A GENETIC APPROACH to align your herd with nature

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A “working with nature” approach to genetic evaluation is essentially about aligning breeding decisions with biological processes, environmental constraints and animal robustness, rather than pushing solely for maximum production. In practice, this means identifying animals that perform well with minimal intervention.

For many years, traditional dairy breeding objectives prioritised increased milk production. However, when breeding efforts focus primarily on a single trait or a limited number of traits, negative correlated responses often occur. Notably, these include reduced milk solid percentages, increased cow size, decreased fertility and decreased longevity. High-producing cows often exhibit shortened productive lives as a result of inadequate udder and feet-and-leg durability.

Globally, breeding objectives have therefore evolved to also include functional traits, such as fertility, longevity and calving ease; health traits, including disease resistance and somatic cell count; efficiency traits, including feed efficiency and maintenance requirements; and adaptation traits, such as tolerance and resilience to heat and other environmental stressors. The key is therefore to define and implement a balanced selection index, ensuring that robustness and efficiency are properly weighted alongside production.

Fitting the right genotypes to the local environment

South African dairy cows typically operate under more extensive and environmentally challenging conditions compared to their Northern Hemisphere counterparts. Consequently, natural selection remains a key factor in shaping adaptation to local environmental and production systems.

Due to this natural selection pressure, cows that exhibit disease and parasite resistance, heat tolerance, rumen adaptation to pasture fibre content and resilience to other unique stressors are favoured. As a result, the genetic composition of animals from different populations around the world generally differs significantly. These differences arise from the combined effects of natural and artificial selection over many generations, including deliberate differences in selection objectives and selection intensities, mutations – random, uncontrolled changes in genetic code over generations and migration effects, particularly through semen exports, which alter gene presence and gene frequencies among populations.

Epigenetic influences—through the masking or modification of gene expression, can further result in different sets of genes being involved in the ultimate expression of traits in different populations. This is especially true for traits that directly influence population survival, such as fertility and longevity (so-called “fitness” traits). Genotype × environment (G × E) interactions are therefore a reality, meaning that animals perform differently across environments.

The reality is that the best AI bulls from one population (country) are therefore not necessarily the best bulls in another population. It is for this reason that all prominent dairy-producing countries (including South Africa) participate in the INTERBULL International Genetic Evaluations for dairy cattle. Each participating country receives a separate ranking list of all global AI bulls, based on that country’s own genetic parameters (heritabilities and genetic correlations among traits), expression of breeding values (unit of measurement) and base year definition.

These multiple across country evaluation ("MACE") breeding values are directly comparable to each country's national breeding values. As these MACE values take not only local genetic merit prediction models and particulars into consideration, but also the possibility of genotype × environment (G×E) interactions, they enable local breeders to determine where any foreign bull ranks locally and, therefore, how his daughters are expected to perform in comparison to the local female population. Trust in genetic merit predictions of foreign AI bulls, even with the inclusion of genomic test results, without proper MACE calculations will most likely result in selection bias favouring the wrong sires.

SADAIRYBULLS.com is an open-access platform, as required by INTERBULL, where all local and foreign AI bulls' breeding values are presented on the South African scale. This is the only tool where all bulls are fairly ranked based on the expected outcomes of their locally produced daughters.

Resilience and robustness of dairy cows need to be addressed with urgency in local breeding objectives. Resilience in dairy cattle can be defined as the ability of cows to maintain performance under stress. Indicators of resilience include variability (or lack thereof) in production. Stability in a cow's production most probably identifies her as being more resilient. Furthermore, recovery after stressful events, such as illness or a severe heat wave, is an indicator of a cow's resilience. This also needs to include survival and longevity. Logix Milk recordings offer a perfect gateway to build up the data and information required to identify these cows and cow families.

Genomic selection – doing it right

The inclusion of genomic information in the estimation of breeding values is the most important contributor to genetic improvement since the establishment of the AI industry. This is especially true for traits of low heritability, traits that are difficult to measure and traits that are measured late in the animal's life. Using genomics improves the accuracy of predicting genetic merit for these traits significantly, particularly for young, not-yet-measured animals. This allows for earlier and more accurate selection, enhancing the rate of genetic improvement.

The application of genomic information for animals considered as candidates for selection must be based on the expression of traits within the population and environment in which those animals produce and survive. The genetic code (as obtained from genomic tests) can only be correctly interpreted when it is linked to and correlated with measurements of animals that already have highly accurate breeding values. These are animals with accurately recorded phenotypic data or with a large number of measured progeny within the population where the genetic code is to be applied.

For these reasons, a significant increase in participation in milk recording and the recording of novel phenotypes, such as methane emissions (environmental impact), feed intake (efficiency), immune response traits and even behavioural traits (grazing ability, temperament), has occurred in all prominent dairy countries since the inclusion of genomic information in their genetic evaluation systems.

Making a selection decision for a local heifer based on genomic test results derived from a different reference or genetic population (such as the USA) fails to account for possible re-ranking and other interactions that may occur.

A balanced selection objective

Dairy breeders need to avoid antagonistic selection objectives by keeping in mind that high production may negatively affect fertility, health and longevity. A working-with-nature strategy explicitly manages genetic correlations through the inclusion of all economically important traits in the selection objective. By applying economic weights, biological inefficiencies are also penalised.

A very powerful tool is the **SADAIRYBULLS.com** mating programme. Participants in Logix Milk can set up a customised selection index for their herd while also considering any bull from around the world in reaching these ultimate breeding objectives. The real power lies in the fact that all these breeding values are directly comparable to those of the cows in the local herd. This furthermore ensures genetic improvement in the next generation for all traits included in the selection objective.

A sustainable selection index should always have optimal lifetime performance in mind.

In conclusion

"Working with nature" involves choosing animals that are efficient rather than extreme, sturdy instead of fragile and suited to their environment rather than merely optimised for ideal conditions. This approach focuses on optimising biological and environmental fit, rather than simply maximising production. Building a herd's and breed's phenotypic and genomic databases is a long-term strategy aimed at sustainability.

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