Breeding Values – How to Understand and Use it

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Introduction

Estimated Breeding Values or EVBs – just like ordinary performance test indexes – is a valuable tool in selection and breeding of beef cattle. However, it is not the alpha and omega of breeding and should of course be used purposefully and in a balanced manner, in combination with other tools such as functional evaluation. It is of no use to breed a bull that can grow 2.5kg per day, but he can not walk! It is also very important that you make sure that your priorities are correct when it comes to selection. Reproduction or fertility should always be number one and you should never compromise on this trait. If too much emphasis is placed on other traits at the expense of fertility traits, you are for sure looking for trouble - the kind that will cost you lots of money - no matter what tools you are using in your selection and breeding plans.

It is equally important that you know exactly what your breeding objective is in the breeding of your cattle. [You know the story that if you do not know where you go, chances are 100% that you will get there]. As with other tools (such as performance test indexes), EBVs can also be used incorrectly. But you must be careful that you do not throw away the baby with the bath water – it's not the tool's (EBVs') fault if you (or your adviser / consultant) use the tool incorrectly. You should thus make sure that you are well informed about the interpretation of EBVs and also listen to the right people when you need help using breeding values for selection and breeding.

What is BLUP?

BLUP (Best Linear Unbiased Prediction) is merely a sophisticated mathematical method used to obtain Estimated Breeding Values (EBVs), using performance test data and pedigrees.

What is an EBV?

- An animal's breeding value is a prediction of its genetic ability, in other words how future progeny of this animal should perform for this trait within the specific breed.

- The following performance and pedigree data is used in the calculation of breeding values:

    - The performance of an animal relative to its contemporaries (animals that were exposed to the same environmental conditions with regard to herd, farm, feeding, season, management, etc.).

    - Similarly, the performance of all the animal's family (parents, siblings, offspring, etc.) in the contemporary groups in which they were tested, taking into consideration the heritability of the trait

    - The performance of the animal in respect of other measured traits, taking into consideration the genetic correlations between the traits.
    - The genetic links or connections between herds, years, seasons, groups, etc.

- From the above it is clear that a breeding value is a more accurate indication of an animal's genetic ability than the animal's performance index for the trait, because all available information is used to obtain an EBV, not only the animal's own performance.

- Breeding Values are not static, i.e. an animal's breeding values can change with each new BLUP analysis as more and more data from the animal, his relatives and progeny becomes available. For this reason the latest available EBVs should always be used. It is also important to remember that the greatest changes in an animal's EBVs happens when his/her own measurement /performance for a particular trait is included in a BLUP analysis (as opposed to a calf that has not been performance tested yet) and then again when the animal's first offspring's measurements for a particular trait are included in the BLUP analysis. The biggest change in a bull's weaning weight maternal EBV occurs when his daughters' first calves' weaning weights are included in the BLUP analysis.

- The accuracy value (which varies between 0 and 99%) of a breeding value is an indication of the amount of performance test data (from the animal and its relatives) which was taken into account in the relevant BLUP analysis for that trait. The more information available, the higher the accuracy. If the accuracy is relatively low, it is usually because the animal was not tested for that trait. In such cases the chance is big that the animal's breeding value will change in the future when more performance test data becomes available. A high accuracy means that the chance is small that the animal's breeding value will change with the addition of data. The breeding values of an AI bull with many offspring will, for example, have a very high accuracy.

- Breeding values are typically expressed in the unit of measurement, e.g. kg for weight EBVs.

- To interpret an EBV, it should always be compared with the average breeding value of the breed and the particular herd. For example, an EBV of +5 kg for weaning weight should first be

compared with the particular breed and herd averages to find out whether it is good or bad. To make this comparison easier, we now also calculate breeding value indexes which express the animal's breeding value as a percentage of the breed's average, where the breed average, is equal to 100.

