

# EBVS may come and EBVs may go but DNA lives forever...

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## Introduction

The objectives of commercial cattle breeding are simple. Decide which traits in an animal are the most important to give you an economic return for the product you sell. Identify the animals that are good and breed them with each other in the expectation that sexual reproduction will throw up new combinations of genes that are even better at giving you what you want.

Easy enough, until you consider that there are a few complicating factors like how easy (or difficult) is it to measure a trait, what is the

heritability, how much variation is there, and are the traits valued now still going to be important in a few years time? There are lots of traits which have an impact on animal performance so you need to consider many, often conflicting, breeding objectives all at the same time.

The basic principles remain the same whatever methodology you apply, hence the “DNA lives forever” part of the title. However, the methods have changed and continue to change, as new understanding and tools become available- hence “...EBVs may come and EBVs may go”.

## The Principles

The graph below (Figure 1) is an imagined population of cattle for which a trait can be reliably measured, e.g. growth rate. The heritability is high and the measures can be repeated and weighing cattle is relatively a low cost exercise – a straightforward trait for which to select.

By selecting parents from the best end of the population distribution and breeding them with each other the breeder can create the next generation that has the same average breeding value as the average of the parents. But because the genes for growth (in fact all genes) have undergone genetic recombination (been mixed about) during the process of meiosis (production of eggs and sperm) making them all genetically unique, half of the new generation are to be better than the average of the parents – some more than others!

By repeating this process in successive generations you can make genetic progress and this is what we have been doing for a few hundred years in our farmed cattle. Figure 2 shows progress in 400-day weight for a mainstream cattle breed in the UK.

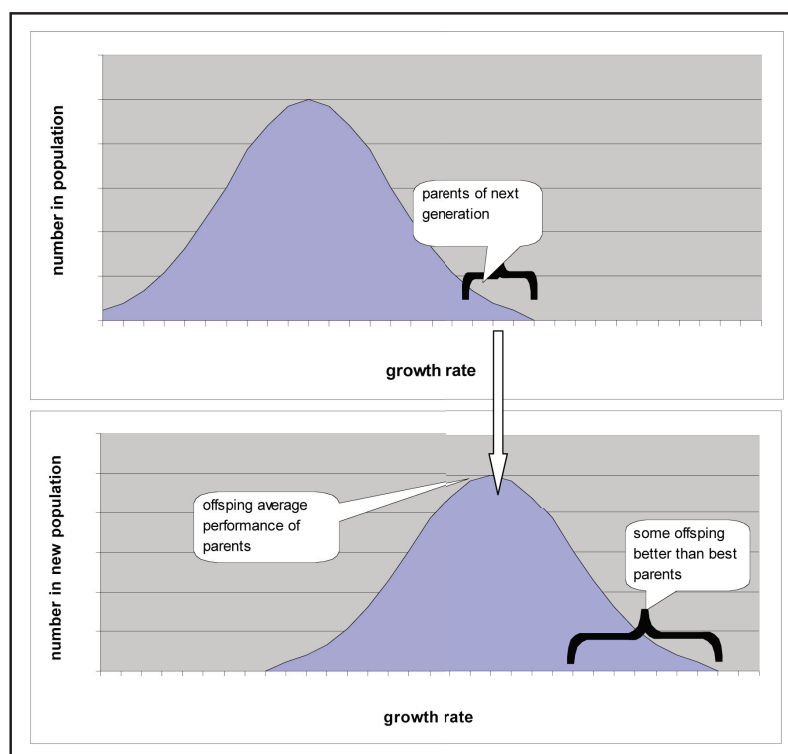


Figure 1 Selection of parents and genetic progress

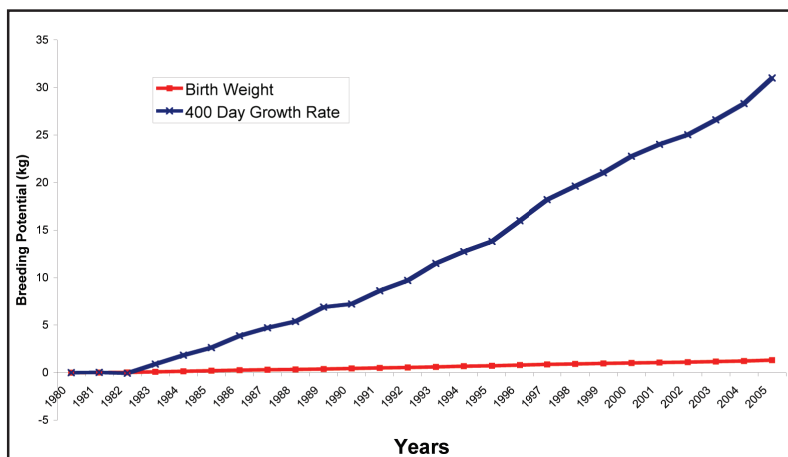


Figure 2 Genetic progress in Birth Weight and 400 day weight EBVs for a main cattle breed

## Measuring Traits

The traits measured by the formal programmes have remained surprisingly consistent over the last 40 years, reflecting the importance of these central traits to the beef cattle profitability. Measures of calving ease, weight gain, fat cover and muscling have always been important. All the time breeders have also selected for performance traits that have not been part of the formal evaluation programme. Locomotion and docility would be good example of such traits. Perhaps now the industry is on the verge of an opportunity to consider more traits in a coordinated way as molecular genetics begins to make an impact.

The ways the measures of performance have been taken have changed as techniques and costs have altered over time. Feed efficiency was, and still is, an economically important trait for beef production. The central bull testing stations measured this trait. However, as the costs were

counted the benefit did not seem to match the effort being expended, so the measurement of this trait was brought to an end.

