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Using EBVs and $Index Values in beef breeding

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Introduction

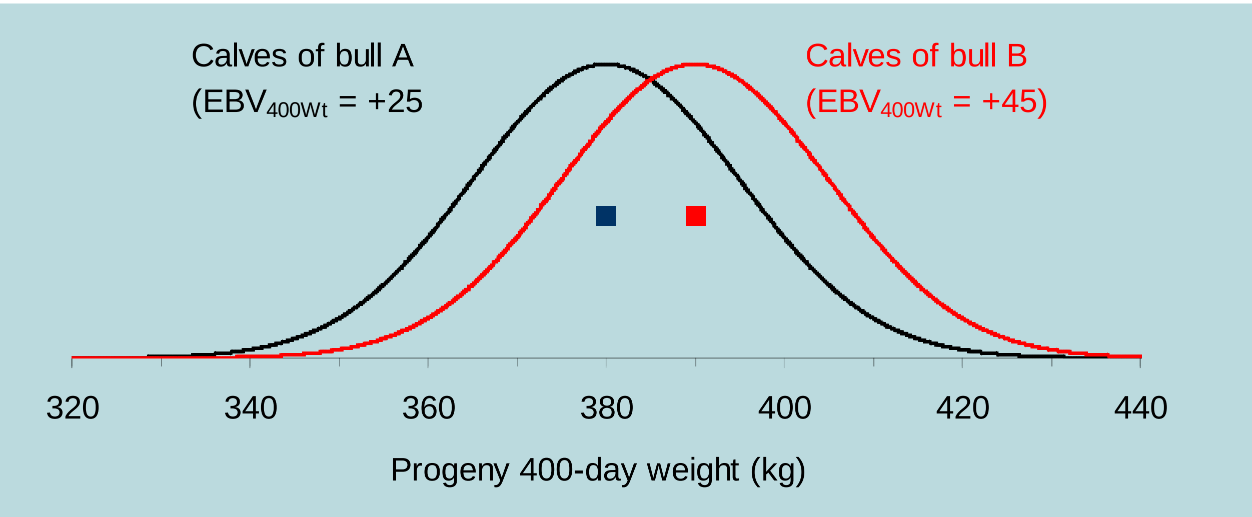
The genetic variability that exists among animals provides an important opportunity to improve the future performance and profitability of your beef herd. The first step in exploiting this variability is to develop a breeding plan for your herd, including a description of your breeding goals/objectives for improvement of your herd. Once these breeding goals have been established they should be the single focus for your bull selection decisions. For more information on developing a breeding plan and breeding objective for your herd, see Primefact 620 *Developing an effective breeding plan for your beef business.*

For many important economic traits Estimated Breeding Values (EBVs) are available to help you choose the right bull to fit your breeding goals. EBVs are calculated by using BREEDPLAN, an advanced genetic evaluation system, developed by the Animal Genetics and Breeding Unit at Armidale, that makes optimal use of pedigree and performance data to estimate differences in the genetic merit of animals for a range of economically important characteristics (traits). (The Animal Genetics and Breeding Unit is a joint institute of NSW Department of Primary Industries and the University of New England.) A brief explanation of the available EBVs for various traits is given in Box 1 on page 5.

A lot of material is available from breed societies and from the BREEDPLAN web site explaining the basis of EBVs and how they can be used to help in bull selection (e.g. see http://breedplan.une.edu.au). The following example illustrates the use of EBVs to help evaluate the likely economic benefits from purchasing a bull with superior EBV for 400-day weight (EBV_{400Wt}).

Suppose, for example, that the average 400-day weight of the progeny of a particular sire ('Bull A') with an EBV_{400Wt} of +25, under a particular

Figure 1. Examples of distributions of 400-day weight for progeny of bulls with different EBV_{400Wt}.



