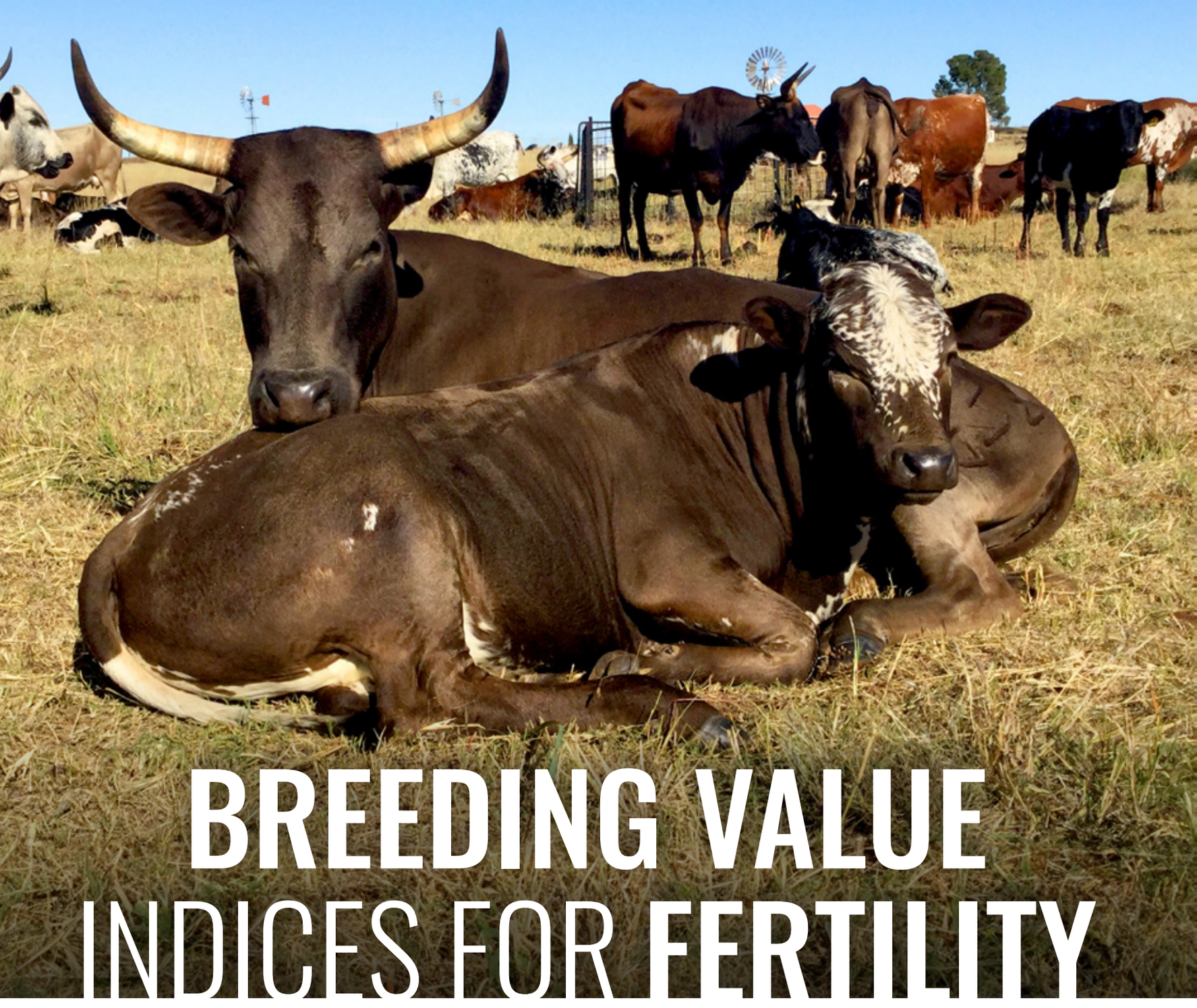

BREEDING VALUE INDICES FOR FERTILITY

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Fertility is a critically important trait in beef cattle herds. When estimating BLUP breeding values, it is necessary for the measurements to exhibit a typical bell curve distribution. Therefore, fertility is defined by indicator traits used in breeding value estimation. For instance, age at first calving serves as a measurement of Heifer Fertility, while inter-calving period represents Cow Fertility. Genetically, fertility traits tend to have low heritability, indicating that environmental factors exert a significant influence.

