Evaluating trial designs for a proof of EBVs demonstration

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Estimated Breeding Values (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 performance of progeny on average.

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.

Simulations can be used to evaluate trial designs

Computer simulations involve the use of a mathematical model to imitate real life scenarios to estimate the chance of various possible outcomes. Simulations have the advantage of being cheaper and faster than actual trials. For each boar the initial parameters the simulation required were EBVs for back fat and average daily gain, accuracy of EBVs, as well as number of recorded progeny and litters. The simulation program was then used to evaluate the reliability of trial designs for proof of EBVs trials.

Data available for the simulation

Data (EBVs and EBV accuracies) from the National Pig Improvement Program (NPIP) of young and old boars available at AI centres in September 2005 were used to provide simulation inputs, reflecting real life data. Sires at the extremes of the EBV range were used for the analysis. The difference of EBVs between the top and bottom boars was 35g/d for average daily gain and 2.6mm for back fat. In addition, boar numbers were also restricted to reflect a trial using limited resources.

Probabilities of trial designs to demonstrate relationship between EBVs and average performance of progeny

The table below shows the probability of obtaining various regression coefficients when using available resources. These results show that there is a 22-37% chance for ADG and 38-48% chance for back fat of obtaining a regression coefficient between 0.4 and 0.6. This occurred even when the number of recorded progeny (total progeny: 6000) was effectively unlimited. This means that there is a less than 50% chance of obtaining a regression coefficient close to 0.5.

The results do show, however, that there was a very high probability of obtaining a regression coefficient greater than zero. There was a 95-99% chance that the regression coefficient would be positive for average daily gain and a 99-100% chance for back fat.

The probability of obtaining a regression coefficient between 0.4-0.6 or greater than zero (>0.0) for varied number of progeny and sires - Average daily gain (ADG) and back fat (BF).

Number of progeny in total		**800**	**1200**	**4000**	**6000**
Number of sires		**4**	**6**	**4**	**6**
Number of litters per sire		**12**		**48**	
Number of progeny per sire		**200**		**1000**	
		Probability - ADG			
Range for regression coefficients	**>0**	95	97	97	99
	0.4-0.6	22	29	31	37
		Probability - BF			
Range for regression coefficients	**>0**	99	100	100	100
	0.4-0.6	38	41	42	48

Implications

This simulation has shown that the probability of obtaining a positive regression coefficient is very high. This indicates that a positive relations between EBVs of sires and average performance of their progeny can be demonstrated. However, the probabilities of obtaining a regression coefficient close to 0.5 were less than 50%. This is because these boars have been selected and the range in EBVs was relatively low. To obtain a sufficient range in EBVs, boars with poorer EBVs would have to be used. Progeny of these boars would have poorer performance and reduced profitability of these progeny would add to the costs of the trial. Boar EBV accuracies can also affect the outcome of a trial, which may require the use of older boars whose EBVs are estimated with higher accuracy. These boars would likely be of lower genetic merit when compared to selected younger boars.

Further reading

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 found at http://npip.une.edu.au

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