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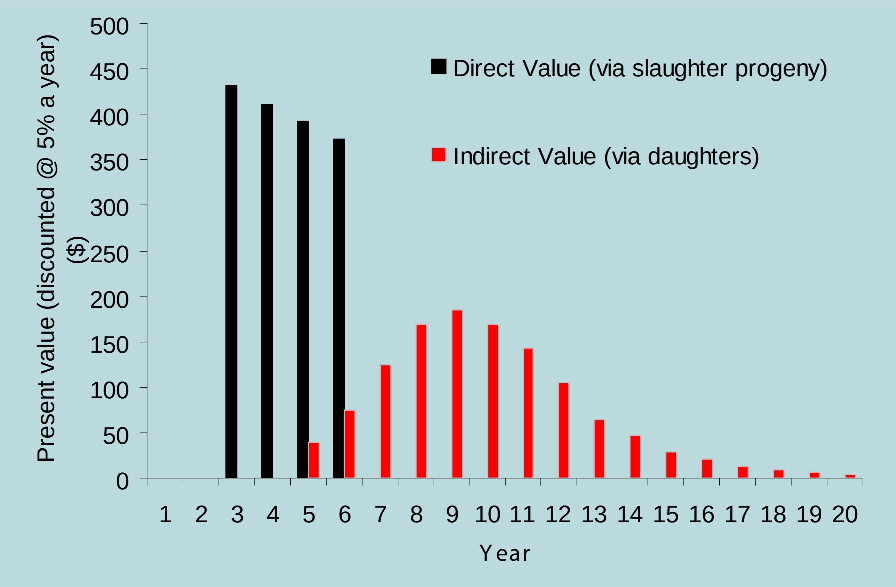

Figure 2. Expected Net Present Value (NPV) of future direct and indirect (via daughters) financial benefits in a commercial beef herd from using a sire with superior 400-day weight EBV; see text for assumptions.

environment and management system, was 380 kg. From the same herd, and under the same environment and management regime, we would expect the progeny of a sire ('Bull B') with an EBV_{400Wt} of +45 to achieve an average 400-day weight of 390 kg (i.e. an average of 10 kg higher than progeny of Bull A). Figure 1 illustrates the expected distributions of 400-day weights among the progeny of Bull A and Bull B.

If we follow the example further and make some additional assumptions regarding herd structure, the anticipated working life of the selected bulls and the value of the additional sale weight, it is possible to estimate the expected additional revenue obtained from the superior performance of the progeny of Bull B.

Suppose, for example, that the bulls are joined to 35 cows each year for 4 years and the herd achieves an average weaning rate of 90 per cent. If an average of 7 daughters of each bull were retained each year as replacements, then each bull would be expected to produce a total of about 100 sale progeny. Also, assume that the value of each additional kilogram of 400-day weight is $1.80. If future revenue is discounted at a rate of 7 per cent a year, we can calculate that the expected Net Present Value (NPV) of the higher 400-day weight performance of the slaughter progeny by using Bull B is approximately $1,330. We can also calculate that the further potential long-term gains in performance in future generations obtained from retaining genetically improved replacement females would equate to an additional NPV of approximately $900, giving an expected total NPV of about $2,230 from using Bull B instead of Bull A. Figure 2 illustrates the expected flow of potential 'direct' (via slaughter progeny) and 'indirect' (via descendants of replacement daughters) financial returns over time from using Bull B.

The above comparison is of course sensitive to the various assumptions used in the analysis, and it ignores any genetic differences between the bulls for other traits influencing profitability. Different results can be obtained by varying factors such as the assumed value for extra sale weight, herd structure, or mating ratio.

Multi-trait selection

In an ideal situation it would be desirable to select animals that excel in all traits. However, in reality, it is always necessary to make some compromises in balancing the strengths and weaknesses among the animals available for selection.

Through careful analysis and experience it may be possible to determine for each trait your own set of 'optimal' EBVs that can be used as a target in your selection decisions. If you use this approach it is important to base your 'optimum' EBV levels on a sound economic basis and not simply on arbitrary targets.

EBV percentile band tables can be a useful guide to the relative ranking of an animal for each trait compared with other animals in the same breed. These tables are normally included in the 'Sire Summary' reports published by the various breed societies.

Despite the intuitive appeal of setting target EBVs for selection it is often difficult to identify sufficient animals that fit your targets for each trait. Also, it can be difficult to reconcile cases where individual animals excel in some traits, but fall below your standards in other traits. For example, if a bull's Birth Weight EBV is just outside the desired range, but his 600-day Weight and Intramuscular Fat (IMF) percentage EBVs are right on target, should you use him?

Genetic variability between animals provides the opportunity to improve future performance. Photo: Brian Cumming

With the large number of EBVs to be taken into account in any selection decision it is often difficult to decide on the relative emphasis you should apply to each trait. For example, if your main market target is the production of feeder steers for the long-fed Japanese B3 market, how much emphasis should you place on IMF percentage (marbling) EBVs compared with EBVs for growth, carcase yield and fertility traits?

