More protifable beef cattle by genetic improvement - balancing your breeding program

Wayne Upton and Peter Parnell
Animal Genetics & Breeding Unit, University of New England, Armidale NSW 2351 • Ph: (02) 6773 3141 • Fax: (02) 6773 3266 • Email: wupton@metz.une.edu.au

Introduction

Most beef producers want to increase the returns from their beef enterprises so it is reasonable to assume that profitability is the major production objective. However the definition of what will increase profit is somewhat difficult. Being able to determine the profit of an individual enterprise and identifying what makes up that profit is essential to planning change and improvements.

There are many characteristics of animals that contribute to profit. It would be ideal to select animals that excel in all traits related to profit but in reality this is not possible; a compromise is always necessary. In the context of making genetic change you must determine if the characteristic related to profit is under a level of genetic control (what is the heritability of the characteristic).

Once you have decided what characteristics are important and whether or not they have high or low heritability you can formulate a plan for improvement. Some characteristics you will improve by genetic selection others you may decide to improve by nutrition or management. The rest of this paper will concentrate on genetic improvement but you should never discount the importance of making sure the whole system is working to maximise the outcome.

Genetics sets the base to which, management and nutrition will value add. The seed stock breeder designs the genetic package. This statement is true if we accept that most of the genetic improvement at the commercial herd level comes from the sires introduced. Selection of females plays a minor part but they are still daughters of previously introduced sires.

The seedstock breeder however is totally dependent on his commercial bull buying clients. Without them the seedstock breeder doesn't have a business. The definition of more profitable animals has to be based on profit at the commercial herd level and associated finishing systems. Genetics must be profitable for all sectors of the production chain or at some point they will be devalued.

In recent years researchers at AGBU have integrated genetics and economics to define genetic improvement in economic terms. The economic terms are those of the commercial herd and associated finishing systems, including grass fatteners and feedlots. The result is an index that describes profitability of animals based on the summation of their individual traits or EBVs.

Breeders now have access to GROUP BREEDPLAN Estimated Breeding Values (EBVs) for a range of traits and index values that describe the profitability of animals for different market and production systems. Through the use of these EBVs and indexes it is possible to achieve a high probability of selecting the best animals for your production environment and customer requirements.

Effective breeding for future markets requires the development of a vision of future customer requirements and the implementation of a planned breeding program that balances these requirements with on-farm production targets Unfortunately, many beef producers only achieve a fraction of the potential economic gains achievable through effective genetic selection. In many cases producers have not adequately identified appropriate breeding goals (objectives) to exploit their production situation and market opportunities, nor have they planned effective selection strategies to achieve genetic progress towards greater profitability. This paper provides a simple framework for defining breeding objectives and for planning an effective breeding program to exploit the opportunities provided by genetic improvement. In addition, it discusses the use of selection strategies that optimize progress towards a given set of breeding objectives.

Setting the direction of your breeding program

The first, and most important step in planning an effective breeding program is to establish a clear set of breeding objectives for your herd. This involves analysing the current performance of your herd and comparing this with the anticipated requirements of your future customers and with your herd production targets. Once you have completed this exercise you will be well situated to specify the characteristics required in replacement breeding stock to meet your breeding goals.

The worksheet in Appendix 2 can be used to assist you in establishing balanced breeding objectives for your herd. The steps required to complete the worksheet are as follows:

Step 1. List the traits of economic importance

List only those traits of real economic importance to your customers and/or your herd's future productivity. This will include traits influencing reproductive performance, growth, carcase yield and meat quality. You may also wish to include traits such as temperament and structural soundness.

Step 2. List your customer's requirements

Remember "the breeding for today is already done". Your breeding objectives should relate to your vision of likely future market demands in at least 3 to 5 years time. That is when the results of your current breeding decisions will be realised.

Obviously it is impossible to be definite about future market opportunities. Nevertheless, careful analysis of market forecasts and trends in consumer demand can provide some "best-bet" insights into likely future customer requirements. The beef producer is just like any other businessman when it comes to making decisions about future markets. He must use the best information to be found to make sound business decisions.

Due to the uncertainty of predicting future market opportunities it is important that your breeding objectives are designed to ensure that future generations of progeny have a high degree of versatility and the ability to match a range of production and market situations.

