Contradictions between EBVs and performance

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Sometimes farmers observe discrepancies between breeding values and the performance observed on their farm as well as the difference between the progeny of the same bull on different farms. This is not always the case and in general breeding values are trustworthy and essential tools in the selection of animals. There are various sources of information to estimate breeding values and they must be understood to interpret and use EBVs more effectively.

The heritability of a trait is used to estimate breeding values and is the **proportion** of a trait's expression due to the animal's genetic composition. Simply having specific genes does not necessarily mean it will be expressed. The remaining portion is mostly due to environmental factors and leads to greater overall variation of the trait. The genetic **potential** of an animal places a limit on the possible performance of an animal but does not mean this limit will be reached. The environment in which the animal is expected to perform can mask the true genetic effect. Sophisticated and highly mathematical techniques are therefore required to "remove" the mask and reveal the true genetic contribution in the form of an EBV.

Furthermore, accurate breeding value estimation relies on connections with and performance of relatives. These relatives may not be on your farm and their performance will not be known to you, but will be on the Logix system and taken into account during the genetic evaluation. Missing measurements of relatives has a detrimental effect on the accuracy of breeding values.

Using EBVs is immensely important in animal selection. Well adapted genetically superior animals will perform better and be more efficient. Even though the environment plays a large role, the genetic value of a trait will determine the true potential of the animal. Some feel that the breeding values are not able to accurately determine an animal's genetic merit. This is a common enquiry: The progeny of a bull with average- or below-average breeding values perform well on your farm. How can this be? Why is this superior performance not reflected in the bull's breeding values?

Among others, the following factors are possible contributors to this perceived contradiction:

1. The environmental mask:

The animal cannot reach its genetic potential if the environment does not allow it. The proportion of variation of a trait due to additive genetics is not 100%. In some cases it is even less than 20% with the remaining portion being due to the environment. An animal on your farm might have a lower breeding value but still perform better than an animal in a different herd with a higher breeding value because the animal on your farm is in an environment that is favourable enough to allow it to reach its genetic potential, while the other animal in a different herd does not. A trait often enquired about is maternal weaning weight (milk). Some cows have lower milk breeding values yet raise heavy, healthy and beautiful calves. It is important to remember that the milk production of a cow is not the only factor influencing calf growth, nor is it the only source of nutrients.

2. Genetic principles:

There are other non-environmental factors that also contribute to this scenario. It is important to realise that the progeny of a bull on your farm does not necessarily also perform well in other herds. The observed "result" of breeding to you is therefore superior although the true result including all the progeny from various herds paints a different picture.

2.1. Luck of the draw

To produce sperm/ova, the DNA of an animal must undergo random recombination and then divide equally into two parts. This means that not all of an animal's progeny receive the same combination. This example attempts to explain the concept: Fill a bowl with 10 red, 10 blue and 10 yellow balls. Mix them together thoroughly and then randomly select 15 balls. Theoretically one should draw 5 balls of each colour. However, in practice this is very rarely the case. Considering that this is only a total of 30 balls with 3 colours, one cannot even comprehend the vast number of different combinations out of billions of base-pairs in a DNA string coding for many different genes! Young animals without any measurements receive a mid-parent breeding value, which is the average of its parents' values and makes the assumption that the half passed onto the progeny is the same in all offspring. This does not happen in reality and therefore breeding values change once measurements of the offspring are known. This will reveal the "combination" the animal actually received. It is possible that, simply by chance, the progeny on your farm received a half with more favourable genes than those of the progeny in another herd. This kind of "skewed" data is more likely to happen when the number of progeny is low.

2.2. The forgotten dam

This genetic factor contributing to the difference in performance of a specific bull's progeny in one herd and the progeny in another herd is a very simple concept that is surprisingly often completely forgotten by breeders: The bull only contributes to half of the offspring's genetic make-up; the other half originates from the dam. Genetically the sire and the dam have equal contributions to the DNA of their offspring. If the average genetic value (EBVs) of the dams used on one farm is inferior to that of the dams used on your farm, your progeny will be superior. The superior performance is therefore due to the higher genetic merit of your cow herd and might not be reflected in the breeding values of the sire. It is true that a bull has a larger contribution to the total gene pool of the herd since one bull can have many offspring in a single calving season while cows can only have one. A large proportion of the herd will therefore be related to a single bull, but all of his offspring will still only have half of its genes. While the random recombination of DNA to produce sperm ensures that all of its progeny will not receive the same combination of genes, the genetic contribution of dams will further ensure that all of the progeny will not be the same. There will be variation between offspring of the same parents (hence full-sibs) and even more between offspring of the same sire but different dams (half-sibs), just as human full- and half- brothers and sisters will not be the same.