These problems can be largely overcome by the use of a selection index. This is a procedure for combining individual EBVs into a single ‘overall EBV’. EBVs are combined on the basis of their relative economic importance for a particular situation and the scope for genetic change of each trait. The poultry and pork industries have made substantial use of selection indexes for many years. To a lesser extent the dairy and wool industries have also used selection indexes. Beef producers can now also use this technology to help establish balanced breeding objectives and rank animals for selection.

Using a selection index

A software program called BreedObject has been developed by the Animal Genetics and Breeding Unit to help design customised breeding objectives and associated selection indexes for beef producers in different environments targeting various markets.

BreedObject uses estimates of the genetic relationships between EBVs and the various economic traits in the breeding objective to determine a set of index weighting factors to apply to each EBV. The individual EBVs are multiplied by these weighting factors and summed to produce an overall $Index Value for each animal. The weighting factors take account of the relative economic importance of the traits in the breeding objective and the capacity to change them through selection on EBVs. Whereas selection on the basis of the $Index Value will maximise the genetic progress towards your chosen breeding objective, further selection can be applied where you are uncomfortable with some of the individual EBVs for particular bulls, or when you have additional knowledge relating to non-EBV criteria.

Most breed societies have developed case study examples of selection indexes using typical production and economic information for representative herds with particular market targets. In some cases, $Index Values for individual animals have been calculated and published in on-line searchable databases on breed society websites (e.g. see links from http://breedplan.une.edu.au).

BreedObject can be used to establish a customised selection index for your particular situation. An online questionnaire needs to be completed to provide information on production costs, performance levels and market targets. This information is used to derive both the relative economic values of different traits and the index weighting factors to be applied to the EBVs for potential candidate animals for selection. Further information on BreedObject can be obtained from the website http://www.breedobject.com.

Using $Index Values to determine how much to pay for a ‘superior’ bull

Individual EBVs can be used to predict differences between animals in the likely performance of their progeny for particular traits. In a similar way, $Index

Table 1. Impact of the $Index Value difference between bulls, and the number of cows joined during the bull's herd life, on the expected additional profit generated across the supply chain.

$Index difference	No. of cows joined				
	50	100	150	200	250
	Additional profit				
+ $10	$250	$500	$750	$1,000	$1,250
+ $20	$500	$1,000	$1,500	$2,000	$2,500
+ $30	$750	$1,500	$2,250	$3,000	$3,750
+ $40	$1,000	$2,000	$3,000	$4,000	$5,000

Values can be used to predict differences in profit resulting from the use of one bull over another.

For example, if we compare a bull with a $Index Value of +$60 to another bull with an $Index Value of +$30 for the same breeding objective, the first bull has the potential to produce an additional ½ × ($60 – $30) = $15 per cow joined (progeny receive only half of the $Index Value differences between the bulls, as half of their genes come from their dams). If the bull were joined to a total of 200 cows during his herd life, then the superior bull would have the potential to generate an additional (200 × $ 15.00) = $3,000 revenue across the supply chain compared with the inferior bull.

Table 1 shows the impact of the number of cows joined during a bull's herd life on the expected extra revenue generated across the supply chain for a range of $Index Value differences between bulls.

Capturing the benefits

When you are investing in 'superior' genetics (particularly for carcase traits) it is important to consider your ability to capture the expected economic benefits generated across the supply chain as a result of the improved performance of future progeny. Unfortunately, many commercial beef producers simply sell on the open 'commodity' market where there is little opportunity to capture a share of the added value resulting from improved end-product performance. Efforts must be made to recoup the benefits (e.g. through programs allowing retained ownership to slaughter, or involvement in alliances that use genuine value-based payment systems). Otherwise, it will be difficult

$Index Values can be used to predict differences in profit resulting from the use of one bull over another. Photo: Brian Cumming

to economically justify any investment in genetic improvement achieved by using $Index Values to predict differences in the profit resulting from the use of one bull over another.

Managing risk

Because of the imperfect inheritance of most traits of economic importance and the random processes involved in gene transmission from one generation to the next, it is impossible to totally manage the risk associated with investment in genetic improvement. Nevertheless, it is possible to minimize the risk of failure by considering some simple principles.

