Calculating Genetic Evaluations for Holstein Conformation Traits

This article is the third in a series of four focusing on the Canadian type classification system and genetic evaluations for conformation traits.

Genetic selection for important conformation traits plays an essential role in the improvement of the Holstein breed in Canada. The national breeding goal is to select for high levels of production, especially protein yield, as well as improved conformation which is required to sustain high production for as many lactations as possible. Canadian producers have been quite successful with this objective as witnessed by the significant rate of genetic progress realized during recent years for both Protein and Conformation. In order to achieve this success, Holstein Canada operates a comprehensive type classification program and forwards this data to Canadian Dairy Network where bull proofs and cow indexes are calculated for a total of 29 type traits, which is expected to be expanded to include three more traits starting 2001. This article provides an in-depth understanding of how these genetic evaluations are calculated.

Data

Classification data for descriptive traits are recorded on a linear scale ranging from 1 to 9. For measured traits, the observed measurement is converted into a linear score at the time of classification in a consistent way for all animals. The seven major scorecard traits, such as Mammary System, Feet & Legs, Rump, Capacity, etc. are recorded as Ex-3, Ex-2, Ex-1, VG-3, VG-2, VG-1, down through Good Plus, Good, Fair and Poor, which results in 18 possible scores. For ease of computer processing the appraisals for these traits are transformed to a linear scale ranging from 18 down to 1, respectively. The actual Final Score of each cow is used to compute genetic evaluations for overall Conformation except that a Final Score of 92 points is used for all Excellent cows and 64 points is used for Poor cows. Classification data since 1981 is combined with complete historical pedigree data to calculate the genetic evaluations. When bull proofs are calculated, only the first classification in first lactation of each daughter is used whereas for cows, the first classification is replaced by the most recent reclassification to derive cow indexes for conformation traits.

Herdmate Contemporaries

As with any genetic evaluation system, a critical element is to define the groups of herdmate contemporaries so that the proper adjustment for herd management and other environmental effects can be made. The aim is to determine groups of cows in the herd which have been exposed to the same environmental and managements treatments. In the type system, all cows which are first classified in the same herd by the same classifier on the same day are considered as herdmate contemporaries. For calculating cow indexes, this means that as a cow is reclassified with age, she is still compared to the original contemporary group as when she was first classified. In this way, cows improving in Final Score over time are appropriately credited when their genetic indexes for type traits are calculated.

Accounting for Age

Although the classifiers in Canada visit each participating herd every seven months, there is obviously still some variability in the age of the cow when classified. Since bull proofs are based only on first classifications in first lactation, the range in age at classification is relatively narrow (Table 1). When reclassifications are considered for cow evaluations, the adjustments for age also depend on which lactation the cow was in when first classified or reclassified. From Table 1, the importance of accurate classifications and adjustment factors for young cows is evident since one-quarter of the classifications used for bull proofs are done when the daughter is 28 months of age or younger.

The objective of the genetic evaluation system is to analyze the existing classification data, consider the other environmental and genetic differences across cows and determine the most appropriate adjustment for the age of each cow at classification. The age adjustments are updated every time new data is added and genetic evaluations are computed. Based on the resulting age adjustment factors, the data indicates that when all other factors are accounted for, cows classified at very young ages do not receive as high a Final Score as older first lactation animals. This is logical since their conformation is not yet fully developed. Therefore, the genetic evaluation system uses an age adjustment factor which credits the younger cows so they are comparable to classifications of older first lactation cows. In practice, the age adjustment is relatively small for cows classified at 32 months of age or older.

Accounting for Stage of Lactation

Similar to the need to adjust for the age of the cow at classification, the genetic evaluation system must also account for differences in the stage of lactation when classified (Table 2). Cows scored at the very beginning of their first lactation tend to score slightly lower compared to those classified later in lactation. This is expected since the udder may still show some swelling, the body condition may be less than optimal for some time after calving and the cow is likely to be still growing depending on the age at calving. The type evaluation system subsequently credits cows classified early in lactation compared to later.

Information on Relatives

The Canadian genetic evaluation system for type traits uses Animal Model methodology. This means that conformation information on the cow, her ancestors and progeny are all considered when determining her genetic index for each trait. Since each cow only has one classification which is used in genetic evaluations (ie: either the first classification or the most recent reclassification), the relative emphasis placed on the genetic potential of parents is approximately two-thirds compared to one-third on the cow's own classification, assuming no scored daughters. Once a cow is old enough to have classified daughters, the main contribution to her genetic index comes from the genetic potential of those daughters for each type trait, and parents count for much less. For bulls, once an official proof is published, which requires at least 20 classified daughters in at least 10 herds and a minimum Reliability of 60%, the contribution from parents is relatively small.

It is also important to note that the genetic merit of each animal's mates is also considered when evaluating progeny performance. For example, a bull who is selectively mated to superior conformation cows will have a better chance of producing high-scoring daughters. When calculating that bull's proof, the genetic potential of the dam of each daughter is taken into consideration to isolate the component of the high daughter classification which is due to the sire rather than the dam.

Summary

The numerous details associated with any genetic evaluation system can sometimes be a source of producer uncertainty. In Canada, the type classification program combined with the genetic evaluation system should, however, give confidence to those wishing to improve the conformation characteristics of their herd.

Table 1: Percentage of 1999 First Classifications in First Lactation by Month of Age at Classification

Age at Classification (Months)	Percentage (%)
Less than 23	0.1
23	0.3
24	1.1
25	3.0
26	5.1
27	7.1
28	8.7
29	9.8
30	10.5
31	10.5
32	9.5
33	7.9
34	6.4
35	4.9
36	3.9
37	2.9
38	2.1
39	1.6
40	1.2
Greater than 40	3.4

Table 2: Percentage of 1999 First Classifications in First Lactation by Stage of Lactation

Stage of Lactation (Months in Milk)	Percentage (%)
1	8.0
2	14.2
3	14.3
4	13.7
5	13.3
6	12.8
7	12.0
8	7.6
9	2.2
10	0.8
Greater than 10	1.1