Heifer Fertility

Age at First Calving (AFC) is commonly used as a measure of heifer fertility. However, in South Africa, AFC is significantly influenced by environmental factors resulting from the breeder's management practices. It is possible for a heifer calving at 36 months to be equally as fertile as one calving at 24 months. The age at which a heifer first calves is solely determined by the management practices of the specific herd, rather than her genetics.

Similar to how weaning weight breeding values are estimated regardless of the favourable or unfavourable environment in which the calf was weaned, fertility breeding values are estimated irrespective of the breeder's management practices. The crucial factor is the contemporary group: if all animals within the same contemporary group are treated equally, those calving earlier within the group are considered more fertile, while those calving later or not at all are considered less fertile or infertile. The definition of the contemporary group for Heifer Fertility accommodates the significant management differences between herds.

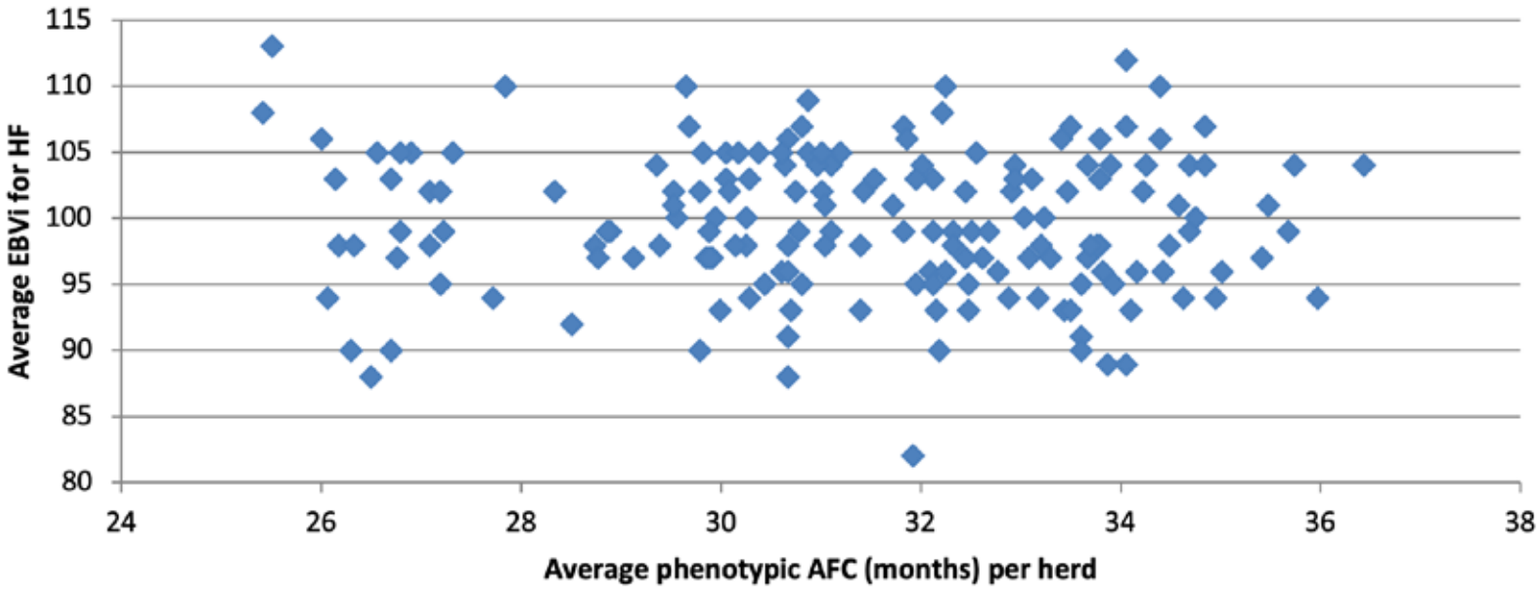
The contemporary group for Heifer Fertility consists of all heifers that are born together within a specific herd-year-season. For instance, consider a group of heifers that were born together and, on average, calved at 30 months of age. The heifers calving at, let's say, 28 months will exhibit above-average genetic potential, while those calving at 32 months will be below average. However, if a heifer calving at 32 months is part of another group with an average calving age of 36 months, she can be genetically superior if she was among the first ones to calve within her contemporary group.

