Relationships Among Indexes for Individual Traits, Stayability, and Total Merit for Swedish Dairy Breeds

Bengt Lindhé, Jan Philipsson, Jan-Åke Eriksson**, Mats Gundel** and Dan-Axel Danielsson*.*

Dept. of Animal Breeding and Genetics, SLU Uppsala
Addresses:
* VHFD, SLU Skara, Box 234, 532 23 Skara.
** SHS, 631 84 Eskilstuna.

Introduction

Involuntary culling is a disturbing factor in the management of a dairy herd and is connected with lower yield and elevated costs in terms of expenditures for veterinary treatments and increased replacements. Nielsen and Pedersen (1995) presented correlations between non-production traits and survival rates in Danish dairy cows and concluded that good reproduction and health traits were of decisive importance in the efforts to produce long-living cows.

The actual total merit index used in Sweden comprises 11 subindexes. In addition indexes for stayability are calculated, which are not included in the total merit index. The aim of the present paper is to illustrate the variation in proofs for stayability and their covariation with the subindexes that constitute the total merit index.

Material and Methods

The data used were the official BLUP proofs for yield of protein (Prot), daughter fertility (Dfert) mastitis resistance (Mast), resistance to "other diseases" (Other), stillbirths as a direct effect (StbD), stillbirths as a maternal effect (StbM) and conformation traits based on all available progeny evaluated in July 1995. Stillbirth data were not available in this study for SRB. For growth rate the proofs are based on performance tests of the bulls. The indexes for conformation traits contain data from 40-50 randomly sampled daughters of bulls preselected for production based on preliminary proofs. The BLUP-procedure applied on yield (including only first lactations) is a single trait MGS model which has been described by Danell and Eriksson (1982). The indexes for disease resistance include events in the first lactation only. The index for daughter fertility (Eriksson, 1989) comprises the three traits "number of inseminations" preceding the three first pregnancies, "number of days from calving to the first insemination" in the first and second lactation and finally (with a low weighting) a subjective score for "heat symptoms" at the inseminations. The BLUP-procedure for disease resistance, described by Eriksson and Wretler (1987), and the one for female fertility are both single trait sire models with relationship matrix used. The same procedure is used for StbD and StbM. The model gives the direct and maternal effects simultaneously. For the conformation traits a single trait animal model is used. For all traits except production and growth rate the genetic standard deviation has been standardized at 7 units.

Three indexes for stayability are calculated. O1 reflects the proportion of daughters surviving the first lactation (calved the second time or not culled 400 days efter the first calving), O2 the proportion still in production 150 days after the second calving and O3 the proportion surviving the second lactation. A single trait BLUP procedure without relationship matrix is applied.

The study comprises 675 progeny tested SRB (Swedish Red and White) bulls born 1984 - 1988 with at least 100 daughters behind the final stayability index, O3. Out of these bulls 190 were progeny tested for conformation

traits. The study also included 454 SLB (Swedish Friesian) bulls that were born in Sweden the same years. Of these 154 were progeny tested for conformation traits.

All original proofs, given as relative breeding values (RBV), were adjusted to a mean of 100 each year. This allowed calculation of relationships without the potential bias depending on varying time trends in different traits. Two types of total merit indexes were recalculated based on the adjusted proofs. TMI.1 is based on protein yield, growth rate, daughter fertility, stbD, stbM, mastitis and other diseases (stillbirths only for SLB). TMI.2 refers to the preselected group of bulls for which the conformation traits were recorded and includes in addition proofs for udder and leg conformation. The b-values used at the calculation of TMI.1 and TMI.2 are identical with those used in the present total merit index in Sweden.

Results and discussion

Means and results of selection

In Table 1 the means, standard deviations and min- and max-values are given for traits recorded for all progeny tested SRB and SLB bulls.

In Table 2 statistics are given for the traits recorded for the 190 preselected SRB-bulls for which also the conformation traits were recorded. The corresponding results for SLB are shown in Table 3. The differences in means and standard deviations for the traits appearing in Tables 2 and 3 compared to Table 1 illustrate the effects of the preselection for production. The preselection was negative mainly for daughter fertility. The standard deviation for protein yield was as expected notably reduced. The proofs for survival rate were only slightly affected by the preliminary selection. The average TMI.2 of the preselected bulls was 5.64 for SRB and 4.88 for SLB.

Two columns of tables 2 and 3 give means for the top 14 and 9 bulls respectively with regard to TMI.2 and O1 during the 5 year period. In a totally integrated national program with bulls still alive at the time the proofs become available these bulls would be enough (100 000 doses after each bull) to cover the need of semen from progeny tested bulls.

It is obvious that the final result is quite different if the top bulls are selected for TMI.2 or for O1. Selection for O1 gives about 6 units higher stayability indexes of the selected bulls of both breeds compared to selection for TMI.2 while the latter is 9 units lower. Protein indexes were 6-7 units lower in both breeds. Subindexes for mastitis were lower in SLB and higher in SRB when selection was based on O1 compared to TMI.2, while daughter fertility indexes were unchanged in SRB but higher in SLB. This reflects the more pronounced negative genetic correlations found between production and fertility in SLB (Holstein) compared to SRB (Lindhé and Philipsson, 1995).