In the future traits currently considered too difficult or too expensive to measure may become economically viable to be included in selection programmes. The development of gene markers may allow animals to be selected for traits like disease resistance and beef eating quality that are not really viable at present. The essential point to remember is that early on in the breeding programme – in the current structure pedigree breeders or equivalent- the depth of recording for traits has to be very thorough. The association between gene markers and traits has to be firmly established. It is only after that work has been done that selection can be made on markers rather than measured traits.

The following traits have long been of interest to commercial producers and are likely to be high on the “wish list” of traits that could be selected for:

- Beef eating quality including tenderness, juiciness and flavour
- Disease resistance to specific diseases and general improved immunity; including resistance to parasitic infections as well as viral and bacterial disease.
- Fertility in males and females.
- Feed efficiency – especially with regard to methane reduction.
- Calf vigour
- Docility

Some, if not all, could certainly be selected for using the quantitative genetics approach but the cost of doing so would be prohibitive or take too long. The point is that hard-to-select-for-traits have an economic benefit and if a cost effective method can be found for selection then there is value to be gained.

## Combining trait data

Making genetic progress on a range of traits at the same time inevitably means there is a trade off between traits that are negatively correlated. The obvious example in beef cattle is that selection for faster growth tends to increase birth weight and hence calving difficulties. To combat the need to progress on a broad front the principle of an economically weighted index has been employed for many years. Table 2 below shows the historical and projected development of the index approach. Importantly, even with marker assisted selection or genome wide selection, the need for some form of index continues – how else can you get a balanced development on diverse traits?

It is important to note that there is an

	Year	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030
Traits											
Beef Index											
Beef Value											
Calving Value											
Maternal Value											
“Disease resistance Value”											
Marker assisted selection											
Genome selection											

Table 2 Systems for multi-trait selection .

overlap between current and future approaches. Marker assisted selection is likely to be used in conjunction with quantitative approaches for a number of years as new techniques are developed. The opportunity opening up is the ability to handle lots of potentially useful data in an exploitable system that allows multi-trait selection on a grander scale than ever before to be achieved. EBVs as we know them to be constructed now may change, using marker information rather than current quantitative data, but they will be a useful summary of a complex trait affected by many genes, just as index is an economic summary.

Before we get carried away, it may be wise to highlight the limitations of marker assisted selection. Markers, for the foreseeable future, will only explain a limited amount of variation between animals – this should improve but predicting the speed is tricky. The effects of markers differ from breed to breed, and probably also depend on environment so there is a great deal of work to be done to apply markers practically. Inevitably the cost of servicing a marker approach will limit how they can be used in practice.

## Thinking about the future

The landscape (literally and metaphorically) for British beef production is changing more rapidly now than it has done for the last 20 years. World shortages in cereals and milk products will alter land use as land managers pursue the most profitable options. The contribution of beef cattle to greenhouse gas production will come under scrutiny and the contribution of beef to a healthy balanced diet will continue to be examined. The current returns for beef production are not enough to sustain the industry let alone expand it, so labour cost will come under pressure.

Against that backdrop what do you breed for? We need beef animals that are fast growing, require minimal husbandry, produce less methane and produce a product that enhances human nutrition. This sounds ominously like the desirable but hard to achieve breeding goals outlined in the introduction.

However, we do have the tools to tackle this problem in a more comprehensive

## Do Pedigree Breeders Still Need to Record?

Now that the vast majority of pedigree cattle in the UK have EBVs with reasonable accuracies, some breeders are questioning whether they still need to record.

Certainly the EBVs of a potential calf can be predicted by adding together the EBVs of its sire and dam and dividing by two. However, as embryo transfer work clearly shows full brothers and sisters can vary widely in terms of their characteristics depending on exactly which genes they inherit from each parent.

As a result, although their EBVs might be similar, they will never be identical so that their actual performance has to be recorded to help calculate their individual EBVs and to identify which has inherited superior genes. This is why all cattle will continually need to be measured/weighed, etc. to ensure future EBVs are as accurate and useful as possible.

A possible exception in the future would be if we were able to accurately measure exactly which genes each animal has inherited, a science which has already started with the commercial availability of gene markers. If we can accurately and easily measure exactly what genes the animal has inherited then there will be no need to monitor its performance providing we know exactly how each gene affects the performance of the animal.

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way than we have ever had before. The existing BLUP traits will continue to be useful for a number of years yet but will increasingly be supplemented by information from genetic tests.

Genetic Marker based tests currently available indicate they can help select beef cattle for improved:

- Marbling
- Coat Colour
- Tenderness
- Maternal milk yield
- Feed efficiency
- Muscle area
- Polling/ horns
- Carcase yield
- BVD PI
- Back fat depth

In the future this library will expand and, given the expected future environment, would benefit from measures of:

- Resistance to economically important diseases e.g. mastitis, pneumonia
- Methane producing potential of digestion- especially on forage diets
- Essential fatty acids (omega-3 and omega-6)

As the library expands the ability to deal with the data becomes ever more important.

We must remember that there also needs to be a market for “low carbon cattle” and “high eating quality cattle”. The market needs to be profitable enough to support all the efforts that could be going to producing these super-bulls.

Perhaps the answer is phenomics; as genotyping becomes cheaper, phenotyping needs to be done efficiently. One approach is to take very extensive measures on a few ‘elite’ herds that are closely linked to commercial breeding programmes. This information can help discover and refine markers but also feed into genomic selection. But they may need a different industry structure and that is a whole different story.....