2.3. Big fish in a small pond

Superiority is relative. A bull with an average- or below breed average breeding value can produce calves that are superior in your herd if the current level of performance of the herd is also below breed average. Offspring of these animals might be stronger and better compared to their herd mates but not superior on breed level (figure 1). This can occur in large herds but mostly in smaller herds where the selection intensity is less (a larger proportion of the herd must be retained and therefore selection criteria cannot be very strict) and the best possible bulls to purchase are not affordable or financially viable. "A big fish in a small pond" applies just as much here as to the small town rugby star who fails to feature when moved to Grey College. Herds differ and the superior animals in one herd might not be superior when compared to those in another herd. This does not necessarily mean that your animals are bad, or your selection decisions were wrong. Although the overall breed performance can be a good benchmark for herds, your personal resources and preferences will set your own breeding objectives. The animals that best suit your breeding objectives and are available to you (and affordable) should be used.

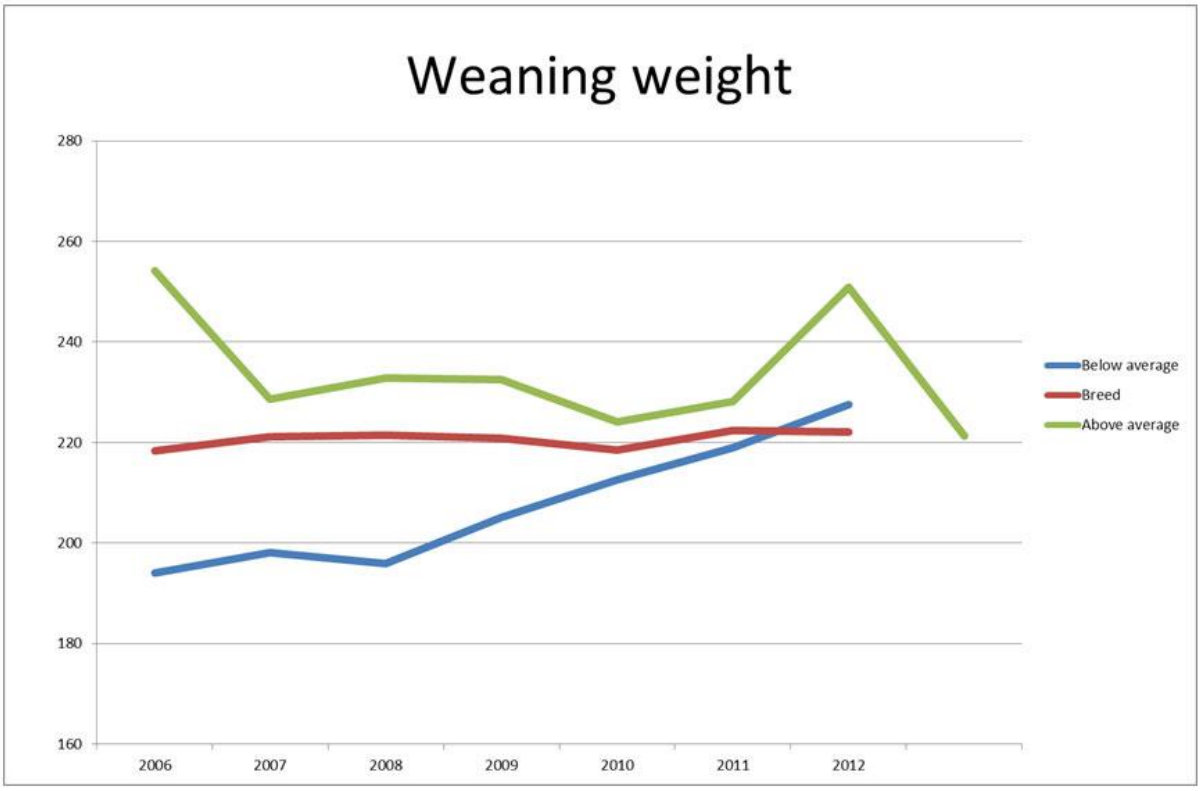

Figure 1: The green herd is the average weaning weight per year and all the values are above the average weaning weights in the breed (red). The blue herd is below average. It is therefore possible that even the best animals in the blue herd will be average or below average in the green herd.

These factors are simply a few possible contributors to this scenario. They are based on simple principles that are often forgotten. To conclude, herds differ environmentally and even the same animal can perform differently in one herd than it would have in another. The random recombination of DNA ensures that offspring will not be identical and therefore one bull can produce offspring that range between poor- and good performers even if all offspring are also from the same dam. Half of an animal's genetic make-up originates from its dam and therefore her genetic merit can "dilute" or "enhance" the merit of the sire's contribution to produce inferior or superior offspring. The performance of a herd as a whole differs from the performance of another and therefore superiority is relative. The superior animals in one herd will not necessarily be superior when compared to animals in another herd.