A New Index for Mastitis Resistance

F. Miglior,[*]‡ A. Koeck,[*] G. Kistemaker‡ and B.J. Van Doormaal‡
[*]Centre for Genetic Improvement of Livestock, University of Guelph
‡Canadian Dairy Network
Guelph, Ontario, Canada

In August 2014, CDN will release the first official run of genetic evaluations for mastitis resistance (Jamrozik et al., 2013). The model for estimation of breeding values for mastitis resistance is a multiple-trait linear animal model including clinical mastitis, mean somatic cell score (SCS) in early lactation, standard deviation of SCS, excessive test-day SCC, fore udder attachment, udder depth and body condition score. Traits for mastitis and SCS are for first parity cows and for second and later parity cows. Genetic evaluations for clinical mastitis in first lactation as well as for clinical mastitis in second and later lactations will be calculated and expressed as relative breeding values (RBV) with a mean of 100 and a standard deviation of 5, where higher values are desirable. Those are the only genetic evaluations that will be outputted from this evaluation system. The other traits are included in the evaluation system as they are well correlated with mastitis and most of them have much higher heritabilities. Therefore, their inclusion provides a significant increase in reliability for the genetic evaluations for clinical mastitis, which are the traits of interest. The objective of this report was to develop a Mastitis Resistance index for official publication that includes the RBVs for the two measures of clinical mastitis as well as officially published genetic evaluations for SCS that originate from the Canadian Test Day Model.

Boettcher et al. (1998) developed an udder health index for use in sire selection for an aggregate genotype that included subclinical mastitis (measured by SCS) in lactations 1 and ≥2, clinical mastitis in lactations 1 and ≥2, and milking time. Estimated economic weights were -\$12, -\$31, -\$15, -\$59 and -\$11, respectively, per genetic standard deviation. At that time clinical mastitis was not recorded, thus traits in the selection index were milking speed, udder conformation and SCS in first and later lactations. In August 2014, CDN will release the first official run of genetic and genomic evaluations for Clinical Mastitis in First lactation (CM-F) and Clinical Mastitis in Later lactations (CM-L) using a multiple trait evaluation model (Jamrozik et al., 2013). Based on the work by Boettcher et al. (1998), an index for Mastitis Resistance was developed that included both the new clinical mastitis traits (CM-F and CM-L) and the official SCS evaluation, which has equal weights on SCS in first, second and third lactation. All traits were standardized before applying the relative weights as follows and the overall Mastitis Resistance index was then standardized as an RBV with an average of 100 and standard deviation of 5.

Mastitis Resistance (MR) = 1/3 CM-F + 1/3 CM-L - 1/3 SCS

where;

CM-F = Clinical Mastitis in First lactation
CM-L = Clinical Mastitis in Later lactations
SCS = overall SCS evaluation as officially published whereby low values are desired

Correlations among sire evaluations for each clinical mastitis evaluation (CM-F and CM-L), SCS and the Mastitis Resistance index are shown in Table 1 based on sires with at least 45% reliability for either CM-F or CM-L. The Mastitis Resistance index was highly correlated with the evaluations for each of the individual traits.

Table 1. Correlations among genetic evaluations related to mastitis based on Holstein sires with a minimum Reliability of 45% for either Clinical Mastitis in First lactation (CM-F) or Clinical Mastitis in Later lactations (CM-L)

Trait	CM-F	CM-L	SCS
MR[1]	0.87	0.92	-0.79
CM-F		0.74	-0.48
CM-L			-0.62

[1] MR = 1/3 CM-F + 1/3 CM-L - 1/3 SCS

The response to selection per year (Table 2) was calculated and it is based on the following assumptions:
1) Heritability for CM-F, CM-L and SCS = 0.03, 0.05, 0.20, respectively
2) Genetic correlations among the three traits: CM-F with CM-L = 0.60 and 0.55 for the other 2 combinations
3) Reliability of RBV for MR traits = 0.30, and for SCS = 0.50 (conservative estimates)
4) Selection only on Mastitis Resistance (with various combinations/emphasis of traits)

Table 2. Response to selection per year for various combinations of Mastitis Resistance index

Weights			Genetic gain per year (RBV points)		
CM-F	**CM-L**	**SCS**	**CM-F**	**CM-L**	**SCS**
1/3	1/3	1/3	0.14	0.19	0.44
0.5	0.5	0	0.13	0.18	0.24
0	0	1	0.13	0.17	0.63
1	0	0	0.15	0.12	0.21
0	1	0	0.11	0.23	0.25
1/6	3/6	2/6	0.13	0.20	0.44
0.5	0	0.5	0.15	0.16	0.50

Correlations with other routinely evaluated traits

Correlations of sire evaluations with clinical mastitis (CM-F and CM-L), SCS and the Mastitis Resistance index with other routinely evaluated traits are shown in Table 2. Desirable associations were found between mastitis resistance with longevity, fertility, overall conformation, mammary system and body condition score.