Experience has shown that using a balanced approach to breeding where all traits are considered will give you a degree of versatility. Major problems arise when single trait selection is practiced and extremes in one trait are used. Animals that may be selected for a specialist market objective such as the long fed Japanese market will still have acceptable EBV values for a supermarket objective. However the progress in the second objective will be sub-optimal; for example you may have unnecessarily wasted selection pressure on marbling but you have still made forward progress for weight, calving ease and retail beef yield. If objectives are designed properly there are very few objectives that will take you in the opposite direction for a second another objective.

Step 3. List your future herd production targets

In order to optimise the use of the land and feed resources allocated to your cattle enterprise it is important to set realistic targets for weaning rates, calving spread, turn-off weights etc.

This may require an investigation of the typical production levels achieved by other producers in your region. Don't be too conservative. It is a good practice to set targets for your herd which are at least as good or better than the top 25% of herds in your region.

Step 4. List your herd's current performance

This is often the most difficult step in many situations. It requires knowledge of your current herd production levels (e.g. weaning rates, percentage of difficult calvings, turn-off weights). It will also require feedback from your customers on the performance of your stock further along the production and marketing chain (e.g. growth rates during the back grounding and finishing phases, carcase yield and meat quality). Appendix 3 is a quick reference sheet of questions you may need to answer in order to determine your current performance.

It is difficult to determine what direction you should be shifting your herd to achieve your future targets unless you have a good understanding of the base from where you are starting. If you haven't been collecting relevant production data and market feedback information then now is a good time to start.

Step 5. List your breeding goals

By comparing your current performance levels with your future herd production targets and future customer's requirements you can identify those traits that need to be emphasised in your selection and bull purchase decisions.

For example, if your customer feedback indicates that your steers tend to be too light with excessive fat cover, and then maybe you need to select bulls with greater growth potential and increased leanness. If your calving rates are less than optimal for your environment, or your calving spread too long, then maybe you should be placing greater emphasis on female fertility and/or reducing the milk production potential of your cows to give them a better chance of re-breeding early in the joining season. Once again Appendix 3 helps you decide this. If you do an audit on the bulls you have purchased over the last few years and find that they are in the top 20% for growth in the chosen breed then the potential to improve growth by genetics is not very high. Maybe you need to look at nutrition. However if the bulls have been below breed average then you have scope to make genetic improvement.

Step 6. List your selection criteria

Once you have determined your breeding goals the next step is to list the relevant selection criteria that are available to assist in meeting these goals. For many important economic traits there are Estimated Breeding Values (EBVs) available to assist in ranking potential candidate animals for selection.

For example, if one of your breeding objectives is to reduce the incidence of calving difficulty in your herd then relevant selection criteria include Group BREEDPLAN EBVs for Birth Weight and Calving Ease. If a breeding goal is to increase retail beef yield then relevant selection criteria include EBVs for Eye Muscle Area, Fat Depth and Retail Beef Yield %.

Unfortunately, not all economically important traits have objective measurements available. Selection for structural soundness and temperament still require visual assessment and judgment.

When listing your selection criteria remember that the more traits you consider the less progress you are likely to make for any particular trait. While single-trait selection is rarely an optimal breeding strategy it is just as important not to try to incorporate too many traits into your selection program. It is important that each selection criteria is related to a breeding goal having real economic importance.

Step 7. Prioritize the selection criteria

In most cases, there will be several traits identified as requiring some emphasis in your breeding program. Once you have identified the relevant selection criteria it is important to establish their relative importance. This will require some knowledge of the scope for genetic improvement of the various traits, the genetic relationships between traits (both favourable and antagonistic) and the relative economic importance of genetic improvement in each trait. The best way to do this is with a selection index package such as BreedObject. This formalised approach will balance all considerations, genetic and economic.

When determining priorities for selection it is important to distinguish between the benefits of achieving gains in your current herd from those obtained from gains in future herd performance. The optimum balance between reproduction, growth and carcase traits to maximise profitability from the current herd will differ from the optimum balance for future herd profitability.

For example, due to the economic importance of maximising the number of live calves born, reproduction traits usually demand greater emphasis when considering culling strategies for the current herd. However, after consideration of its low heritability and limited scope for genetic change, fertility usually commands less emphasis in selection to improve future profitability. It is more economically sound and achievable to make improvements in fertility first by culling non-performers from the current cowherd eg. pregnancy test and cull empties. A true balanced index will still place emphasis on fertility at the genetic level but it will be slower progress.

