Maximising Genetic Improvement in a Seedstock Beef Breeding Enterprise

One of the key measures of the success of any seedstock beef breeding enterprise is the genetic improvement that is made within their breeding program from one year to another. In a climate of declining terms of trade, genetic improvement provides an important tool that can be used to facilitate an improvement in the phenotype, performance and ultimately profitability of animals in both seedstock and commercial beef herds.

Genetic improvement is achieved when the average genetic value of the progeny is higher than the average genetic value of the parents from which they were selected, with the rate or amount of genetic improvement achieved being determined by the degree of superiority of the progeny relative to their parents.

Having a good understanding of the factors that influence the rate of genetic improvement is consequently an important consideration for all seedstock beef breeding enterprises.

Factors Influencing the Rate of Genetic Improvement

Most seedstock beef producers will have an understanding of the factors that influence the rate of genetic improvement (or response to selection) being achieved each year within their breeding program, however this can be more formally defined by the following equation. This equation equally applies to the genetic improvement that is made for an individual trait, selection index or the overall breeding objective.

$$R = \frac{i \times r \times \sigma_g}{L}$$

Where:

R = *Response to Selection*
i = *Selection Intensity*
r = *Accuracy of Selection*
σ_g = *Genetic Variation*
L = *Generation Length*

Seedstock beef producers need to appreciate how these factors interact in the dynamics of a breeding herd to ensure that long term sustainable genetic improvement is achieved within their breeding program.

Selection Intensity (i)

The selection intensity is the difference in the average genetic value of the animals selected for breeding versus the average genetic value of all animals in the population from which they were selected (see Figure 1). The higher the selection intensity (or the degree of superiority), the higher the rate of genetic improvement that will be achieved.

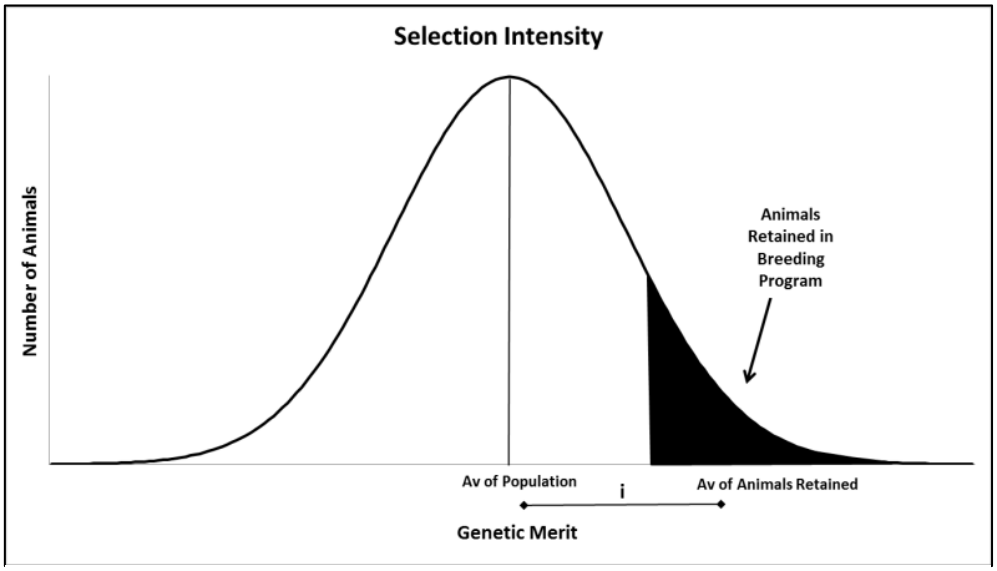

Figure 1 – Selection intensity has a major influence on the genetic improvement that is achieved in a seedstock beef breeding enterprise

The practices conducted within a beef seedstock enterprise have a large influence on the selection intensity within a breeding program. When a large proportion of animals are selected as parents, as is normal for selecting replacement heifers, the resulting selection intensity will be small. Conversely, when a smaller proportion of animals are selected as parents, such as is normal when selecting bulls, the resulting selection intensity will potentially be quite large.

In general, the smaller the proportion of animals selected, the higher will be their relative genetic superiority, therefore the higher the selection intensity.

Use of reproductive technologies such as artificial insemination and embryo transfer provide seedstock beef producers with powerful tools that can be used to increase selection intensity and hence the genetic improvement that is achieved.

Accuracy of Selection (r)

Accuracy of selection is determined by the magnitude of the correlation between the true breeding value of the animal's available for selection as parents, and the information on which the selection decisions are based. The accuracy of selection will be influenced by such factors as the heritability of the individual trait, the quantity and quality of information available, the availability of selection tools, and the accuracy of these selection tools. The higher the accuracy of selection, the more informed and correct the selection decisions are that are made, and the more genetic improvement that is achieved.

In a modern beef seedstock operation, accuracy of selection can be maximised by:

- accurately performance recording and measuring all animals within the breeding program
- accurately performance recording and measuring as many traits as possible within the breeding objective
- utilising genetic tools such as BREEDPLAN EBVs and selection indexes when making selection decisions
- using proven sires as opposed to younger bulls
- considering the use of DNA based technologies where available.

Genetic Variation (σ_g)

The amount of genetic variation that exists within the population of animals that are available for use within the breeding program influences the amount of genetic improvement that is possible, with greater genetic variation providing a greater potential to make genetic improvement.

The amount of genetic variation that exists is difficult for a seedstock enterprise to influence. In practice, the degree of genetic variation can be increased by expanding the gene pool from which animals are selected, such as through sourcing genetics from herds or bloodlines not previously utilised or from overseas countries. Strategies such as crossbreeding can also be used to increase genetic variation, particularly in commercial operations.

Generation Length (L)

Generation length is defined as the average age of the parents in a population at the time that their progeny are born, with a shorter generation length resulting in greater genetic improvement being achieved.

Fast Facts

- Understanding the factors that influence the rate of genetic improvement is important to a seedstock producer

- Greater genetic improvement will be achieved by:
  a) Increasing selection intensity
  b) Increasing the accuracy of selection
  c) Increasing the amount of genetic variation
  d) Decreasing the generation interval

Beef animals are somewhat constrained by contrast to other livestock species (eg. poultry) due to an older age of puberty and longer length of gestation, however generation length can be reduced through use of younger animals within a beef breeding program. This includes strategies such as retaining a higher proportion of replacement heifers, ensuring heifers have their first calf at 2 years of age and the use of yearling sires.

The Trade Off

As with many of the economically important traits that exist within a breeding objective, an antagonistic relationship also exists between many of the factors which influence the rate of genetic improvement achieved in a beef breeding program. For example, shorter generation length may result in a lower accuracy of selection. Seedstock beef producers need to carefully consider how these factors interact to ensure that overall genetic improvement is maximised.

In conclusion, knowledge of the factors that influence the rate of genetic progress and how they interact is important for all beef seedstock producers. By increasing selection intensity, increasing the accuracy of selection decisions, increasing the genetic variation and decreasing the generation length, a greater rate of genetic improvement can be achieved within both individual seedstock beef breeding enterprises and across the Australian beef industry as a whole.

References

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