ANIMAL GENETICS AND BREEDING UNIT
A joint unit of NSW DPI and UNE

Boar EBVs predict differences in average progeny performance better than the boar's own performance

Anna Hansson, Kim Bunter and Susanne Hermesch

What are EBVs?

Estimated Breeding Values (EBVs) reflect the genetic merit of an animal. They can also be defined as the value of an animal's genes to its progeny. EBVs can be used to select genetically superior pigs for performance in particular traits, such as average daily gain (ADG) and back fat (BF). Accurate selection of genetically superior parents will then result in superior progeny on average.

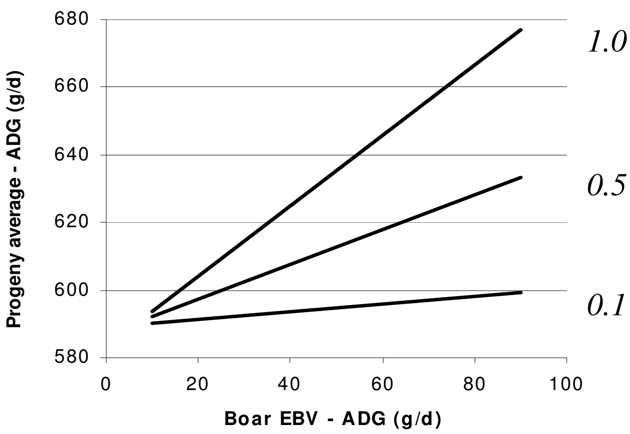
The National Pig Improvement Program (NPIP) provides *across-herd* EBVs so that genetic comparisons can be made between purebred animals from different herds.

How do we know that EBVs work?

Boars and sows each pass half of their genes to their progeny. Therefore, half of the differences in EBVs between sires should be reflected by differences in average progeny performance. We can prove that EBVs work by regressing average progeny performance on sire EBV, where we expect a regression coefficient *close* to 0.5. Chance or sampling effects can affect the observed regression coefficient.

A bit on regression coefficients

A regression line summarises the relationship between two variables. It shows how the response variable (y; progeny average) changes when the explanatory variable (x; boar EBV, or boar performance) changes. A regression line can *predict* the differences in progeny averages based on EBVs of sires. A regression coefficient of 0.5 indicates that for each 1 unit change in x (boar EBV), the difference in y (progeny average) will change by 0.5.



For example:
An increase of the Boar EBV (x) from 30 to 50g/day (a difference of 20g/day) corresponded with an increase of the progeny average (y) from 605g/day to 615g/day (a difference of 10g/day). Therefore 10/20 = 0.5; equivalent to a regression coefficient of 0.5.

Data available for this demonstration

We can demonstrate this principle using real data. Performance data were available from the study by Bunter and Bennett (2004) where approximately 1 000 pigs were recorded together for production traits over a short time period. Semen from 11 Large White, 8 Landrace and

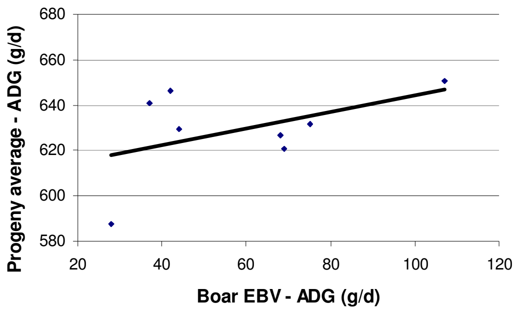
8 Duroc boars was used for inseminating QAF Meat Industries sows. The resulting progeny were recorded in August and September 2004. Only boars with more than 10 progeny recorded in the QAF herd were included in this demonstration.

The data used to calculate the NPIP EBVs and the sire's own performance were obtained independently from purebred animals reared in conventional production systems. However, the largely crossbred progeny at QAF were reared in large groups within an eco-shelter production system. This difference in environments may influence the regression coefficient obtained if performance in the two systems does not have exactly the same genetic influence.

