The relationship between reproductive performance of crossbred sows and the EBVs of their purebred dams

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Introduction

In vertically integrated pig production schemes the number of crossbred sows at the commercial level is much higher than the number of purebred sows at the nucleus and multiplier levels. This indicates the relative importance of enhancing the performance of the crossbred offspring rather than that of the purebreds themselves and reinforces the idea of setting the breeding goal towards enhancing the performance at the commercial level (Brandt and Täubert, 1998). The estimated breeding values (EBVs) obtained for a certain trait in purebred dams at the nucleus and multiplier levels using only purebred information, reflect the additive genetic effects of the purebred animals and can be used to predict the genetic merit of their purebred daughters. However, do EBVs from purebred dams predict the performance of their crossbred daughters in the commercial environment? Genetic correlations between purebred and crossbred sows for reproductive traits have been estimated previously and estimates ranged from 0.21 to 0.99 in the studies by Täubert *et al.* (1998), Boesch *et al*. (1998) and Nakavisut *et al*. (2005). Such a spread of estimates makes it difficult to extrapolate results to a specific case. A full pedigree structure at the commercial level is required to estimate these genetic correlations. If full pedigree information is not available, performance of crossbred offspring may be regressed on the EBV of a parent. This approach was used by Hall *et al*. (2002) in sheep data. The aim of our work was to study the relationship between the reproductive performance of commercial crossbred F1 sows and the EBVs of their purebred dams based on purebred data only.

Material and methods

Description of the dataset. Reproductive data from 2,637 F1 crossbred sows (Large White -LW- and Landrace -LR- reciprocal crosses) collected from two commercial piggeries in Australia, between July 1995 and October 2004 were utilized. There were 10,817 records available for litter size at birth (NBA) and litter size at weaning (NW), 1,981 records for average piglet weight at birth (ABW) and 1,728 for average piglet weight at weaning (AWW). Pedigree information was only available for purebred dams of crossbred sows, since F1 sows were mated to multiple sires. Purebred LW and LR data were recorded from 1995 to 2004.

Statistical analyses. The reproductive performance of the F1 sows for the traits: NBA, NW, ABW and AWW were regressed on the EBVs of their dams for NBA, ABW, AWW and NW using a Generalized Linear Model procedure (PROC GLM) in SAS (SAS Institute Inc., 1990). Further fixed effects fitted were dam breed (NW), season nested within piggery (NW, ABW and AWW), parity nested within piggery (all traits) and farrowing day of the week nested within piggery (NBA), lactation length nested within piggery (AWW) and the linear interaction between piggery and dam breed (NW). Dams' EBVs for NBA, ABW, AWW and NW were fitted as linear covariables.

The EBVs for purebred dams were obtained from univariate animal mixed models using ASReml (Gilmour *et al.* 2002). Separate analyses were done for LW and LR sows. Only data from purebred animals at the nucleus and multiplier levels of Myora Farm were utilized.

The actual regression coefficients obtained were compared to the expected correlated responses, which were defined as half the correlated responses in crossbred sows (Y) per unit change in dam EBV (X). For one unit change in X, the expected response in character Y is given by the regression of the breeding value of Y on the breeding value of X [$b_{(A)YX} = r_A (\sigma_{AY}/\sigma_{AX})$] where $b_{(A)YX}$ is the regression coefficient of regressing the EBV of Y on the EBV of X, r_A is the genetic correlation between traits X and Y, σ_{AY} is the standard deviation of the EBV for trait Y and σ_{AX} is the standard deviation of the EBV for trait X (Falconer and McKay, 1996). The genetic correlations (r_A) between reproductive traits recorded in purebreds and standard deviations of the EBVs were described in Suárez (2005).

Results and discussion

The regression coefficients obtained from regressing the NBA, ABW and AWW performance of F1 sows on their dams' EBVs for the same trait were not significantly different from the expected value of 0.5 (Table 1). These results indicate a genetic correlation between purebred and crossbred animals that is not significantly different from one. Estimates of genetic correlations for litter size between purebred and crossbred lines from a German study (Boesch, *et al.* 1998) varied from 0.49 to 0.81. Purebred data were obtained from 2 nucleus and 2 multiplier herds and the crossbred data were recorded on 10 multiplier farms over 7 years. The authors concluded that purebred and crossbred information should be combined for selection. In comparison, Täubert *et al.* (1998) analysed litter size in purebred and crossbred sows using Australian and German data. Genetic correlations were high (0.69 to 0.99) for both data sets despite very different data structures. The Australian data were collected on one farm; the German purebred data came from nearly 200 farms and the crossbred data were from 81 farms. The purebred data used in this study to estimate the EBVs came from one nucleus and multiplier herd with a shared environment and very similar management practices. The crossbred data were collected on two commercial piggeries with similar environments and management practices between them and Myora Farm. Therefore, the EBVs for NBA and ABW of purebred dams predicted difference in performance of F1 sows as expected suggesting high genetic correlations between purebred and crossbred records for these traits.