It is important for heifers to be born and calve on the same farm in order to be included in the same group. The influence of management practices (such as 2- or 3-year calving) then becomes an environmental effect.

Figure 1 demonstrates that herds with an average calving age of 2 years do not necessarily have the highest breeding values for AFC, and herds calving at a later age do not necessarily have poorer breeding value indices.

To ensure fair comparison among heifers and account for different ages when they are bred, the calving within a contemporary group begins at day 0 when the first

Figure 1: When phenotypic herd averages for Heifer Fertility (HF) are plotted against the herd average for the breeding value index for HF, it can clearly be seen that earlier calving herds do not have the higher EBVs, showing that the herd management effect of calving age have effectively been removed from the breeding values.



heifer calves, using a standard age. The number of days that each heifer calves are added to the standard age of the contemporary group. The variations between different contemporary groups are also standardized. These adapted values then serve as the measurement for Heifer Fertility.

When estimating breeding values, it is crucial to include less fertile and infertile heifers, including those that skipped a calving or never calved, to avoid bias in breeding values. It is also important to incorporate data on infertile daughters in the estimation of breeding values for sires.

Following international practices, animals that are still present in the herd at a late stage without having calved are penalized by assigning them an extreme age at first calving value. It is considered that a heifer is infertile if a breeder removed her at 3 years of age or older without a recorded calving, or if she was included on a mating list but did not produce a calf. An Age of First Calving exceeding 4.5 years is then assigned to her, enabling a comparison with heifers that did calve.

Cow fertility: Inter-calving Period (ICP)

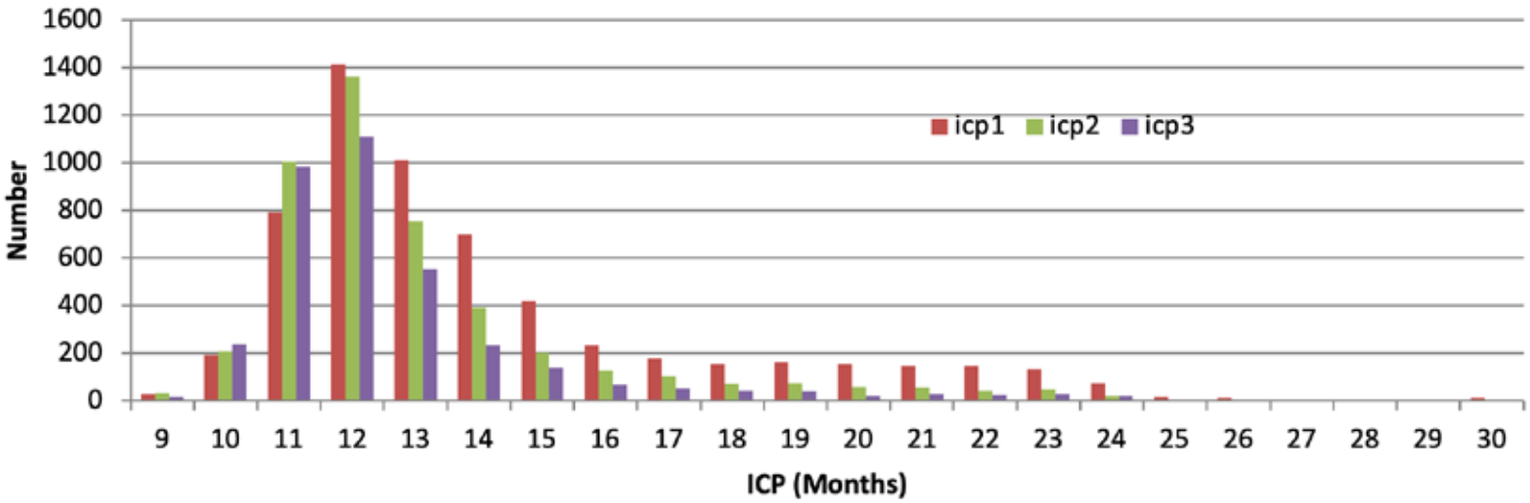
The best measure of cow fertility is the inter-calving period, abbreviated as ICP. ICP can be measured multiple times throughout a cow's life, and including multiple measurements in the breeding value calculation enhances accuracy. However, when ICPs 1 to 12 are included as a repeatable trait in the evaluation model, the heritability is found to be only 7%, indicating a low heritability.