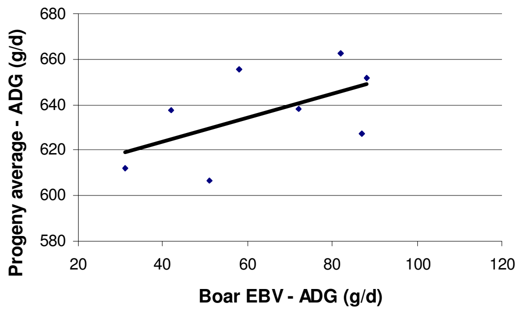
Sire EBVs predict differences in average progeny performance

Results for average daily gain (ADG)

The figures below show the relationship between sire EBVs and their progeny averages. The regression (trend) line for both Landrace and Duroc pigs was positive. The regression coefficients (illustrated by the slope of the regression line) were 0.36 for Landrace pigs and 0.52 for Duroc pigs, with results for Duroc very close to the expected value of 0.5. The result for Duroc pigs indicates that for each g/day increase in boar EBV there was a 0.52g/day increase in average progeny performance. In comparison, the regression coefficient for Landrace was slightly lower than expected. This could be the result of sampling: for example, the number of observations was relatively low. In addition, the distribution of sire EBVs and progeny averages varied between the two breeds.



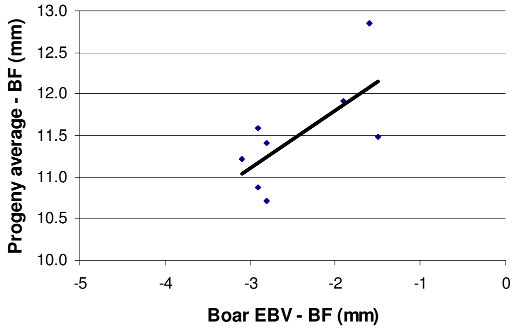
Landrace



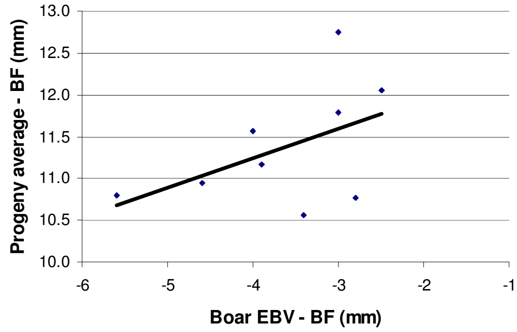
Duroc

Results for back fat (BF)

A positive relationship between boar EBV and average progeny performance was also shown for BF. These figures show that the regression coefficient was higher for Landrace (0.69) than Large White pigs (0.35), although both were still relatively close to 0.5.



Landrace



Large White

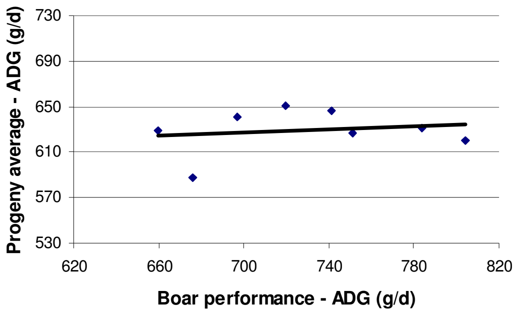
The outlier at the top right hand corner contributed to the higher regression coefficient for Landrace, since there were relatively few observations. Similarly, the regression coefficient for Large White was decreased by the observations at the bottom right of the figure.

Sire performance is not a reliable indicator of progeny performance

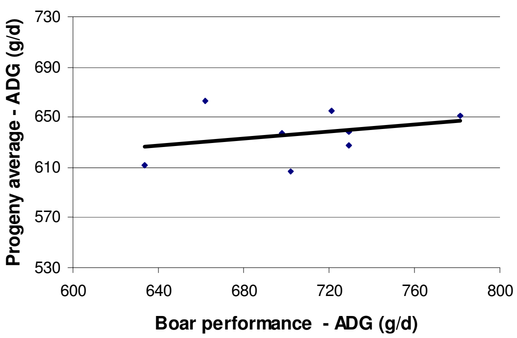
The same procedures and data as above were used, but sire EBVs were replaced with each boar's *own performance* record. Given each boar's performance is influenced by their own performance test environment, we do not expect a boar's own performance to be a reliable indicator of the genetic merit it will pass on to its progeny, and therefore it's progeny's performance.

Results for average daily gain (ADG)

The figures below show that the regressions of average offspring performance on sire phenotypic performance were weaker than the relationship between average progeny performance on sire EBVs, for both Landrace (0.07) and Duroc (0.14).