- The BLUP method makes it possible to separate the influence of the environment (farm, year, season, group, etc.) on a particular trait from the genetic influence. This separation makes it possible to compare the genetic merit (or breeding value) of animals over years, herds, seasons, groups, etc., provided that sufficient genetic links are available. (By the way, the lack of genetic links across breeds is why EBVs are not directly comparable across breeds). The use of AI bulls, the purchase of bulls from other breeders who do performance testing and the exchange of bulls between breeders, is the best way to obtain strong genetic links between herds.

- Breeding values are expressed as a deviation from the base year. This means that, to ensure that breeding values are compared year after year against the same basis, a certain year is arbitrarily chosen in which the average breeding values for animals born in that year are equated to zero. For example, if the base year is 1990, an EBV of +6 kg for weaning weight direct means the animal's breeding value is 6 kg more than the average EBV of all animals in the breed born in 1990.

- Breeding values can be calculated for animals that are not tested for that particular trait, for example for young animals not yet performance tested, and for traits that can only be measured in one of the genders, for example, maternal ability or milk production. In such cases, the animal's breeding value is calculated based on the animal's performance in other traits that are genetically correlated, as well as the performance of the animal's family. As already said, a bull's maternal weaning weight EBV is only really accurate when his daughters' calves' weaning weights are included in the BLUP analysis.

- The BLUP method makes it possible to distinguish direct effects from maternal effects on traits where the mother has a direct impact on the performance of her calf, such as birth weight and weaning weight. For example, weaning weight direct EBV is an indication of the calf's own pre-weaning growth ability, while the maternal breeding value is an indication of the mother's maternal ability, especially milk production.

Myths About Breeding Values

Perhaps we should also stamp out a few myths regarding performance testing and breeding values, namely:

- The fact that you measure (performance test) a certain trait in your herd, does not necessarily mean that you have to select animals with the highest (or lowest) breeding values for that trait. The preferred animal depends inter alia on your breeding goals, available feed, climate, breeding system and production system. Consider shoulder height: if your goal is to breed medium frame animals, you will not select bulls with high breeding values for shoulder height only because they were measured for shoulder height in a Phase C or D test, will you? The mere measurement of a trait therefore has nothing to do with how the particular breeding value is used.
- Performance testing and breeding values as such do not make cattle less efficient. An animal's genetic makeup is not changed by simply weighing an animal and calculating a breeding value for it. It is only when selection (by the breeder or inspector) in a specific direction occurs that the genetic composition of a breed or herd is changed.

- Although there are positive genetic correlations between birth weight, weaning weight, growth rate (ADG) and mature weight, these correlations are not 100%. This means that it is possible to genetically increase growth rate without necessarily increasing birth weight and/or mature weight.

Description of Traits and Guidelines for Selection

With each of the traits a guideline for selection is given. Please note that these are general guidelines and can vary from breeder to breeder, depending on your specific breeding objectives and needs.

REPRODUCTION

- **Calving Rate** – This EBV is an indicator of fertility and the retention of a bull's female offspring. For a bull to get a high calving rate EBV, his daughters firstly need to be retained in the breed (i.e. a large percentage of his daughters born, are retained as replacement heifers, or are sold to co-breeders) and secondly, his daughters need to calve regularly until the age of 6 years. A hundred daughters of an average bull will, for example, give together 97 calves before the age of 6 years. The breeding value therefore reflects the number of calves that 100 of a bull's daughters will give more or less than the average bull. All relatives' measurements are fully taken into account via the pedigrees. The EBV is only published for males in the breed. Select bulls with above average calving rate breeding values for fertile daughters with high retention of their progeny.

- **Scrotal Circumference** – This EBV is an indication of the animal's genetic ability for scrotal size as measured in Phase C and D growth tests. Avoid bulls with low breeding values for scrotum circumference for fertile bulls that can cover a lot of cows.

BIRTH

- **Birth Weight Direct** – This EBV is an indication of the animal's genetic ability for birth weight. Animals with lower breeding values will breed progeny with lighter birth weights and consequently a smaller chance of calving problems in the mothers.

