# Fundamentals of Animal Model Genetic Evaluations

Canadian Dairy Network (CDN) maintains six different genetic evaluation systems for analyzing all traits of current interest for dairy cattle improvement. These include separate systems for production, type, longevity, reproductive (i.e.: fertility and calving) performance, milking speed and milking temperament. All genetic evaluation calculations in Canada use a methodology known as the "Animal Model", which refers to the specific goal of estimating each animal's genetic merit. This article aims to provide an understanding of the fundamental principles underlying the "Animal Model" approach.

Sources of Contributions

The genetic evaluation of each animal is based on contributions from three possible sources, namely parents, performance and progeny (Figure 1). The starting point for estimating the genetic merit of any animal is its Parent Average, which can easily be calculated (i.e.: [Sire + Dam] divided by 2) at the time of mating, conception, birth or any time later in life. What is less obvious to many people is that an animal's Parent Average continually evolves as the sire, dam and/or older ancestors in the pedigree add performance data on themselves as well as on existing and/or new progeny. In general, Reliability levels associated with Parent Averages vary from 30 to 40% for production and type traits and are lower for most functional traits.

Figure 1: Sources of Contribution with "Animal Model" Genetic Evaluations
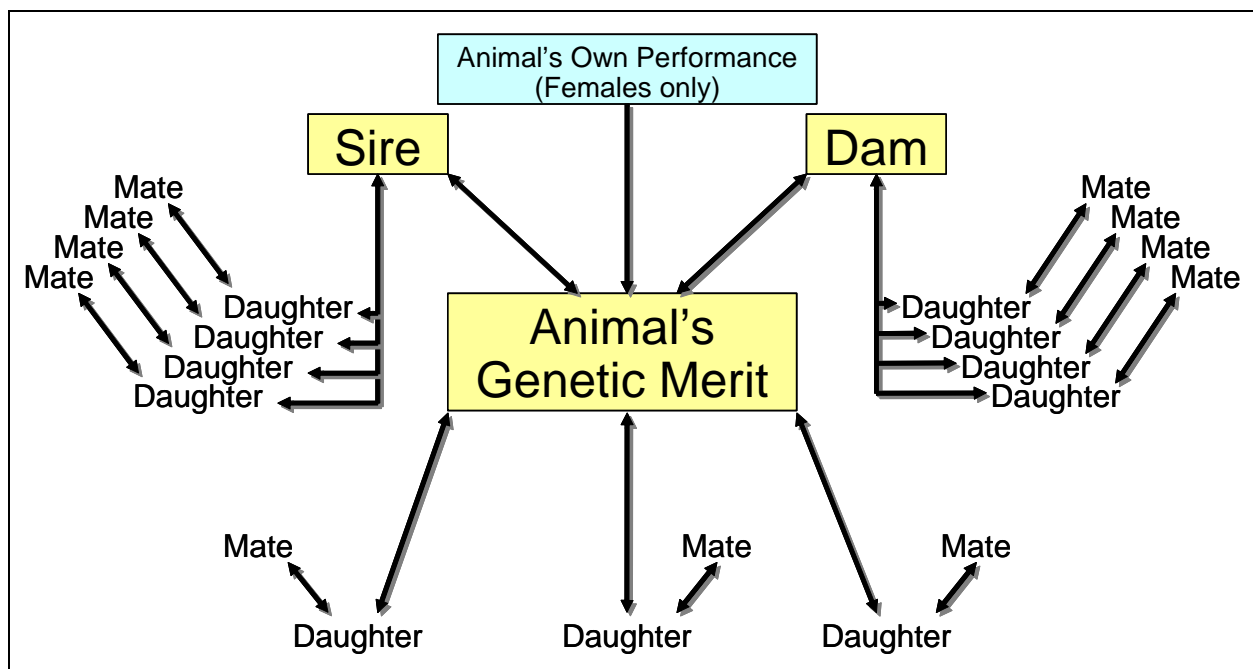
For females, once they start to have their own performance data recorded (i.e. breedings, calvings, lactations, classifications, etc.) it too contributes to the estimation of their genetic merit. As more performance data gets added, less weight is given to the Parent Average when calculating the animal's genetic evaluation. In general, however, as long as a cow has only first lactation data available, the Parent Average still contributes at least two-thirds of the information to her genetic index. For this reason, it is often the case that cows with very high Parent Averages maintain very high official genetic indexes to rank not far from their dam on top lists for their breed. In terms of Reliability levels, once a cow adds her own performance data, the Reliability increases by about 10 percentage points over what she previously had based on Parent Average alone.

The major contributing source of information for estimating an animal's genetic merit is logically the performance of their progeny. In fact, for sires, this is the whole purpose of current young sire testing programs, which are aimed at producing an average of 100 daughters in production with a proof Reliability over 85% at their first official LPI. While cows rarely reach 100 daughters in production, all recorded daughter performance contributes to their dam's genetic evaluation and the impact depends on the number of daughters produced either naturally or by embryo transfer. This additional source of information allows most cows to reach Reliability levels near 60% although popular bull dams and ET donor cows can reach Reliabilities over 95%. A critical part of examining the progeny performance information when estimating an animal's genetic merit is accounting for the genetic level of the mate (i.e.: other parent). This step is particularly important when sires are not used randomly in a population such as those with imported semen that may be used primarily in elite herds or to breed superior cows or young sires that may partially be used in below average herds.

"Animal Model" Calculations

The detailed process of calculating genetic evaluations using the "Animal Model" is complex and involves several steps, which can be simplified as follows:

- Herdbook identification and pedigree data links all relatives to each other regardless of the herd where they are located.
- Production yields on each test day are adjusted to account for differences in variation that exist from herd to herd with a similar adjustment also made for type classification data.
- The performance records for each animal are adjusted to account for differences in age at calving, month or season of calving, days in milk or stage of lactation, lactation number, etc., so that they become comparable across all animals.
- Groups of herdmate contemporaries are established to represent those animals assumed to have received the same management and environmental effects within the herd.
- Each adjusted record for the animal is compared to the average of its herdmate contemporary group and this deviation provides the contribution of the animal's own performance to the estimation of its genetic merit, along with the contributions from its Parent Average and possibly its progeny.

Summary

Canada's genetic evaluation systems are all based on "Animal Model" methodology, which is internationally respected as the most accurate model known. This approach uses all available information and considers contributions from parents, performance and progeny (adjusted for the genetic merit of the other parent) when estimating an animal's genetic merit. While Parent Average is the first indicator of an animal's own genetic ability, and a cow's own performance improves the accuracy of estimation, high levels of Reliability can only be reached via the contribution from performance data for several daughters and/or from several proven sons.

Author: Brian Van Doormaal
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