Udder health index: selection for mastitis resistance

Gerben de Jong and Lucia Lansbergen

Royal Dutch Cattle Syndicate, P.O. Box 454, 6800 AL Arnhem, The Netherlands

Abstract

Direct and indirect selection on clinical masititis incidence was studied. Based on literature estimates and estmitates from Dutch data a genetic parameter set was constructed. Traits used for indirect selection were somatic cell count, milking speed, and linear udder type traits. Based on selection index calculations an udder health index was constructed as a tool for selection against clinical mastitis.

From the index calculations it was concluded that indirect selection on clinical mastitis resulted in the same genetic progess as direct selection. Combining direct and indirect selection gave 14% higher response. The udder health index for indirect selection consisted of the traits, in order of importance for genetic response, somatic cell count, udder traits with udder depth and fore udder attachment, and milking speed.

1. Introduction

Mastitis is one of the most important diseases in dairy herds. Mastitis results in economic losses by decrease of milk production, including milk not delivered, treatment costs, labor costs, early culling and contamination of other cows. As mastitis infection causes high levels of somatic cells in the milk and most payment systems of milk include reduction of milk prices for milk with high levels of somatic cell counts (SSC), the reduction of mastitis incidence is of economic importance. Management factors and therapy get a lot of attention to reduce mastitis incidence. Reduction of SCC can also be enforced by selection. Mastitis demonstrates itself in two ways, in a clinical and in a subclinincal form. Clinical and subclinical mastitis are not exactly the same traits. Genetic correlation is lower than one (Emanuelsen,1988).

Selection on mastitis resistance requires selection on clinical and subclinical mastitis. As little is known on genetic parameters for subclinical mastitis and correlations of subclinical mastitis with other traits, a selection for clinical mastitis could be the best next. This seems justified because of the high positive correlation between clinical mastitis and subclinical mastitis. Selection on clinical mastitis can be done directly and indirectly. For direct selection data on mastitis cases are needed and to be collected on the farms. In the Netherlands no registration of mastitis infections is available on national level. Further mastistis resistance has a low heritability of about 0.03.

In this research the alternative of indirect selection on mastitis resistance is studied. For indirect selection breeding values for linear udder traits, SCC and milking speed are available. Objective of the study was to define an index which makes it possible to select for clinical mastitis resistance. This index is furtheron called the udder health index.

2. Genetic parameters

The genetic parameters required for selection index calculations are listed in table 1. Parameters were based on literature and on analysis of data of dairy cows in the Netherlands. For the type udder traits the heritabilities, genetic and phenotypic correlations were based on a genetic analysis of Dutch Black&White cow data. The genetic correlations between milking speed, SCC and udder traits were calculated from correlations between Dutch breeding values. The correlations between milking speed en udder traits were very low and set to zero. The heritabilities for milking speed (De Jong, 1993) and SCC (Fox, 1994) were based on Dutch data.

Heritability of mastitis resistance was to be found to be between 0.008 and 0.03 (Lund (1994), Emanuelson (1988), Lawstuen (1988), Philipsson (1995), Koenen (1994) and Groen (1994)). A heritability of 0.03 was used.

Correlations for mastitis resistance with other traits used in table 1 are based on literature values (see table 2). Udder depth shows that deep udders cause more mastitis. The variation of genetic correlations with mastitis incidence varies from -0.69 to +0.18. Deep udders cause more often mastitis infections. Fore udder attachment was correlated with mastitis incidence with -0.57 to +0.18, which means better attached udders reduce mastitis incidence. Correlation of suspensory ligament with mastitis incidence showed a variation from -0.51 to +0.26, Three papers showed that a stonger ligament results in less mastitis. Groen(1994), however found that strong suspensary ligaments give a higher mastitis incidence. The variation of genetic correlation between mastitis incidence and teat placement was from -0.73 to -0.06, saying narrow teat placement gives less chance for mastitis infection. Again Groen(1994) found opposite results.

Genetic correlation between mastitis resistance, which is opposite of mastitis incidence, and udder traits were assumde to be 0.40 for udder depth, 0.35 for fore udder attachment, 0.15 for teat placement and 0.10 for suspensary ligament (table 1). These values are used in selection index calculations.

Rear udder height was not correlated with clinical mastitis incidence. Teat length had a genetic correlation with mastitis incidence of -0.72, saying that long teats give less mastitis. Dutch data with about 1500 cows showed a correlation of 0.87, which menas that short teats are preferred to avoid mastitis. Due to the low genetic correlations found for rear udder heigth with mastitis incidence and disagreement of the high genetic correlation found between teat length and mastitis incidence, these two udder traits were not used in the index calculations.

