



Behind the Scenes of a Dairy Cattle Genetic Evaluation: Bringing It All Together and Looking Ahead

- Genetics Tools
- [21/10/2026](#)

Previous articles in this series explored the key building blocks of genetic evaluations and how they are combined to produce an Estimated Breeding Value (EBV). We also examined how reliability and shrinkage account for differences in the amount and quality of information supporting the prediction. The final step is to see how all these pieces work together. This means considering relationships among traits, combining multiple traits into selection tools, validating results, and continuing to adapt as new data and technologies become available.

Bringing it all Together

Traits Don't Exist in Isolation

We often think about traits one at a time, but they are rarely genetically independent. Genes that influence one trait can also influence another.

Genetic correlations describe these relationships and help us understand how selection for one trait can cause genetic change in another. These relationships can be favourable, allowing improvement in one trait to benefit another, or they can create trade-offs. For example, historical selection for greater milk production was associated with unfavourable genetic changes in fertility. Understanding these relationships is therefore essential when trying to achieve balanced genetic progress.

Genetic correlations can also be used directly within genetic evaluations by analyzing related traits together, known as multi-trait evaluations. This allows information from one trait to contribute to the prediction of another, which can be valuable when records are limited or traits have low heritability. For example, Lactanet's Calf Health evaluation analyzes Diarrhea and Respiratory Problems together. With a genetic correlation of approximately 0.5, records for either disease contributes to the evaluation of both traits, increasing the reliability of breeding values

Looking Beyond Direct Measurements

Genetic correlations are also valuable when the trait we want to improve is difficult or expensive to measure. Traits such as feed efficiency and methane emissions require specialized equipment to collect direct measurements. In these situations, an indicator trait that is easier to record can provide useful information if it has a strong genetic relationship with the trait of interest. For example, milk mid-infrared spectra are collected routinely from DHI milk samples and are used to [predict methane production](#). These predicted records greatly expand the number of animals with information available for methane-related genetic evaluations compared to relying only on expensive direct methane measurements.

Combining Traits into One Decision Tool

While multi-trait evaluations use genetic relationships to improve the prediction of individual traits, breeders ultimately need to make selection decisions for many traits at once. This is where selection indexes become

important. National selection indexes such as the Lifetime Performance Index (LPI) and Pro\$ balance genetic progress across several traits according to industry goals and, in the case of Pro\$, their contribution to profitability.

The goal is not to produce an animal that ranks first for every individual trait. Instead, the objective is to achieve the most desirable overall genetic response while managing the relationships and trade-offs among traits. Keep in mind that farms may still have different priorities. For example, a herd facing mastitis challenges may place greater emphasis on udder health, while another may prioritize fertility, efficiency, conformation, or environmental impact. National indexes provide a balanced starting point, while tools such as artificial insemination mating programs or Lactanet's personalized LPI allow producers to adjust emphasis according to their breeding objectives.

Looking Ahead

From Multi-Step to Single-Step

Early genomic evaluations generally involved several stages, with phenotypes and pedigree combined with genomic predictions in subsequent steps. As genomic testing expanded, methods were developed to integrate these sources of information more directly. Today, many dairy evaluations use single-step genomic methodology, which incorporates pedigree relationships, genomic relationships, and phenotypic information within the same evaluation. Rather than treating genotyped and non-genotyped animals as separate populations, single-step allows information to flow throughout the entire connected population. The benefit is that all available sources of information contribute to one coherent prediction of genetic merit. Lactanet's Hoof Health evaluation, introduced in 2018, was the first single-step evaluation in Canada. Since then, all new genetic evaluations developed at Lactanet have used single-step methodology. Plans are also underway to implement single-step evaluations for other traits in Canada. By making

more effective use of available data, this methodology can provide more accurate and reliable predictions of genetic merit.

More Data, New Traits

Genetic evaluations will continue to evolve as new data sources become available. Automated milking systems, activity monitors, cameras, feed bins, milk mid-infrared spectra, environmental sensors, and other precision technologies can generate phenotypes at a scale that would have been difficult to imagine only a few decades ago. These technologies may make it possible to routinely evaluate characteristics that have historically been difficult to measure. At the same time, more genomic information and sequence data may improve our understanding of the biological factors underlying important traits, while advances in computing will allow larger populations and more sophisticated models to be evaluated.

Final Message

Across this series, we have followed the path from phenotypes to genetic prediction. Environmental effects are accounted for so animals can be compared fairly, while pedigree and genomic information connect animals and strengthen predictions. Statistical models then combine this information to estimate breeding values and the confidence surrounding them. Although the methods will continue to evolve, the foundation of Canadian genetic evaluations remains the same: good data, fair comparisons, strong genetic connections, and effective use of all available information. Ultimately, genetic evaluations look beyond what an animal does today to predict what it is likely to pass to the next generation.

At Lactanet, this work continues every day through the development and delivery of reliable genetic predictions for more than 100 traits. By continuously improving evaluations and making the best use of available data and technology, we help Canadian dairy producers make informed breeding decisions that contribute to the ongoing improvement of the dairy industry.

Pour plus d'informations, n'hésitez pas à [contacter l'équipe de Lactanet Canada](#).



By Colin Lynch, Ph.D

Originally from Dublin, Ireland, Colin completed his undergraduate degree in Agricultural Science, majoring in Animal Science, from University College Dublin in 2018. In pursuit of international experience and a passion for livestock breeding, Colin moved to Canada where he completed his MSc (2020) and PhD (2024) in Animal Breeding and Genetics at the University of Guelph. Upon completion of his PhD and a desire to continue contributing to Canadian agriculture, Colin joined Lactanet in October 2024 as a geneticist.



By Hannah Sweett Ph. D.

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