Using genetics to maximise profit for a given beef market

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Over the past 17 years an information system for use by Australian beef cattle breeders has developed into one of the most sophisticated systems in the world. BREEDPLAN is a technically sound genetic evaluation system that is sufficiently flexible and includes enough traits to cater for the great environmental diversity under which cattle are produced in Australia and the variety of markets supplied. Other products such as BreedObject and TGRM have been developed to complement and value add to BREEDPLAN information. Used astutely the tools are available for breeders to tailor cattle to any production system, market combination.

Hammond *et al*. (1992) when describing the modern approach to animal breeding describes three primary components. These being the breeding objective, genetic evaluation and breeding program design. BREEDPLAN and associated products provides the beef cattle breeder with a breeding information system that allows these three steps to be applied at the practical level.

BREEDPLAN version 4.1 (Johnston *et al*. 1999) is the genetic evaluation system for the Australian beef industry that produces EBVs for most of the economically important traits. BreedObject (Barwick *et al*. 1998) uses BREEDPLAN EBVs, the target market specifications and production details from a commercial beef herd to rank animals that will be most suitable for increasing profitability in that scenario. BreedObject defines the breeding objective and calculates appropriate weightings for EBVs (selection criteria). The selection index component of BreedObject formally links the genetic evaluation system, BREEDPLAN, with the breeding objective developed as the first part of BreedObject.

TGRM (Total Genetics Resource Management) (Meszaros 1999, Vagg *et al*. 1999) is a computer program designed to help achieve maximum genetic gain with a minimum of inbreeding. TGRM maximises the index value of the progeny within given constraints while controlling the rate of inbreeding.

BreedObject

The first step in designing an effective breeding program is to develop the breeding objective. The breeding objective answers the question, what should we be breeding for? The breeding objective is basically a genetic job description. It describes the traits affecting profit and how important each is to the profit change you can make by breeding.

An objective will be specific to the market being supplied and the production environment in which production is occurring as well as the current level of herd performance. Economic considerations need to encompass all the factors affecting returns and costs. Returns are a function of the weight and price per unit of product sold, having regards to any premiums and discounts applying to particular traits. Cost of supplying extra feed, time taken to manage calving heifers and the cost of labour are examples of the costs included.

Using this economic data, the value of a one unit increase in each trait of the breeding objective is assessed while holding all other traits constant. An example of the traits included in an objective and the economic values of traits is shown in table 1. Economic values are discounted for time of expression and the flow on benefit to later generations is included. Negative values (eg cow weight) mean that an increase will reduce profit.

Relative economic values, being the value of one genetic standard deviation of change in each trait are shown in the third column of table 1 entitled Relative Economic Values. These values give the relative importance of each trait for breeding. In this example for a Bos indicus breed supplying a grassfed export market, weaning rate is most important followed by saleweight, cow survival rate and saleable meat yield. This trait importance can change for different production systems and market endpoints. It can also differ among breeds addressing similar markets.

Table1: Traits in the breeding objective, economic values and relative economic values for Bos indicus breed supplying a grassfed export market

Trait	Economic Values	Rel. Econ. Values
Sale Liveweight Dir.	0.406 $/Kg	15.1 $
Sale Liveweight Mat.	0.246 $/Kg	1.2 $
Dressing %	5.434 $/%	5.6 $
Saleable Meat %	4.343 $/%	6.4 $
Fat Depth (rump)	2.121 $/MM	2.7 $
Cow Weaning Rate	1.906 $/%	19.9 $
Marbling Score	0.000 $/scor	0.0 $
Cow Survival Rate	2.599 $/%	7.7 $
Cow Weight	0.029 $/Kg	1.0 $
Calving Ease - dir.	0.215 $/%	0.2 $
Calving Ease - mat.	0.078 $/%	0.1 $

Once the breeding objective has been developed the next step is to apply it to a set of data to assist in the selection process. Information available on the animals will not be exactly the same as the traits in the breeding objective. For example the liveweight of economic interest is

the sale weight of steers and surplus females from the commercial herd, whereas BREEDPLAN weight EBVs are calculated on young bulls and heifers in the seedstock herd from weights taken at prescribed ages. The genetic relationship (genetic correlations) between the traits in the breeding objective and the EBVs are used, together with the assessed economic importance of traits, to calculate the appropriate weighting for each EBV. Table 2 shows the EBV weightings for the same example shown in table 1. These weightings describe the aggregate EBV, or Index, that best addresses the breeding objective.

Table 2: EBVs and weightings

EBV	Index Weighting
Calving Ease - dir.	3.127
Calving Ease - mat.	5.96
Birth Weight - direct	-0.387
200-day Milk	-0.188
200-day Growth	-0.037
400-day Weight	0.021
600-day Weight	0.651
Days to Calving	-0.568
Scrotal Size	1.321
Carc. Fat Depth	1.07
Carc. Retail Beef Tld%	3.746
Mature Cow Weight	0.024

For each animal the weightings are multiplied by the appropriate EBV value for that animal and summed to give an overall figure, the index value. These index values allow you to rank animals on the basis of potential profit from progeny.

BreedObject consequently performs three tasks;

1. derives the breeding objective (from economic inputs provided)
2. provides optimum weightings on EBVs to target that breeding objective
3. applies the weightings to rank animals available for selection.

These three steps very effectively combine economics with genetic principles and the level of information on animals available for selection. The economic component says which direction breeding should go. What is able to be achieved is then a function of the information available to make the selection and the animals available for selection.

