

Use of Commercial Crossbred Data in Breeding Value Estimation

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Franklin, KY

December, 2005

Genetic improvement programs are continuously evolving to assure highly efficient production of quality pork in order to maximize the economic return to all investors in the pork chain. Examples of this evolution include:

- Specialized sire and dam lines are now developed to improve breeding objectives that include traits relevant not only to producers but also to processors, retailers and consumers.
- New measurement technologies allow the incorporation of more accurate selection criteria.
- Improvement programs have also adopted more robust methods of genetic evaluation in order to increase the accuracy of their trait estimated breeding values.
- The use of genomics offers more rapid improvement especially in traits that are difficult or costly to measure in the prospect breeding animal.

The continuing challenge ahead lies in assuring that predicted genetic potential is expressed under commercial rearing conditions. It is well understood that a specific difference in an environment (climate, nutrition, health, management, etc.) does not have necessarily the same effect on different genotypes or the progeny of different individuals (of the same genotype) due to varying degrees of sensitivity to the environment.

Genotype by environment interactions are very relevant to genetic improvement programs as the progeny of individuals raised and tested under test conditions have to perform under a range of varying environments. Genetic correlations between purebred and crossbred performance (r_{pc}) for economically important traits deviate significantly from unity indicating, not all the improvement predicted (based on measures in a genetic nucleus environment) will be realized when progeny of individual genotypes are to perform in a different environment.

Brandt and Täubert (1998) summarized r_{pc} estimates for a number of traits in pigs. Daily gain estimates summarized from the literature ranged from 0.19 to 0.73 (estimates from their study ranged from 0.47 to 0.99), while estimates for back fat ranged from 0.21 to 0.88 (0.54 to 1.00). Lutaaya et al (2001) estimated r_{pc} for lifetime daily gain (0.62 to 0.99) and back fat (0.32 to 0.70).

Differences in gene frequencies of parent lines and the role of dominance (heterosis) can make the genetic correlation between purebred and crossbred performance less than 1.

The use of commercial crossbred information with the objective to select genotypes that have good average performance under commercial conditions has been a subject of review. Examples include:

- Bijama and Van Arendonk (1998) showed that a combined crossbred and pure line selection method was superior to pure line selection in many different situations.

- Lutaaya et al (2002) reported a joint evaluation of purebred and crossbred breeding values for growth and back fat. When separate line evaluations were replaced by evaluations with crossbreds, accuracy of predicted breeding values increased by 2 to 9% for purebreds and by 21 to 72% for crossbreds. Rank correlations between these breeding values were > 0.99 for purebreds but 0.85 to 0.87 for crossbreds.

Van der Werf et al. (1994) demonstrated that in order to successfully use crossbred information in genetic evaluations, the genetic correlation between purebred and crossbred performance (r_{pc}) and the crossbred heritability (h^2_c) are crucial factors.

Table 1 shows the five-year (discounted) economic response ($i/t = 1.45$) in a terminal sire line improvement program that uses half-sib crossbred information and where the selection objective is crossbred performance, vs. a program where the selection objective is the improvement of purebred performance (crossbred performance improvement thus, is a correlated response). Traits included in the selection objective are Age at 90 kg carcass weight (Age), average daily feed intake (ADFI), back fat (BF), loin depth (LD), pH-24 hours and post-wean mortality (G-F Mort). The predicted economic improvement per pig to slaughter is significant in favor of the program that uses crossbred information and where the (only) objective is the improvement of crossbred performance.

Table 1. Predicted Cumulative Economic Response at Commercial Progeny Level of Two Selection Programs over 5 Generations: Purebred (PB) Data and Purebred Objective vs. PB and Crossbred (CB) Data and Crossbred Objective.

Year	PB Data, PB Objective	PB + CB Data, CB Objective	Difference
1	\$1.69	\$2.11	\$0.42
2	\$3.21	\$4.01	\$0.80
3	\$4.59	\$5.73	\$1.14
4	\$5.83	\$7.28	\$1.73
5	\$6.94	\$8.66	\$1.73

Interest rate = 5%

Economic values per unit of improvement: Age = $-\$0.52/d$; ADFI = $-\$18.50/kg$; BF = $-\$0.77/mm$; LD = $+\$0.20/mm$; pH-24 = $+\$25.00$ and G-F Mort = $-\$100/\%$.

A program that does not gather crossbred information but whose breeding goal is the improvement of commercial crossbred progeny offers little advantage and still lags well behind a program that measures crossbred performance and which focuses on the crossbred improvement (Table 2).

Also, gathering crossbred data but not switching the improvement objective towards crossbred performance offers minimal (if any) advantage. The process of recording crossbred information is tedious but worthwhile:

- Traits to measure in the commercial crossbreds should be those that have a pure bred – cross bred genetic correlation significantly lower than one. Traits that are difficult to measure in a Nucleus environment are also of interest to record in crossbred animals in commercial environments.