References

Boettcher, P. J., J. C. M. Dekkers, and B. W. Kolstad. 1998. Development of an udder health index for sire selection based on somatic cell score, udder conformation, and milking speed. J. Dairy Sci. 81:1157-1168.

Jamrozik, J., A. Koeck, F. Miglior, G. J. Kistemaker, F. S. Schenkel, D. F. Kelton, and B. J. Van Doormaal. 2013. Genetic and genomic evaluation of mastitis resistance in Canada. Interbull Bulletin No. 47. Nantes, France, August 23-25, 2013.

Miglior, F., J. Chesnais, and B. J. Van Doormaal. 2012. Genetic improvement: a major component of increased dairy farm profitability. Invited Presentation at 38th ICAR Biennial Session held in Cork, Ireland, May 28- June 1, 2012 http://www.icar.org/Cork_2012/Manuscripts/Published/Miglior%20A1.pdf

Table 3. Correlations between RBV of sires with at least 10 daughters for clinical mastitis in first (CM-F) and/or later lactations (CM-L), SCS and Mastitis Resistance index (MR) and other routinely evaluated traits (n=number of sires; only correlations where P<=0.05 are shown)

Trait	CM-F (n=3,675)	CM-L (n=3,675)	SCS (n=3,675)	MR (n=3,675)
LPI	0.17	0.18	-0.33	0.26
LPI-Production	-0.05	-	-0.11	-
LPI-Durability	0.31	0.22	-0.31	0.32
LPI-Health & Fertility	0.28	0.26	-0.41	0.37
Milk Yield	-0.14	-0.07	-0.03	-0.06
Protein Yield	-0.09	-0.04	-0.06	-
Protein Deviation	0.10	0.07	-	0.07
Fat Yield	-	0.08	-0.17	0.10
Fat Deviation	0.13	0.15	-0.13	0.16
Lactation Persistency	-	-	-0.14	0.04
Herd Life	0.38	0.36	-0.50	0.48
Direct Herd Life	0.33	0.32	-0.42	0.41
Indirect Herd Life	0.38	0.37	-0.56	0.51
Somatic Cell Score	-0.47	-0.60	1.00	-0.80
Calving Ability	-	0.04	-0.14	0.06
Daughter Calving Ability	0.04	0.05	-0.13	0.08
Calving Ease (heifers)	0.07	0.06	-0.15	0.11
Calf Survival (heifers)	-	-	-0.08	0.04
Calving Ease (cows)	0.09	0.08	-0.13	0.11
Calf Survival (cows)	-	-	-0.06	0.04
Daughter Fertility	0.12	0.09	-0.13	0.13
Age at First Service	-	-	-	-
56-d Non-Return Rate (heifers)	-	-	-0.05	-
Number of Services (heifers)	0.03	0.05	-0.08	0.06
First Service to Conception (heifers)	0.04	0.06	-0.09	0.08
Calving to First Service	0.19	0.15	-0.17	0.19
56-d Non-Return Rate (cows)	0.06	0.04	-0.08	0.07
Number of Services (cows)	0.09	0.06	-0.09	0.09
First Service to Conception (cows)	0.12	0.08	-0.13	0.13
Days Open	0.16	0.12	-0.16	0.17

Trait	CM-F (n=3,675)	CM-L (n=3,675)	SCS (n=3,675)	MR (n=3,675)
Conformation	0.24	0.14	-0.19	0.22
Rump	0.04	-	-	-
Mammary System	0.28	0.15	-0.22	0.25
Feet and Legs	0.10	0.10	-0.12	0.12
Dairy Strength	-	-	-	-
Udder Depth	0.39	0.20	-0.25	0.32
Udder Texture	0.13	0.09	-0.15	0.15
Median Suspensory	0.05	0.05	-0.08	0.07
Fore Attachment	0.33	0.15	-0.16	0.25
Fore Teat Placement	-	-	-	-
Rear Attachment Height	0.14	0.08	-0.12	0.13
Rear Attachment Width	-	-0.04	-	-
Rear Teat Placement	-0.05	-0.04	0.07	-0.06
Teat Length	-	-0.06	-	-0.03
Foot Angle	0.10	0.08	-0.08	0.10
Heel Depth	0.14	0.10	-0.10	0.13
Bone Quality	-0.08	-	-0.04	-
Rear Leg Side View	-0.06	-0.07	0.04	-0.06
Stature	0.08	-	-0.04	0.05
Height at Front End	-	-	-0.06	0.04
Chest Width	0.12	0.08	-	0.09
Body Depth	-	-	0.07	-
Angularity	-0.13	-0.09	0.05	-0.11
Body Condition Score	0.19	0.12	-0.09	0.15
Milking Speed	-	-0.09	0.25	-0.14
Milking Temperament	-0.08	-0.13	0.15	-0.14

Genetic trends

As shown previously by Miglior et al. (2012), genetic trends for SCS improved markedly since 2004, becoming favorable instead of unfavorable (Figure 1). Also, the genetic trend for overall mastitis (Figures 1 and 2) was favorable over the last years due to indirect selection for lower SCS.