The regression coefficients shown on the diagonal of Table 1, which represent reproductive traits recorded in F1 sows regressed on the same trait EBV of their dams, had a higher standard error for AWW in comparison to NBA and ABW since fewer records were available. Regression coefficients for AWW deviated further from the expectation of 0.5 compared to NBA and ABW. This may have resulted from cross-fostering practices. In addition, different piggeries measured this trait at slightly different weaning ages. For NW regression coefficients were 0.00 (±0.06) in LW and 0.15 (±0.45) in LR. This trait was strongly influenced by cross-fostering at Myora Farm and heritabilities were 0.04 (± 0.01) in LW and 0.01 (± 0.01) in LR (Suárez, 2005). Given these management practices this trait is not a reliable trait for selection.

Table 1. Values for the regression of reproductive performance of F1-sows on the EBVs of their LW and LR dams, and the expected correlated responses (below in brackets)

Dam EBVs	Dam Breed	Regression coefficients of the F1-sows ± std errors and Expected correlated responses (below in brackets)			
		NBA	ABW	AWW	NW
NBA EBV (piglet)	LW	0.40 ± 0.05	-0.03 ± 0.01 (-0.04)	-0.14 ± 0.04 (-0.08)	-0.02 ± 0.03 (-0.09)
	LR	0.44 ± 0.10	-0.03 ± 0.03 (-0.06)	-0.01 ± 0.08 (-0.02)	0.05 ± 0.05 (-0.05)
ABW EBV (kg)	LW	-0.86 ± 0.44 (-2.45)	0.51 ± 0.10	1.47 ± 0.31 (0.62)	0.12 ± 0.24 (0.67)
	LR	-2.59 ± 0.66 (-2.22)	0.50 ± 0.13	0.46 ± 0.41 (0.57)	-0.09 ± 0.36 (0.28)
AWW EBV (kg)	LW	-0.87 ± 0.20 (-1.33)	0.04 ± 0.05 (0.16)	0.61 ± 0.16	0.01 ± 0.11 (0.43)
	LR	-0.38 ± 0.32 (-0.20)	-0.01 ± 0.07 (0.13)	0.35 ± 0.21	0.34 ± 0.18 (0.11)
NW EBV (piglet)	LW	-0.32 ± 0.11 (-0.41)	-0.02 ± 0.03 (0.05)	-0.03 ± 0.09 (0.12)	0.00 ± 0.06
	LR	2.91 ± 0.82 (-2.99)	-0.51 ± 0.19 (0.45)	-0.75 ± 0.60 (0.74)	0.15 ± 0.45

Abbreviations: NBA number of piglets born alive; ABW average piglet birth weight; AWW average weaning weight; NW number of piglets weaned. LW Large White; LR Landrace.

Regression of reproductive performance of F1 sows on NBA EBV of their dams showed no significant differences from their expected correlated response (first main row in Table 1). These results showed that F1 sows from dams with higher NBA EBV had lighter piglets at birth and at weaning. For AWW this unfavourable relationship was stronger in F1 daughters of LW dams. The genetic correlation between NBA and NW was negative in purebred dams (Suárez, 2005) leading to a negative expected regression coefficient for NBA EBV. Actual regression coefficients were higher than the expected value in both breeds, which may partly be due to less cross-fostering at the commercial farms.

The expected coefficients from the regression of NBA performance on ABW EBVs were -2.45 in LW and -2.22 in LR given the range of genetic correlations between NBA and ABW of -0.83 to -0.54 in these breeds (Suárez, 2005). The actual coefficient differed significantly from this expectation in daughters of LW dams (-0.86 ± 0.44). In addition, the favourable relationship between ABW EBV and the weaning weight performance of their F1 daughters was stronger for these animals. Daughters of LW dams with higher ABW EBVs had higher NW performance (b: 0.12) in contrast to a negative coefficient for daughters of LR dams (b: -0.09).

Coefficients differed between breeds from the regression of NW performance on AWW EBVs. Daughters of LR dams with higher AWW EBVs had higher NW performance. The actual regression coefficient of 0.34 (±0.18) was higher than the expected value of 0.11. In contrast, LW daughters of dams with higher AWW EBVs did not have higher NW performance (b:0.01). These results indicate that the relationship between performance of F1 sows and EBVs of their dams is influenced by the breed of the dam. Selection in different breeds may need to focus on different traits to enhance reproductive performance of their F1 daughters at commercial level.

Conclusions

The results of this study showed that the EBVs for NBA, ABW and AWW estimated from LR and LW purebred dams are good predictors of the performance of their crossbred F1 daughters at the commercial level. In contrast, the dams' EBV for NW did not predict their daughters' performance and should not be used for selection decisions. Selection using ABW is recommended in Myora Farm's LW and selection should consider AWW in LR to enhance reproductive performance of their crossbred daughters.

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