- **Birth Weight Maternal** – This EBV is an indicator of a cow's genetic ability to limit the growth of a calf until birth (as a natural protection from calving problems). The maternal EBV of a bull is an indication of his daughters' ability to limit the birth weight of their offspring.

GROWTH RATE

- **Weaning Weight Direct** – This EBV is an indication of the animal's own genetic ability to grow until weaning age. Select bulls with above average weaning weight direct EBVs for calves that will grow rapidly and thus have high weaning weights.

- **Weaning Weight Maternal** – This EBV is an indicator of a cow's (the calf's mother) genetic maternal ability (primarily milk production) to create an environment in which her calves can grow optimally. The weaning weight maternal EBV of a bull is an indication of his daughter's maternal ability to wean heavy calves. Please note that there is usually a low negative genetic correlation between weaning weight direct and maternal breeding values. When you are selecting for weaning weight, both these breeding values thus need to be taken into account. Select bulls with above average weaning weight maternal breeding values to breed daughters with good maternal ability that could wean heavy calves.

- **Yearling Weight** – This EBV is an indication of the animal's genetic ability to grow until one year of age. Please note that yearling weight is a function of pre-wean and post weaning growth. Select bulls with average to slightly above average yearling weight EBVs for average sized animals.

- **Weight: 18 Months** – This EBV is an indication of the animal's genetic ability to grow until 18 months of age. It is also to some extent an indication of the animal's mature weight. Like yearling weight, 18 months weight is a function of pre-and post weaning growth. Select bulls with average to slightly above average 18-month weight EBV for average sized animals.

- **Mature Weight** – This EBV is an indication of the animal's genetic ability for mature weight. Weights of cows 4 years and older at weaning of their calves to be used to estimate adult weight EBV. Select average adult breeding values for average sized animals.

- **Average Daily Gain (ADG)** – This EBV is an indication of the animal's genetic ability for post weaning growth, as measured in Phase C and D growth tests.

EFFICIENCY

- **Feed Conversion Ratio (FCR)** – This EBV is an indication of the genetic ability of the animal to efficiently convert feed into body weight, as measured in Phase C growth tests. Please note that animals with a low FCR EBV are more efficient. Select bulls with low breeding values for efficient feed converters.

- **Kleiber Ratio** – This EBV is an indirect indication of the animal's genetic ability for feed conversion efficiency, as measured in Phase D growth tests. Animals with a higher breeding value are more efficient. Select bulls with above average Kleiber Ratio EBVs for good growth efficiency.

- **Feed Intake** – This EBV is an indication of the genetic ability of the animal for daily feed intake, as measured in Phase C growth tests. Animals with a high ADG EBV and a low feed intake EBV are more efficient and therefore desirable.

- **Feedlot Profit Index** – This EBV is an indication of the genetic ability of the animal to be profitable in a feedlot or similar environment. The EBV is a selection index that is composed of breeding values for feed intake, beginning weight and end weight, taken into account the relative economic weights of each.

BODY MEASUREMENTS

- **Shoulder Height** – This EBV is an indication of the genetic ability of animals for shoulder height, as measured in Phase C and D growth tests. Select bulls with average shoulder height breeding values for medium frame type animals.

- **Body Length** – This EBV is an indication of the genetic ability of the animal for body length (measured from the shoulder bone to the pin bone), as measured in Phase C and D growth tests. Select bulls with above average body length breeding values and average shoulder height breeding values for relatively long animals.

CONCLUSION

Because EBVs are a combination of an animal's own performance, his relatives' (pedigree) performance and the performance of his offspring in a single figure, it is a very accurate and very powerful tool in the hands of a breeder. Fast genetic progress can be obtained with the purposeful and balanced use of EBVs, without adverse effects on other traits. Worldwide, there is sufficient evidence to substantiate this claim. The question is: do you do performance testing and use breeding values to your advantage?

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