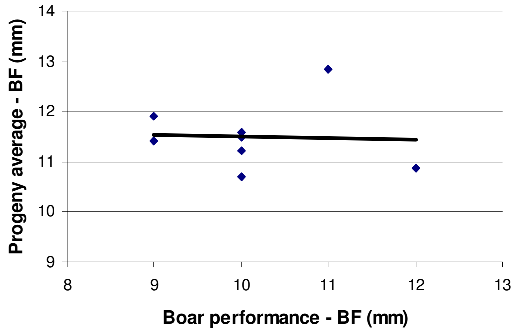
Landrace



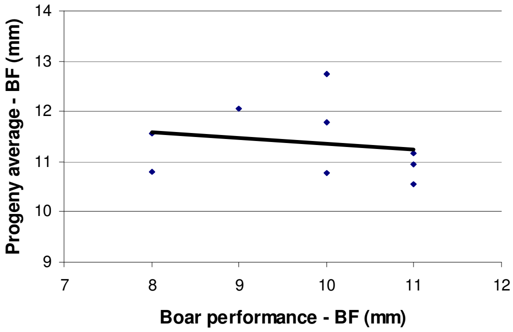
Duroc

Results for back fat (BF)

The relationship between the sire's own performance and progeny average was actually negative for BF, when only a positive value was expected. Regression coefficients were -0.03 for Landrace and -0.12 for Large White. That is, fatter boars produced leaner progeny on average, which is very unlikely. This result further illustrates that the boar's own performance is a less informative predictor of differences in progeny average, since its own performance was influenced by its own environment (which its progeny are not subjected to).



Landrace



Large White

Contrast sire EBVs versus sire's own performance

The regression coefficients for both ADG and BF were 0.5 when averaged across breeds, indicating that EBVs are generally a reliable indicator of differences in average progeny performance. In contrast, the relationship calculated from the sire's own performance in place of the sire EBV was consistently lower than expected across traits and breeds. This means that differences between sires in their own performance will explain less of the observed differences in their progeny performance than would differences in sire EBVs.

These examples show that sire EBV is a much more accurate and robust predictor of differences in average progeny performance than the sire's own performance.

It is difficult to obtain regression coefficients of exactly 0.5 (for progeny performance on sire EBV) from real data examples due to chance and sampling effects. For example, in this data:

- Numbers of progeny and litters per sire were low; averaging only 19 piglets and 2.7 litters per sire in QAF respectively. This will increase the effect of the individual dams on each sire's progeny average.
- Progeny were reared in a different environment to their sires. Results might be more accurate if progeny were also performance tested in a conventional system, like their sires.
- The range of sire EBVs must have sufficient variation. For example, the variation in sire EBVs for BF was only approximately 2mm for Landrace sires used at QAF, which is a lower range than recommended for proof of EBVs trials. This suggests that both young and old boars (possibly using frozen semen) would need to be used.
- Within breed, boar numbers were low. Generally, a larger number of boars are recommended (within reason, i.e. 10 rather than 5 sires). This is more important if using boars whose EBVs are estimated with lower accuracy (i.e. young boars)

Sire EBV was still a better predictor of differences in the average performance of the progeny than the sires own performance, despite these limitations in the QAF data. With large numbers of boars and progeny the average regression coefficient will be as expected.

Further reading

K. Bunter and C. Bennett (2004). *Genotype comparisons for meat and eating quality traits*. Pig Genetics Workshop, Armidale, Australia, pp.59-70.

A.C. Hansson, R.E. Crump and S Hermesch (2005). *Reliability of trial designs for a proof of Estimated Breeding Values (EBVs) analysis*. Australasian Pig Science Association Conference, Christchurch, New Zealand, November 27-30, p.113

A.C. Hansson and S. Hermesch (2005). *Estimated Breeding Values of sires predict average progeny performance*. Australasian Pig Science Association Conference, Christchurch, New Zealand, November 27-30, P.100

Further information on the National Pig Improvement Program (NPIP) can be und at http://npip.une.edu.au

Australian Pork

AGBU, University of New England, Armidale, NSW, 2350 Ph: (02) 6773 2055,
Fax: (02) 6773 3266, http://agbu.une.edu.au