First, the higher the accuracy of the EBVs among replacement sires the lower the risk that the EBVs and associated $Index Values will change in the future as more information becomes available. Obviously, if you are selecting among young, unproven bulls the accuracies for most traits will tend to be low, or moderate at best. In this case the best that you can do is to source your replacement sires from seedstock suppliers with a strong history of diligent performance recording. Also, be aware that just because an animal has an EBV published for a particular trait does not necessarily mean that the animal has been individually recorded for that trait. You should check which traits are routinely recorded by your potential seedstock suppliers. Some breed society websites now list the particular traits that have been recorded for individual animals.

It is important not to get too carried away with the importance of accuracy values. Remember, irrespective of the accuracy values, an animal's EBV for a particular trait, or its $Index Value, is still the best possible estimate of the animal's true genetic merit. Provided that the EBVs are not biased in any way, there is just as much chance that they will change in either a positive direction or a negative direction when extra information is added.

On-line access to EBV and $Index information

Comprehensive online database search facilities are now available to enable breeders to conduct their own research on the availability of animals that meet their particular requirements. These facilities typically include full pedigree and EBV information on all animals recorded on various breed society databases. Several breed societies also provide $Index Values on individual animals for a range of selection index case studies. Links to the various breed society online databases are provided by the BREEDPLAN web site at http://breedplan.une.edu.au.

Box 1. A brief description of EBVs and their accuracies

Calving Ease DIR (%)
Estimates of the genetic differences between animals in the ability of their calves from 2-year-old heifers to be delivered without help.

Calving Ease DTRS (%)
Estimates of the genetic differences between animals in the ability of their 2-year-old daughters to calve without help.

Gestation Length (Days)
Estimates of the genetic differences between animals in the number of days from the date of conception to the calf birth date.

Birth Weight (kg)
Estimates of the genetic differences between animals in calf birth weight.

200-Day Weight (kg)
Estimates of the genetic differences between animals in live weight at 200 days of age.

400-Day Weight (kg)
Estimates of the genetic differences between animals in live weight at 400 days of age.

600-Day Weight (kg)
Estimates of the genetic differences between animals in live weight at 600 days of age.

Mature Cow Weight (kg)
Estimates of the genetic differences between cows in weight at 5 years of age.

Milk (kg)
Estimates of the genetic differences between animals in milk production, expressed as variation in the 200-day weight of their daughter's calves.

Scrotal Size (cm)
Estimates of the genetic differences between animals in scrotal circumference at 400 days of age.

Days to Calving
Estimates of genetic differences in female fertility, expressed as the number of days from the start of the joining period until subsequent calving.

Carcase Weight (kg)
Estimates of the genetic differences between animals in carcase weight, adjusted to 650 days of age.

Eye Muscle Area (cm^2)
Estimates of the genetic differences between animals in eye muscle area at the 12/13th rib site, in a 300-kg carcase.

Rib Fat (mm)
Estimates of the genetic differences between animals in fat depth at the 12/13th rib site, in a 300-kg carcase.

Rump Fat (mm)
Estimates of the genetic differences between animals in fat depth at the P8 rump site, in a 300-kg carcase.

Retail Beef Yield Percentage (RBY%)
Estimates of the genetic differences between animals in percentage retail beef yield, in a 300kg carcase.

Intramuscular Fat Percentage (IMF%)
Estimates of the genetic differences between animals in percentage intramuscular fat (marbling) at the 12/13th rib site, in a 300-kg carcase.

Net Feed Intake (NFI)
Estimates of the genetic differences in feed intake for animals adjusted to the same growth rate and live weight base.

Accuracy (%)
An indication of the reliability of an EBV. As more performance information becomes available on an animal (or its progeny or relatives) the accuracy of its EBVs for particular traits will increase.

Notes: DIR = direct DTRS = daughters

EBVs are calculated by using BREEDPLAN software developed by the Animal Genetics and Breeding Unit, a joint institute of NSW DPI and The University of New England. Ongoing research and development to enhance the BREEDPLAN system is supported by funding provided by Meat and Livestock Australia.

Further reading

Primefact 249 *Checking your bull is ready for joining*

Primefact 620 *Developing an effective breeding plan for your beef business*

Primefact 621 *Market specifications for beef cattle*

Primefact 622 *Live beef cattle assessment*

Primefact 623 *Cattle breed types*

Primefact 624 *Beef cattle breeding systems*

Primefact 626 *Selecting and managing beef heifers*

Primefact 627 *Economic advantages of better management of your beef breeding herd*

Further information

For further information contact your local NSW Department of Primary Industries Livestock Officer (Beef Products).

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