Réseau laitier canadien
Canadian Dairy Network

Genetic Selection for Longevity

Longevity of dairy cattle has a major impact on the profitability at the farm level. Ideally, producers would like to make all the culling decisions for their herd but in fact there is a high proportion of the milking herd which is eliminated for reasons not controlled by the herd owner. This type of disposal is usually referred to as *"involuntary culling"*. The main reason for genetic selection to increase longevity is to reduce the percentage of involuntary culling in the herd, therefore increasing the percentage of voluntary culling.

Measuring Longevity

One major problem with selecting for longevity is that it is truly only known one a cow's productive life is complete. For genetic evaluations of bulls, this means they are already very old themselves when the true longevity of their daughters is known. In Canada, this problem is addressed by publishing bull proofs as a combined evaluation of true daughter survival with another evaluation which is an early predictor of daughter survival based on the bull's proof for various type traits. These published bull proofs are called "Herd Life" evaluations and reflect the additional number of lactations which their daughters are expected to produce due to reduced culling for non-production reasons. For simplicity, the average bull proof is fixed to an arbitrary value of 3.00 lactations which remains constant as genetic progress for longevity is achieved. The focus of Herd Life proofs is therefore the difference between bulls or relative to the average bull so that the producer expectation of longer functional herd life is achieved by the bulls with proofs higher than 3.00. The range in Herd Life evaluations for Holsteins is from the poorest bulls at 2.25 to the best bulls at 3.50. This indicates that the maximum genetic difference between bulls for the extra longevity that can be gained by reducing culling for reasons other than low production, is one and a quarter lactations.

Combining Direct and Indirect Herd Life

Published Herd Life proofs are a combination of true daughter survival and an indirect measure of longevity based on type traits. Direct survival is measured as the proportion of daughters which successfully pass through first lactation into second, from second into third and from third into fourth, as the daughters become older. Indirect herd life is estimated as a function of each bull's proof for Mammary System (57%), Feet & Legs (29%), Rump (7%) and Capacity (7%).

Table 1 indicates the relative emphasis placed on indirect herd life versus true survival, or direct herd life, when calculating a bull's published Herd Life proof, according to the stage of his production proof. When the daughters of a bull are all in their first lactation, the published Herd Life proof is a combination of his parent average for direct survival, with an emphasis of 30%, and his indirect herd life evaluation which receives 70% of the weight. As a bull's daughters progress through each lactation and more information about the true survival of his daughters is known, the contribution of the indirect herd life evaluation decreases. For active A.I. sires which eventually have thousands of second crop daughters in production, the published Herd Life proof is based 75 percent on the daughter survival and 25 percent on the indirect herd life estimated from the bull's type proof.

Table 1: Relative Emphasis of Direct Survival and Indirect Herd Life in Herd Life Bull Proofs

Stage of a Bull's Production Proof	% Relative Emphasis in Herd Life Proof	
	Direct Survival	**Indirect Herd Life**
First crop daughters are only in 1st lactation	30%	70%
First crop daughters survive past 1st lactation	51%	49%
First crop daughters survive past 2nd lactation	53%	47%
First crop daughters survive past 3rd lactation	55%	45%
Second crop daughters survive past 1st lactation	63%	37%
Second crop daughters survive past 3rd lactation	75%	25%

Herd Life and Other Traits

The relationship between published Herd Life proofs and genetic evaluations for other traits can be evaluated by calculating the correlation amongst bull proofs. Since newly proven bulls receive a Herd Life proof which is heavily based on indirect herd life while older bulls have greater emphasis placed on the actual survival of their daughters through the first three lactations, correlations can be compared across these bull groups as presented in Table 2.

Published Herd Life proofs should have a correlation close to zero with production traits. Although the values in Table 2 are not very high, there seems to be a positive trend between Herd Life proofs with the yield traits and a negative trend with fat and protein percentages. This suggests that the genetic evaluation model is not able to remove all the effects of increased production on longevity when calculating Herd Life proofs.

For type traits, the strong relationship with Herd Life proofs for newly proven bulls is as expected since the bull's proofs for type traits serves as the indirect measure of longevity when no daughter survival information is available. For the group of older bulls, the Herd Life proof mainly reflects true survival since they have second crop daughters which have completed their third lactation. The positive impact of quality udders with superior feet and legs for reducing involuntary culling is clearly shown by the relatively high correlations which still exist for these bulls. It is interesting to note that the proof correlation between true survival and capacity is slightly positive in Canadian Holsteins.

Somatic Cell Score appears to have an important impact on longevity in both bull groups as does milking speed. Calving Ease generally has no relationship with Herd Life proofs, except for a slight positive relationship in favour of bulls with daughters that give birth to their calves easily.

Also of interest when selecting for longevity is the relationship that Herd Life has with both LPI and TEV. The relatively high correlations in Table 2 for newly proven bulls reflect the emphasis placed directly on the type traits in both the LPI or TEV formula and the indirect herd life evaluation. Of interest, however, is that both selection tools have the same relationship with true survival with a correlation of 14% indicating that the LPI and TEV have equal merit at increasing longevity through reduced involuntary culling.

Table 2: Correlation Between Proofs for Herd Life and Other Traits by Bull Group		
Trait	Newly Proven Bulls With 1st Lactation Daughters	Bulls With Second Crop Daughters Past 3rd Lactation
Milk Yield	+.10	+.14
Fat Yield	+.03	+.12
Protein Yield	+.04	+.16
Fat Deviation	-.10	-.04
Protein Deviation	-.13	-.01
Conformation	+.78	+.53
Frame / Capacity	+.25	+.05
Feet & Legs	+.57	+.36
Mammary System	+.76	+.56
Udder Depth	+.46 (Shallow)	+.38 (Shallow)
Somatic Cell Score	-.20 (Desirable)	-.41 (Desirable)
Milking Speed	+.14	+.15
Calving Ease	-.06	+.05
Maternal Calving Ease	-.02	+.18
Lifetime Profit Index (LPI)	+.57	+.14
Total Economic Value (TEV)	+.38	+.14

The Future

The dairy improvement industry is currently working with researchers to develop an improved genetic evaluation system for longevity based on actual survival of daughters to each test day in the herd. This will provide direct information on daughter survival earlier in each lactation. On the international scene, a research project will soon be initiated with the objective of estimating MACE evaluations for longevity. This will be important in the near future as the Lifetime Profit Index (LPI) is expected to include Herd Life directly in the formula along with some udder health traits.