Since only 16% of Nguni calves are born from cows aged 5 years or older (fourth ICP or later), ICP1, ICP2, and ICP3 are included in a multitrait model along with weaning weight.

Cows have three opportunities for measurements. For example, if a cow has three short inter-calving periods (ICPs), she will be considered highly fertile compared to cows with only one or two short ICPs, as measured within the same contemporary group. Genetic correlations between traits are also utilized to enhance the accuracy of breeding value estimation. The breeding value for ICP is therefore a weighted measure that combines three ICP breeding values: ICP1 (between the first and second calf), ICP2 (between the second and third calf), and ICP3 (between the third and fourth calf). These three ICPs are equally weighted and then combined into a single ICP breeding value.

The contemporary group for Cow Fertility follows a similar approach to Heifer Fertility. It consists of a group

Figure 2: Phenotypic Intercalving Periods for active Nguni cows. ICP peaks around 11-13 months.



of cows that have calved together on the same farm, in the same year-season, and calve their next calf together on the same farm. Cows can be included in the same group even if some have skipped a calving, as long as all cows calved on the same farm and the previous calf was born in the previous year.

The inter-calving period (ICP) limits for cows that have calved are set between 270 and 900 days (approximately 8 to 30 months). ICP values between 200 and 270 days are set as 270 days, while values exceeding 900 days are set as 900 days. Cows that have been cancelled at a late stage and did not calve are assigned an ICP of 902 days. An ICP1 of 902 days is also allocated to cows that were cancelled at 4 years and only calved once. Similarly, cows are penalized for ICP2 if they were cancelled at 5 years and only calved twice, and for ICP3 if they were cancelled at 6 years or later but only have 3 calves.

A cow's fertility may also be influenced by whether she has successfully weaned her previous calf or not. Cows that did not wean a previous calf are therefore penalized in the estimation of Cow Fertility Estimated Breeding Values (EBVs).

Other factors

If three or more cows from the same contemporary group are sold, they will form their own new group.

Data from cows calving in contemporary groups with less than 3 animals are removed from the dataset, similar to other traits.

Measurements of animals that gave birth to embryo calves, as well as data from subsequent calving, are excluded.

Animals for which measurements are not included during breeding value estimation receive breeding values based on pedigree information.

Breeding values are released once 60% of cows in a contemporary group have calved.

Longevity

Animals with a long lifespan can also be profitable, especially if their offspring is selected and contributes to the genetics of the herd. Initially, selection of young animals is based on various factors, including performance, likability, and even the price paid for the sire. However, over time, only high fertility will ensure the retention of cows in the herd. Therefore, a Longevity breeding value is also estimated and combined with Heifer Fertility and Cow Fertility to form the Fertility Selection Value.

The measurement of longevity starts with a group of calves born together in the same contemporary group. Each calf is marked as present or absent at specific milestones, such as weaning age and year-age, up to 10 years of age, and this information is used in breeding value estimation.

Since Longevity is a breeding value, the performance of family members is also taken into account through the pedigree.

Summary

Successful selection for fertility in a beef herd is achievable by using the Fertility Value, which combines breeding values for Heifer Fertility, Cow Fertility, and Longevity.