- It must assure that all individuals on which measures of the traits of interest are to be taken have sires and dams identified:
 - Single sire matings should be performed in systems where typically sows are mated (same service) using semen from more than one boar.
 - Piglets should be individually identified and such id must be preserved throughout the whole process, from birth to the point where the last trait measure is taken.
- Timing is crucial, all crossbred information must be in the system ready to be used in the genetic evaluation of their purebred half-sibs at the time they come off test.

Table 2. Predicted Cumulative Economic Response at Commercial Progeny Level of two selection programs over 5 generations: Pure bred (PB) data and Crossbred Objective vs. PB and Cross bred (CB) data and Crossbred Objective.

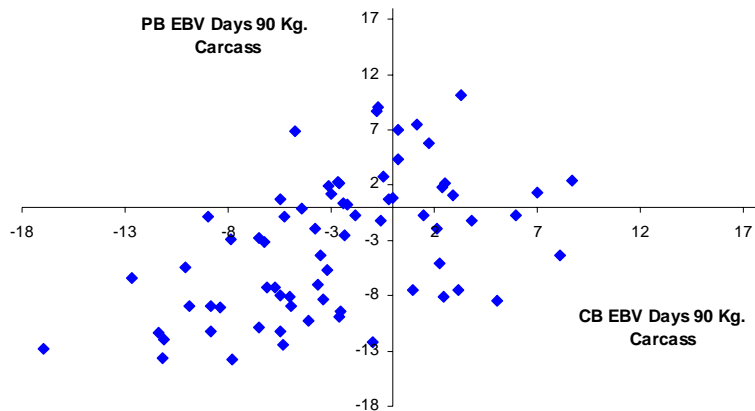
Year	PB Data, CB Objective	PB + CB Data, CB Objective	Difference
1	\$1.81	\$2.11	\$0.30
2	\$3.45	\$4.01	\$0.57
3	\$4.92	\$5.73	\$0.81
4	\$6.25	\$7.28	\$1.03
5	\$7.44	\$8.66	\$1.22

Interest rate = 5%

Economic values per unit of improvement: Age = $-\$0.52/d$; ADFI = $-\$18.50/kg$; BF = $-\$0.77/mm$; LD = $+\$0.20/mm$; pH-24 = $+\$25.00$ and G-F Mort = $-\$100/\%$.

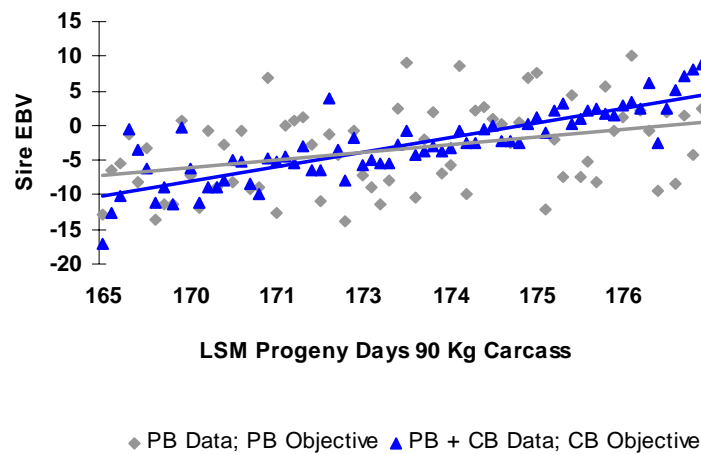
Graph 1 shows the distribution of breeding values predicting purebred performance (PB; Y-axis) versus the breeding values predicting crossbred performance (CB; X-axis) for the trait age at 90 kilos of carcass weight. The best individuals in terms of crossbred performance are not necessarily the best in terms of purebred progeny performance.

Graph 1. Purebred (PB) and Crossbred Breeding (CB) Values for Age at 90 Kilos of Carcass Weight.



This is further illustrated in Graph 2, where the progeny least square means for age at 90 kilos of carcass weight are plotted against the predicted purebred breeding value (PB Data; PB Objective) and the crossbred breeding value (PB + CB Data; CB Objective). The slopes of those predictions indicate the better predictive ability of the crossbred breeding value of crossbred progeny performance.

Graph 2. Predictive Ability of Crossbred Breeding Values for Age at 90 kilos of Carcass Weight.



Summary

- The use of crossbred information to predict crossbred progeny performance results in higher predictive ability of commercial crossbred progeny performance.
- Line development selection objectives that focus on crossbred performance will deliver higher rates of genetic and economic improvement to the pork chain.
- Any other approach that does not combine measuring crossbred information with the breeding goal to improve commercial crossbred performance, will deliver little or marginal value (at the commercial level) over the traditional approach focused on the improvement of purebred progeny performance.

References

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