BREEDPLAN

Of the suite of technologies involved in the information system for genetic improvement of beef cattle, BREEDPLAN was the first developed. Behind BREEDPLAN there is some simple genetic theory (half the genes come from each parent), sophisticated statistical procedures, technically advanced computer software and a large bank of data. A considerable amount of computer grunt is needed to produce the EBVs that are the outcome. But the concept is very simple. Take as much good information as possible about an animal and use that information to predict what his/her progeny will be like.

So why does the beef industry need EBVs? Most traits of beef cattle that we would like to improve have low to moderate heritability. Of the differences you see in a group of animals treated alike, only about 30% will be passed onto their progeny. BREEDPLAN by combining recorded observations (mostly objectively measured) with the pedigree will greatly improve the accuracy of selection. No longer does the selection decision rely totally on one observation. An estimated breeding value (EBV) is based on observations on the individual as well as observations on all known relatives within the recorded population and on related traits.

If a trait is very highly heritable there is no reason to calculate an EBV, but the fact of the matter is that none of the important traits are very highly heritable. What you see isn't what you get, in the progeny, that's why EBVs are essential for increased accuracy of selection. Even traits that we commonly refer to as highly heritable are only about 50% heritable

Then there are traits that you can't readily see such as marbling or female fertility. Using the known association between traits, by taking measurements over the life of animals and by using sophisticated measurement techniques such as ultrasound scanning BREEDPLAN builds up a genetic profile for a suite of traits that relate to profitability.

BREEDPLAN was first used in the beef industry in 1985. Developments over time have seen the inclusion of many more EBVs so that now most of the important traits are addressed. The complexes of weight, carcase yield and fertility are covered reasonably well and recent developments have seen the first attempts at providing information on feed intake which is the major cost of beef enterprises. A description of BREEDPLAN and the individual EBVs provided by BREEDPLAN can be found on most breed society websites and in breed society sire summary reports.

TGRM

Total Genetic Resource Management (TGRM) works at the level of breeding program design providing assistance with selection and mate allocation. Having developed an objective and chosen the index that will rank animals on their suitability for meeting that objective, TGRM allocates matings that will maximise index value in the progeny while controlling inbreeding to a level specified by the breeder.

TGRM is a powerful new concept for exploiting state-of-the-art genetic technologies in genetic improvement programs. It can accommodate key technical, logistical and cost issues, as well as producer attitudes. Applications to date have involved DNA markers, subjective structural assessments, embryo transfer, maintenance of genetic diversity, inbreeding, and multiple market end-points.

Independent culling levels can be imposed on individual traits should the breeder feel it is necessary but if the breeding objective and index has been developed correctly the need for this should be minimal. Breeders will often use this to limit birthweight, independent of the emphasis given to it by the index. In some cases this is a lifestyle (I don't want to pull any calves) rather than a straight profit driven decision. Using these facilities more than one index can be considered if the breeder believes he needs to address more than one market/ production environment scenario. The primary index is the one being maximised but a limit (usually lower) can be placed on any other index at the same time.

TGRM reports sire usage average progeny trait performance and mate allocations for each female in the herd. At the operational level a histogram display of trait distributions is available for interactive decision making.

While the most apparent advantage of TGRM is in the mate allocation area it is also a valuable selection tool. Selection is dynamic attempting to achieve the goals set while considering the sires and dams that are available. The value as a selection tool is often overlooked especially for females where the breeder will often preselect females and leave no room for selection. This is a reality of beef breeding where culling of females is generally for non-genetic reasons such as pregnancy status. Selecting females for AI or ET work however would benefit from using the selection capabilities of TGRM.

TGRM works with Breedplan and BreedObject to provide a complete solution.

Using All Available Genetic Resources

The discussion to this point has focused on the use of genetic selection within breed but the beef breeder has access to a much wider diversity of resources than just selection within breed. To make the best use of these resources they must:

- select the most profitable breed or breeds
- select the best breeding system – choose a crossbreeding system if it is economically advantageous
- having chosen the breed you are going to use, select the most profitable bull to mate to the current cow herd.

It may appear that to include this at this point in the paper is an after-thought but the fact is that the principles described above will hold in many cases just as well for designing a crossbreeding system as it does for a straightbreeding. You still need to go through the process of deciding what traits are most profitable – BreedObject – and what is the best mate allocations – TGRM. However the breeding values aren't as easy to access as currently there is no formalised process to compare animals across breeds nor to estimate the hybrid vigour; two essential components of a crossbreeding system. To design a profitable crossbreeding system you will need to do some research yourself or use a consultant who has intimate knowledge of breed comparisons and hybrid vigour.

Conclusion

Australian beef cattle breeders are well serviced with an information system that facilitates genetic improvement at a rapid rate. Genetic improvement of profitability is the target. This is possible as most of the economically important traits are addressed.

Seedstock breeders, on whom the industry depends for genetic improvement, have available systems for data recording, evaluation and conversion of the information into selection decisions. Commercial breeders can select bulls that will increase profitability of their commercial progeny.

Breeds more commonly used in the north have been slower to adopt the currently available technology mainly due to difficulties of recording data under the extensive management that is normal for this environment. We are however seeing an encouraging increase in the data from scanning and for the reproductive traits. Genetic improvement is a source of improved profits so the more widespread use of advanced technologies should be promoted.

References

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Notes