3. Index calculations

Index calculations were made with mastitis resistance as breeding goal (H). Mastitis resistance was defined as the reverse trait of clinical masitits incidence. In the index (I) milking speed (MS), SCC, udder depth(UD), fore udder attachment(FU), suspensory ligament(SL) and teat placement(TP) were used. The formula of the breeding goal is:

$$H = v_1 * MR$$

The formula of the index is:

$$I = b_1 * BV_{FU} + b_2 * BV_{UD} + b_3 * BV_{TP} + b_4 * BV_{SL} + b_5 * BV_{MS} + b_6 * BV_{SCC}$$

where BV is breeding value.

Selind was used to determine b-values. Different combinations of selection index traits were tested on response of mastitis resistance as breeding goal. Results of different combinations of trait in the selection indices can be found in table 3. Using mastitis resistance data of 100 daughters of a bull results in an index having a correlation (R_{IH}) of 0.656 with the breeding goal mastitis resistance. This is direct selection on mastitis resistance. When seperate traits are used the respons and R_{IH} are lower. SCC gives 93 percent of the response compared with direct selection. Milking speed and udder traits give respectively 43 and 60 percent of the respons when compared with direct selection.This shows clearly that SCC is the best single indirect trait for mastitis resistance and milking speed is least informative. When using milking speed, udder traits and SCC in the index the response is 1 percent higher than direct selection for MR. The highest repons was found when direct and indirect selection was combined: 14 percent higher respons than with only direct selection.

When taking a closer look at the four udder traits it is obvious that one trait is more informative than the other. In table 4 selection indices are defined with milking speed and SCC plus one or more udder traits. When including one type udder trait in the index jointly with milking speed and SCC, the index with udder depth gave the highest reponse with 0.297, followed by the index including fore udder attachment with a genetic response of 0.292. Both responses were close to the response of the index including all the type udder traits jointly with milking speed and SCC: 0.298. Adding teat placement or suspensary ligament to the index already including milking speed and SCC improved the response sligthly. The index with milking speed, SCC, udder depth and fore udder attachment gave the same response as the index with all the six traits combined.
This results in an index for indirect selection on udder health containing the traits milking speed, SCC, udder depth and fore udder attachment:

$$I_{uh} = 0.0080*BV_{FU} + 0.0189*BV_{UD} - 0.0164*BV_{MS} - 0.6725*BV_{SCC}$$

4. Conclusion

Indirect selection for mastitis resistance gave the same genetic response as direct selection. Such an indirect selection is based on combining the traits milking speed, SCC, udder depth and fore udder attachment. Other udder type traits such as suspensory ligament and teat placement did not increase the genetic response on mastitis resistance. A combination of direct and indirect selection gave 14 percent higher respons than only direct selection. The selection index for udder health or mastitis resistance is:

$$I_{uh} = 0.0080*BV_{FU} + 0.0189*BV_{UD} - 0.0164*BV_{MS} - 0.6725*BV_{SCC} \quad [1]$$

The relative weight of the trait in the index expressed in their own genetic standard deviation is 8, 19, 16, 57 respectively for fore udder attachment, udder depth, milking speed and SCC.

6. Discussion

This paper shows the results of several index calculations for indirect selection on mastitis resistance. The basis for these clalculations are the parameters of table 1. Definitive values were based on literature estimates and estimates in Dutch data sets, using common sense. The question is how rubuust the index is.

Index calculations show definitely what the most important traits are to use for the selection on mastitis resistance. By far somatic cell count is the most important trait, followed by the udder traits and milking speed. Changes in genetic parameters, as far as they are likely to change, will change the weighting factors for the traits but it is expected they will not immediately change the order of importance of the traits. Further, in this paper parameters are used which hold for clinical mastitis. Little is known on correlations between the index traits and subclinical mastitis. It is assumed that selection on clinical mastitis also will decrease the incidence of subclinical mastitis.

7. Literature

De Jong, G. Analyse van enquête voor gedrag bij melken, melksnelheid en melkuitliggen bij vaarzen. NRS report.

Emanuelson, U., B. Danell, and J. Philipsson, 1988. Genetic parameters for clinical mastitis, somatic cell counts, and milk production estimated by multiple-trait restricted maximum likelihood. J. Dairy Sci. 75:467-476

Fox, M.J.H., E.W. Brascamp, G. de Jong, J.B.M. Wilmink, 1994. Mogelijkheden van fokwaardeschatting voor celgetal in Nederland. NRS report.

Groen, A.F., I. Hellinga and J.K. Oldenbroek, 1994. Genetic correlations of clinical mastitis and feet and legs problems with milk yield and type traits in Dutch Black and Whhite dairy cattle. Neth. J. Agr. Sci. 42:371-378.

Koenen, E.P.C., B. Berglund, J. Philipsson, and A.F. Groen, 1994. Genetic parameters of fertility disorders and mastitis in Swedish Friesian breed. Acta Agric. Scan. 44:202-207.

