The Importance of Genetics and Objective Selection

1. An Introduction to Genetics

It is unlikely that many breeders think of their role in these terms but you are in fact geneticists! That is, as a seedstock producer your job is to manipulate the gene pool to deliver superior quality genetics to the commercial beef industry.

You are essentially at the top of the food chain, with the ability to influence the final quantity and quality of beef product eaten by the end consumer. As an integral component in the beef industry hierarchy, it is important that you have a basic understanding of genetics and the role of objective selection in genetic improvement.

Within any population of animals there is what is known as a normal distribution around the population average. This is illustrated in Figure 1 and is commonly called a bell curve.

![Population Normal Distribution or ‘Bell Curve’](image)

The concept of a normal distribution is quite simple. It tells us that the majority of animals in the population perform close to average and there are small numbers of animals at the extremes - high or low – in the expression of each trait. By knowing which animals differ significantly from average we can select from this group to 'move' the population average in the desired direction.

While the shape of the bell curve may differ, the normal distribution of animals’ performance applies to all economically important traits.

2. Genetic Improvement

Genetic improvement occurs in a population when the average genetic merit for a trait is moved in a desired direction. That is, when the average of the population is moved, as
illustrated by the bell curve in Figure 2. Increased weight gain and carcase yield or decreased days to calving are examples of genetic improvement for those traits.

The direction of genetic improvement should be determined by well defined breeding objectives set for a population of animals, such as a breeding herd or group of animals within the herd. Breeding objectives relate to the traits to be improved and the relative emphasis to place on each trait to achieve the goals of the breeding program.

Before any trait is prioritised into a herds’ breeding objective, there are three basic “tests” that it should pass. They are:

1. Is the trait of economic importance to the herd (and to your clients)?
2. Is the trait heritable
3. Can it be measured with reasonable accuracy and at reasonable cost?

If the answer to all three questions is yes then it is reasonable to include it in your selection criteria.

It should be noted that for some traits the breeding objective may be maintaining the current breed average and endeavouring to minimise variation.

3. Rate of Genetic Improvement

There are three key factors that influence the rate of genetic improvement, or response to selection. They are;

- the heritability of the trait,
- the generation interval, and
- the selection differential.

Heritability: The heritability of a trait is defined as the proportion of the difference between animals which can be passed on to their progeny. Genetic progress can be made more quickly for traits with a higher heritability. A list of indicative heritabilities for tropical cattle is displayed in Table 1.
Table 1. Indicative Heritability Estimates for Brahman & Other Tropical Breeds.

<table>
<thead>
<tr>
<th>TRAIT</th>
<th>HERITABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth Weight</td>
<td>0.30</td>
</tr>
<tr>
<td>200 Day Weight</td>
<td>0.20</td>
</tr>
<tr>
<td>400 Day Weight</td>
<td>0.35</td>
</tr>
<tr>
<td>600 Day Weight</td>
<td>0.50</td>
</tr>
<tr>
<td>Mature Cow Weight</td>
<td>0.45</td>
</tr>
<tr>
<td>Milk</td>
<td>0.06</td>
</tr>
<tr>
<td>Scrotal Size</td>
<td>0.45</td>
</tr>
<tr>
<td>Days to Calving</td>
<td>0.08</td>
</tr>
<tr>
<td>Carcase Weight</td>
<td>0.35</td>
</tr>
<tr>
<td>Eye Muscle Area</td>
<td>0.30</td>
</tr>
<tr>
<td>Rib Fat</td>
<td>0.30</td>
</tr>
<tr>
<td>P8 Fat</td>
<td>0.30</td>
</tr>
<tr>
<td>Retail Beef Yield %</td>
<td>0.40</td>
</tr>
<tr>
<td>Intramuscular Fat %</td>
<td>0.20</td>
</tr>
</tbody>
</table>

**Generation Interval:** The time interval between generations, defined as the average age of parents when their progeny are born. In beef cattle this generally averages around 4.5 – 6 years.

**Selection Differential:** The difference between the average genetic merit of the parents selected and the average of the population from which they come.

In considering these three drivers of the rate of genetic improvement, we are considerably restricted as breeders because we cannot change the heritability of a trait and we can do little to reduce generation interval (especially in commercial herds) which leaves us with the selection differential as our primary tool to drive genetic improvement. That is, selecting the superior animals in a population to be the parents of the next generation of progeny is the factor that cattle breeders have most control over to make genetic improvement.

4. Animal Selection

Animal selection involves identification of differences between animals for commercially desired traits and then selecting those animals which have the best overall combination of traits relevant to the breeding objective.

However, the differences identified between animals must be genetic if those characteristics are to be passed on to their progeny. Progress can only be made using the genetic component of the desirable attributes you identify in any animal. The difficult question is how much of the ‘good’ you see in an animal is an expression of genetic merit and how much is a result of the environment? Here we refer to the ‘environment’ as all non-genetic influences.

There’s a saying that what you see in an animal is ‘30% breeding and 70% feeding’. While we can argue the exact percentages involved, the message is true. This is depicted in Figure 3 where the term “genotype” means the genetic composition of the animal.
A simple example of an environmental effect is nutrition. In the seedstock industry, the effect of nutrition can at times have a significant influence over a bull’s sale value. However, what must be remembered is that a bull’s genetic merit is constant irrespective of his condition. Another example of an environmental effect is disease or sickness, which may affect an animal’s performance.

Objective selection refers to the practice of making selection decisions with the assistance of objective measurements, rather than subjective interpretations. Maximising genetic improvement by repeatedly selecting animals of superior genetic merit is difficult, if not impossible, without some form of objective measurement to aid selection decisions. This principle reflects the adage “If you can’t measure it, you can’t manage it.” Objective measurement of commercially desirable traits forms the basis of the international genetic evaluation system, BREEDPLAN.

5. The Role of BREEDPLAN in Animal Selection

BREEDPLAN is a modern genetic evaluation system for beef cattle that calculates Estimated Breeding Values (EBVs) using known pedigree records and performance data submitted by seedstock herds.

An EBV is an estimate of an animal’s true breeding value, or its genetic merit for a particular trait. BREEDPLAN removes or adjusts for the environmental effect on an animal’s performance so that EBVs differentiate animals based only on their genetics. That is, EBVs can be used to identify the ‘30%’ that you can take home with you.

EBVs play a key role in ranking animals within a breed for a range of traits. This enables breeders to select animals of desired genetic merit and exploit the selection differential so that genetic improvement can be sustained and monitored.