Strategies For Mult-Trait Selection

In an ideal situation it would be desirable to select animals that excel in all traits. But, 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 weightings" for Group BREEDPLAN EBVs that can be used as a target in your selection decisions. If this approach is used then 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 used as a useful guide to the relative ranking of an animal for each trait compared with other animals in the same breed.

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 for some traits, but fall below your standards for other traits. For example, if a bull's Birth Wt EBV is just outside the desired range, but his 600-Day Weight and IMF% EBVs are right on target, should you use him?

With the large number of EBVs to be taken into account in any selection decision it is often difficult to decide what relative emphasis should be applied to each trait. For example, if your main market target is the Japanese B3 market how much emphasis should you place on IMF% (Marbling) EBVs compared to EBVs for growth, carcase yield and fertility traits?

These problems can be largely overcome through the use of a selection index. This is a procedure for combining individual EBVs into a single "overall EBV". The 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 assist in the establishment of balanced breeding objectives and in the ranking of animals for selection.

Using a Selection Index

The Animal Genetics and Breeding Unit (AGBU) to assist in the design of customised breeding objectives for individual beef producers in different environments targeting different markets have developed a software program called Breedobject. It is also being used by breed societies to develop standard cases for use by members who don't want to go to the effort of developing their own. The program calculates $Index Values which provide an overall ranking of animals on the balance of their Group BREEDPLAN EBVs to suit a particular breeding objective.

Individual EBVs can be used to predict differences between animals in the likely progeny performance for particular traits. In a similar way, $Index Values can be used to predict differences in the net profit resulting from the use of one bull over another. For example, a bull with a $Index Value of +$60 compared to another bull with a $Index Value of +$30 for the same breeding objective; the first bull has the potential to produce an additional ½ x ($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 was joined to a total of 200 cows during his herd life, then it is predicted that the superior bull has the potential to generate an additional (200 x $15.00) = $3,000 more revenue than the inferior bull.

Examples of the use of Selection Indexes

Two example selection indexes are shown below to demonstrate the application of selection index technology for different market targets. In each example, typical production parameters, prices and production costs were used for a self-replacing commercial beef enterprise operating in temperate Australia in 2001. It was assumed that the enterprise obtains benefits from improved carcase performance (eg. via retained ownership to slaughter) in addition to improved herd productivity. It was assumed that feed was a limiting resource for a large part of the year and any increase in herd feed requirements has a cost. An average calving rate of 85% was used, with a moderate concern for calving difficulty.

The Japanese B3 Index was derived for an example enterprise targeting the production of steers for the long-fed export markets that value marbling. The Domestic Supermarket Index was derived for an example enterprise targeting grass-finished production for the domestic supermarket trade with no marbling requirement.

The emphasis on various economic traits included in the breeding objectives derived for each example is shown in Figure 1.

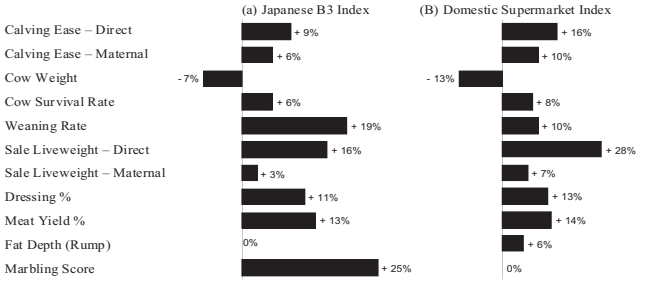

Figure 1. Percentage emphasis on each economic trait for example selection indexes derived for self-replacing commercial beef enterprises targeting (a) Japanese B3 market and (b) Domestic supermarket.

For the Japanese B3 Index marbling score is the most important trait followed by weaning rate and sale weight. For the Domestic Supermarket Index sale weight is the most important trait. Meat yield traits (saleable meat % and dressing %) and calving ease traits are also important in both examples.

While the percentage emphasis on each economic trait in an index provides an indication of what traits are most important for particular situations the potential genetic change achieved by using the index in selection decisions will depend on the EBVs that are available, and how they are related to the economic traits contributing to the overall breeding objective.

