident. The significant effect of the interaction of sire's breed and dam's parity suggests that the effects on sow performance of breed of sire may be further amplified after sows reach fully maturity since parity number is a reliable index of body maturity and farrowing experience of the sows. Hill and Webb (1982) have stated that the proportion of variance due to the breed of the sires is less than 1% of the total, and therefore not of major economic importance. Yet the importance of the effects of sire breed, especially on total litter size in the lifetime of multiparous sows, must now be reconsidered.

Gaugler et al. (1984) founded an nonsignificant effect of sire-breed on litter size, and disagree with the results presented here. The discrepancy probably follows from the following: 1) Gaugler et al. focused on maternal effects and used reciprocal-cross design, an overwhelming maternal effect might attenuate the marginal sire-breed effect. 2) The small sample size in Gaugler's paper (N from 20 to 29) might not identify differences in litter size among LL (10.74), LY (10.43), and LD (10.06) with standard errors between 0.73 and 0.81. 3) A major part of the sire-breed effect on sow performance is through it's interaction with parity, especially later parities (Figure 1), such an interaction was not considered in Gaugler's work.

Only a single breed of dam (L) was chosen in this study, and all sows were assumed homogenous in genetic background. This may not have been truly the case because L sows are sired with L or Y boars to produce breeding pigs, and sired with D boars to produce market hogs. Further study may be needed to clarify this possibility.

In summary, the breed of sire may affect subsequent

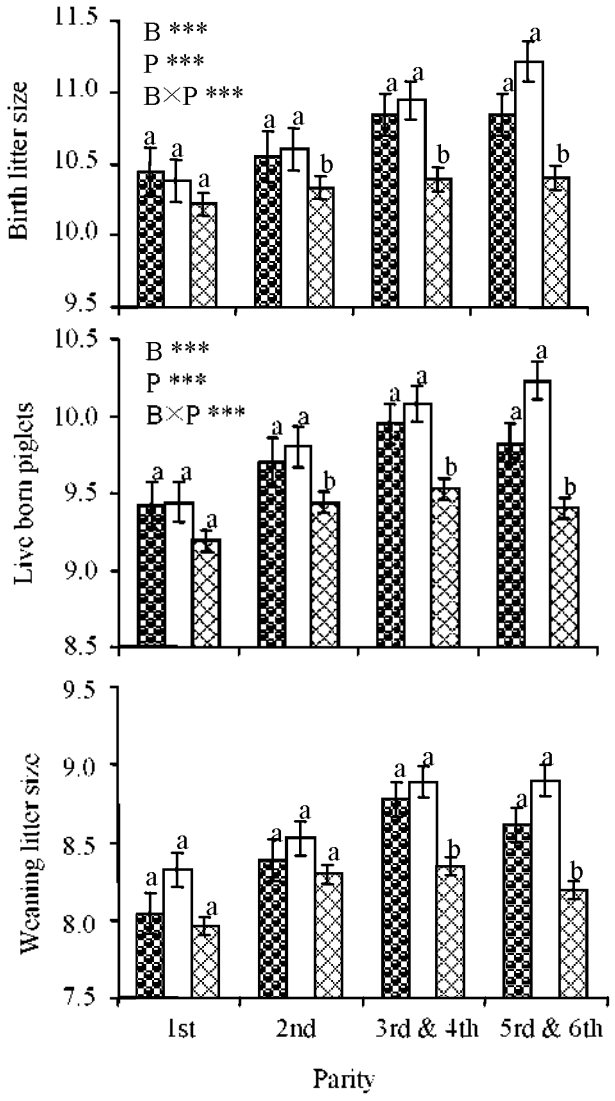

Figure 1. Interaction between boar breeds (B) of Landrace (▩) Yorkshire (□) and Duroc (■) and parity (P) of Landrace sows in some reproductive traits. *** $p<0.01$. [a, b] Significant difference between columns within parity.

reproduction performance in L sows, and the dam line (L and Y boars) may be superior to the sire line (i.e. D boars). This siring effect may be further augmented by the parity effect: the difference in reproduction performance between the two lines increases as parity advances. The difference may not be in the lactation capability of the sow, but in the growth potential and survival capability of the embryo/fetus in the uterus of the sow.

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