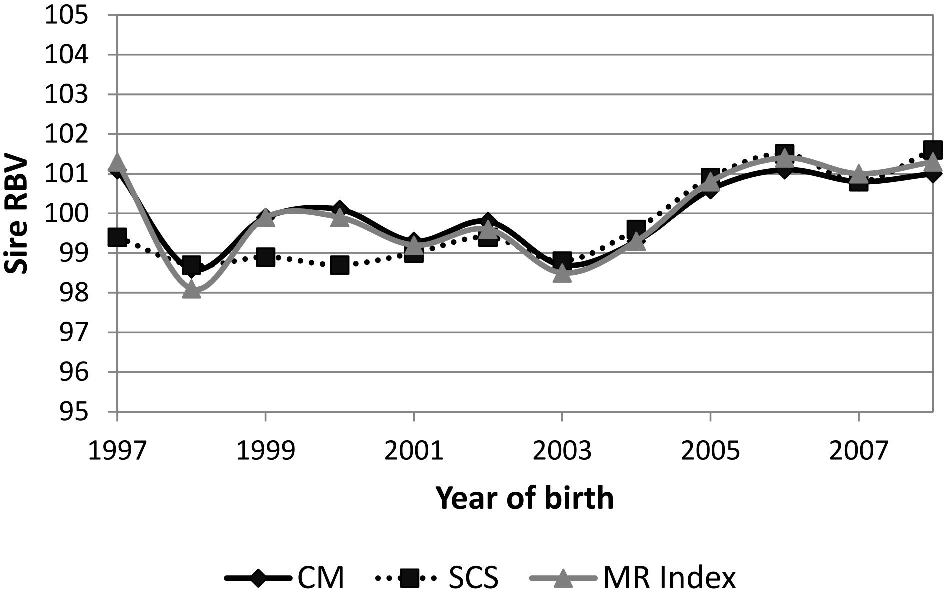

Figure 1. Genetic trend for overall clinical mastitis (CM), SCS and Mastitis Resistance (MR)

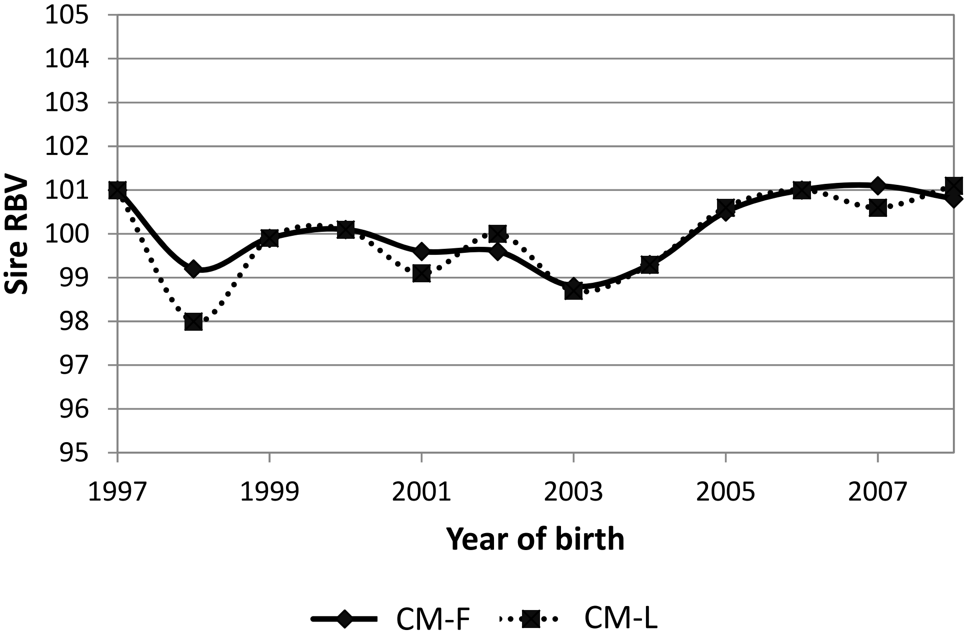

Figure 2. Genetic trend for clinical mastitis in first (CM-F) and later lactations (CM-L)