BreedObject translates the relative economic importance of the traits listed above to the appropriate weightings for available EBVs through known genetic relationships (genetic correlations). 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. While selection on the basis of the $Index Value will maximise the genetic progress towards the chosen breeding objective, further selection can be applied where you are uncomfortable with some of the individual EBVs for particular bulls, or have additional knowledge relating to non-EBV criteria.

Develop your own customized selection index

Breedobject can be used to establish a customised selection index for your particular situation. A questionnaire needs to be completed to provide information on production costs, performance levels and market targets. This information is used to derive the relative economic values of different traits, and the index weighting factors to be applied to the EBVs for potential candidate animals for selection.

Use Your Criteria In Sire Selection

Once you have identified you're breeding goals and prioritized the associated selection criteria it is important to use this information in all future sire selection decisions.

The accuracy and intensity of sire selection is generally much greater than it is for female selection. Consequently, the sire selection policy will usually dominate the direction of genetic change in a herd. Most breeders consider that their breeding females are the foundation of their herd. But, many fail to recognize that the sires used over the last few generations largely determine the genetic composition of any self-replacing herd.

In any particular calf crop, half of the genes come from the sire(s) of these calves. In addition, an average of one-quarter of the genes come via their dams from their maternal grandsire(s) and another one-eighth of the genes come from their maternal great-grandsire(s). That's a total of over 87% of the genetic composition of the current drop of calves influenced by the sire selection policy over the last 3 generations. Consequently, sire selection and/or purchase decisions should be viewed as an important investment into the future performance of your herd.

Conclusion

Significant opportunities exist for the use of genetic improvement to improve the long-term profitability of commercial beef enterprises. The beef industry is equipped with the knowledge and tools to make faster genetic progress than any other time in history. Unfortunately, most beef producers will fail obtain the full potential benefits from genetic improvement due to inadequate planning of their breeding objectives.

In order to fully benefit from genetic improvement it is essential to carefully plan the appropriate direction for your breeding program, and to persist with a long-term strategy to pursue this direction, despite the pressures of short and medium-term challenges to the enterprise.

All decisions made with respect to the breeding program must be made using sound economic and genetic principles. The tools available to the Australian beef breeder to assist in these decisions, are world class and every breeder should become familiar with the tools and use them to achieve long term genetic improvement.

Acknowledgements

The authors gratefully acknowledge Dr Steve Barwick, Animal Genetics and Breeding Unit, UNE; and, Mr Bob Dent, Extension and Youth Manager, The Angus Society of Australia; for their assistance in developing the ideas and material presented in this paper. Meat and Livestock Australia, NSW Agriculture and the University of New England provide financial support for the ongoing development of Group Breedplan and BreedObject technology.

Notes

Appendix 1
Examples of establishing breeding objectives

Tables 1 and 2 show completed work sheets used for establishing breeding objectives in two case study situations.

In the first example (Table 1), the major target is the production of feeder steers for the Japanese B3 market. The breeder has identified that the major breeding goals are to increase steer turn-off weight, carcase weight and marbling performance. Some emphasis is also required on improving retail beef yield, heifer calving ease and weaning rates. Appropriate emphasis should be placed on the various EBVs related to these traits.

In the second example (Table 2) the major target is the production of yearling cattle suitable for the domestic supermarket trade. It was determined in this example that the major emphasis should be placed on increasing sale weights and carcase weights; with some emphasis also on improving finishing ability, heifer calving ease, female fertility and reducing mature cow size. Again, relevant EBVs are available to assist in selection of animals to improve these traits.

Table 1. Example of a completed worksheet for establishing breeding objectives in a situation where the main market target is the production of feeder steers for the Japanese B3 market.