Lawstuen, D.A., L.B. Hansen, and G.R. Steuernagel, 1988. Management traits scored linearly by dairy producers. J. Dairy Sci. 71:788-799.

Lund, T., F. Miglior, J.C.M. Dekkers, and E.B. Brunsside, 1994. Genetic relationship between clinical mastitis, somatic cell count, and udder conformation in Danish Holsteins. Livest. Prod. Sci. 39:243-251.

Philipsson, J., G. Ral and G. Berglund, 1995. Somatic cell count as a selection criterion for mastitis resistance in dairy cattle. Livest. Prod. Sci. 41:195-200.

Table 1. Parameters used to calculate the udder health index. In upper triangle phenotypic correlations, on diagonal heritabilities, in lower triangle genetic correlations. The last column shows the genetic standard deviation of the traits.

	MR	FU	TP	UD	SL	MS	SCC	sd
MR	0.03	0.10	0.10	0.10	0.10	-0.20	-0.40	0.45
FU	0.35	0.29	0.38	0.47	0.20	0.00	-0.10	4.50
TP	0.15	0.60	0.33	0.25	0.33	0.00	-0.10	4.50
UD	0.40	0.72	0.28	0.40	0.23	0.00	-0.10	4.50
SL	0.10	0.32	0.44	0.34	0.21	0.00	-0.10	4.50
MS	-0.30	0.00	0.00	0.00	0.00	0.30	0.10	4.50
SCC	-0.70	-0.30	-0.10	-0.35	-0.05	0.30	0.12	0.38

MR= mastitis resistance (low-high), FU=fore udder attachment(loose-strong), TP=teat placement (wide-narrow), UD=udder depth (deep-shallow), SL=suspensary ligament (weak-strong), MS=milking speed(slow-fast), SCC=somatic cel count on 2log-scale (low-high), sd=genetic standard deviaton.

Table 2. Genetic correlations between mastitis incidence and udder type traits, milking speed and SCC.

	Lawstuen (1989)	Lund (1994)	r bv DK-US [1]	Groen (1994)	
FU	-0.57	-0.18	-0.35	0.09	- = loose -> more mastitis
TP	-0.73	-0.13	-0.06	0.11	- = wide -> more mastitis
UD	-0.69	0.11	-0.45	0.18	- = deep -> more mastitis
SL	-0.51	-0.32	-0.02	0.26	- = weak -> more mastitis
RU	0.07	-0.14	-0.02	-	- = low -> more mastitis
TL	-	0.72	-0.10	-	+ = long -> more mastitis
MS	-0.57	-0.29	-	-	- = slow -> more mastitis
SCC	-	0.27	-	0.77	+ = high -> more mastitis

(1) correlations between Danish breeding values for mastitis and US breeding values for udder traits. Personal communication with G.W. Rogers.

Table 3. Genetic response (Resp) and correlation between index and aggregate genotype (R_{IH}) with an index consisting of different combinations of udder traits, milking speed (MS), somatic cell count (SCC) and mastitis resistance (MR). UDD stands for all udder type traits. Calculations are based on 100 daughters per bull for all traits.

Index	Resp	RIH	% of MR
MR	0.295	0.656	100
MS	0.127	0.283	43
UDD	0.178	0.396	60
SCC	0.274	0.609	93
MS+UDD	0.219	0.487	74
MS+SCC	0.280	0.622	95
UDD+SCC	0.290	0.646	98
MS+UDD+SCC	0.298	0.662	101
MR+MS+UDD+SCC	0.336	0.746	114

Table 4. Weighting factors, genetic response and correlation between index and aggregate genotype (R_{IH}) with an index consisting of one or more udder traits, milking speed (MS), somatic cell count (SCC) and mastitis resistance (MR). Calculation based on 100 daughters per bull for all traits.

index	weighting factors						response	R_{IH}
	FU	TP	UD	SL	MS	SCC		
SCC+MS+UDD	.0075	.0012	.0198	-.0027	-.0164	-.6710	0.298	0.662
SCC+MS+UD	-	-	.0242	-	-.0163	-.6786	0.297	0.660
SCC+MS+FU	.0206	-	-	-	-.0156	-.7076	0.292	0.649
SCC+MS+TP	-	.0092	-	-	-.0144	-.7691	0.283	0.628
SCC+MS+SL	-	-	-	-.0063	-.0142	-.7765	0.281	0.625
SCC+MS+FU+UD	.0080	-	.0189	-	-.0164	-.6725	0.298	0.662
SCC+MS+FU+UD+TP	.0080	.0001	.0189	-	-.0164	-.6725	0.298	0.662
SCC+MS+FU+UD+SL	.0075	-	.0194	-.0024	-.0164	-.6708	0.298	0.662