Trait	Future customer's requirements	Future herd production targets	Current performance level	Breeding goals	Selection criteria	Relative importance
Sale weight of steers		380-420 kg @ 16 months	360-400 kg @ 16 months	Increase steer weight at turn-off	↑$EBV_{600\ Wt}$	****
Carcase weight	400 -420 kg @ 26 months	-	370 - 400 kg @ 26 months	Increase carcase weight of steers	↑$EBV_{600\ Wt}$	****
Retail Beef Yield	68 - 70 %	-	65 - 67 %	Increase retail beef yield	↑$EBV_{RBY\ \%}$	** ** **
Marble Score	> 3	-	1 - 4 (40% > 3)	Increase marble score	↓$EBV_{P8\ Fat}$ ↑EBV_{EMA} ↑$EBV_{IMF\%}$	****
Heifer calving difficulty	-	< 5 %	5 %	Maintain heifer calving ease	↑$EBV_{CE\ DIR}$	** ** **
Weaning rate	-	> 90%	85 %	Improve female fertility	↑$EBV_{CE\ DTR}$ ~$EBV_{Bth.\ Wt}$ ↕EBV_{SS}? ↓EBV_{DC}	* ***

Appendix 1
Examples of establishing breeding objectives

Table 2. Example of a completed worksheet for establishing breeding objectives in a situation where the main market target is the production of yearling cattle suitable for the domestic supermarket trade.

Trait	Future customer's requirements	Future herd production targets	Current performance level	Breeding goals	Selection criteria	Relative importance
Sale weight of steers	-	200-230 kg @ 15 months	170-210 kg @ 15 months	Increase steer weight at turnoff	↑$EBV_{400\ Wt}$	****
Carcase weight	180-230 kg (milk teeth)	-	-	Increase carcase weight	↑$EBV_{400\ Wt}$	****
Fat depth	6-12 mm	-	4 - 8 mm	Improve finishing ability	↑$EBV_{P8\ Fat}$	**
Heifer calving difficulty	-	< 5 % in heifers	10 % in heifers	Improve heifer calving ease	↑$EBV_{CE\ DIR}$ ↑$EBV_{CE\ DTR}$	** **
Weaning rate	-	> 90%	85 %	Improve female fertility	~$EBV_{Bth.\ Wt}$	** ***
Mature Cow Weight		450 – 500 kgs	480 – 520 kgs	Reduce mature cow weight	↑EBV_{SS} ↓EBV_{DC} ↓EBV_{MWt}	*

Appendix 2
Worksheet for establishing balanced breeding objectives

STEP 1 List traits of economic importance	
STEP 2 List future customers requirements	
STEP 3 List future herd production Targets	
STEP 4 List current performance levels	
STEP 5 List breeding goals	
STEP 6 List selection criteria	
STEP 7 Prioritise selection criteria NB Best done using BreedObject index	

Appendix 3

Are your sires up to scratch?

(this should help you fill in Steps 4 and 5 of the Worksheet in Appendix 2)

To complete this task you will require

1. A recent kill sheet of stock killed for your main target market and some indication from the buyer of what he expects; or what the average is for similar stock in the current season.

2. EBVs on purchased sires (this may be available in the catalogue of the sale from which you bought the sires, from published sire summaries or from the web. Failing these sources you may need to contact the vendor)

Some indicators of performance. **Implications**

From kill sheets fill in the following information

What was the average carcase weight of your stock? *Growth EBVs*

Were any penalties incurred for?
- Overweight *+ve fat EBVs to sell earlier*
- Underweight *Growth EBVs*
- Excessive dentition (ie greater than that specified for the market) *Growth EBVs*

Would there be an advantage in turning off animals at an earlier age?
Were penalties incurred for
- Overfatness *-ve emphasis fat EBVs*
- Underfatness *+ve emphasis fat EBVs*

Was there any other carcase specifications included in the price grid (eg. marbling)?

Did your cattle meet these specifications? *IMF% EBV*
Carcase yield? *RBY%, Fat and EMA EBVs*

From your herd performance

Are daughters of the current sires getting pregnant adequately? *SS & DtoC EBVs*

From sale catalogue, sires summaries or the web, fill in the known EBVs for your sires to complete a sires' audit

	EBVs												**Indexes**	
	BWt	200	400	600	MWt	Milk	SS	CWt	EMA	Fat	RBY	IMF	**B3**	**SM**
Sire 1														
Sire 2														
Sire 3														
Sire 4														
Sire 5														
Sire 6														
Sire 7														
Sire 8														
Av														
***Anag Av.**	**+4.0**	**+26**	**+50**	**+64**	**+63**	**+7**	**+0.8**	**+29**	**+0.7**	**-0.2**	**+0.1**	**0.0**	**+$36**	**+$32**