Proofs for stayability

In Table 4 the average proportion of surviving daughters (P1 - P3), the phenotypic values corresponding to O1, O2 and O3, are given for the same bulls as were represented in Table 1.

On an average 69% of the cows survive the first lactation and 53% the second for both breeds. The stayability proofs of the best and worst bulls based on at least 150 daughters each differ substantially. Only 36% survive the second lactation after the worst bulls in both breeds but 73 and 69% after the best SRB and SLB bulls respectively. It is misleading to present the min-values for bulls with more than 700 daughters as these bulls belong to the selected ones. However, the max-values for O3 of these bulls were 73% for SRB and 66% for SLB. The highest value for O3 for a SRB bull with more than 700 daughters was thus more than 19 per cent units above the mean of the breed. For SLB this superiority amounted to more than 12 per cent units (only 9 SLB bulls with >700 daughters behind O3).

Proof correlations

In Table 5 simple proof correlations between O1, O2, O3 and the subindexes are given. These were calculated only for the subindexes in Table 1 as the sample of bulls tested for conformation traits were preselected, mainly for yield. For protein yield, growth rate and stillbirths the correlations were as expected much higher with TMI.1 than with O1-O3. For daughter fertility, mastitis and other diseases the reverse was true. Obviously, yield related traits and calf losses have the highest correlations with the economic index TMI while the cost related traits have the highest correlations with O1, O2 and O3. There is a striking similarity between the correlations with O1-O3.

In Table 6 the partial coefficients of regression are given with O3 and TMI.2 as dependent variables.

Table 6. reveals the similarities and the differences between O3 and TMI.2 as regards the influence of the part indexes. The partial coefficients of regression with TMI.2 are identical with the b-values and by definition the multiple correlation is unity. There are large similarities between O3 and TMI.2 as regards the influence of the cost related traits daughter fertility, mastitis and other diseases. Protein yield and stillbirth proofs have as shown before a larger influence on TMI.2. This is also true for the conformation proofs. The proof for growth rate is, not unexpectedly, the most divergent part index as it is of economic value only from a beef point of view, for the fattening merits of the calves and for the salvage values of the cows.

The results in Table 7 indicate rather high correlations between the proofs measured at various stages during the two first lactations. This is supported by the the results of Table 5 indicating that approximately the same relationship with different subindexes exist with all three stayability proofs.

Conclusions

From this study it is obvious that the subindexes presently included in the total merit index also have a large impact on stayability proofs measured at various stages. The multiple correlations were 0.5-0.6 although body conformation and temperament were not included. The partial coefficients of regression of the cost related traits, that mostly affect unvoluntary culling, are about the same for TMI and O3 which means that they are reasonably well accounted for in the total merit index applied. Some conformation traits may be overestimated in the present selection system.

Although the stayability proofs, presently used in Sweden, are rather crude and not corrected for yield traits, there is a considerable variation among bulls for these proofs. As the present total merit index already includes important causes of variation in stayability a closer study of the real nature of the other factors and their genetic background is urgent. Until then stayability proofs could be used complementary to the total merit index. Daughter groups of bulls with strongly diverging proofs for TMI and stayability should be carefully examined.

References

Danell, B. and Eriksson, J.-Å. 1982. The direct sire comparison method for ranking of sires for milk production in the Swedish dairy cattle population. Acta Agr. Scand. 32, 47.

Eriksson, J.-Å. and Wretler, E. 1987. Sire evaluation for diseases in Sweden . EAAP, Lissabon.

Eriksson, J.-Å. 1989. Avelsvärdering honlig fruktsamhet. SHS Fgu 44-89.

Lindhé, B. and Philipsson, J. 1995. Effects of unknown vs. known genetic relationships between economically important traits in total merit indexes for dairy bulls. EAAP, Prague, 1995.

Nielsen, U.S. and Pedersen, G.A. 1995. Relationship between non-production traits and survival rates in Danish dairy cows. Interbull Bulletin No. 11.

Table 1. Means, standard deviations, min- and max-values for traits recorded on 675 progeny tested SRB bulls and 454 SLB bulls born 1984 - 1988

	SRB				SLB			
Trait	Mean	S.d.	Min	Max	Mean	S.d.	Min	Max
Protein yield	100	5.86	78.9	124.2	100	6.60	79.2	116.8
Growth rate	100	2.53	92.7	108.8	100	2.22	93.1	108.3
Daughter fert	100	6.41	78.8	117.2	100	6.80	82.8	123.0
StbD					100	4.21	85.4	113.1
StbM					100	4.77	80.7	113.8
Mastitis	100	5.85	76.6	114.6	100	6.08	77.6	117.1
Other dis.	100	4.58	85.7	114.4	100	4.45	88.1	114.3
O1	100	4.47	82.9	117.9	100	4.75	85.9	117.3
O2	100	4.61	84.0	118.4	100	5.16	82.5	117.5
O3	100	5.39	84.4	122.7	100	5.73	82.4	121.0
TMI.1	0	6.12	-22.5	23.8	0	6.98	-26.6	24.5

Table 2. Statistics for all traits recorded on 190 SRB bulls that were preselected to be progeny tested for conformation traits

					14 top bulls	14 top bulls
Trait	Mean	S.d.	Min	Max	TMI.2	O1
Protein yield	105.90	4.44	97.0	124.2	112.1	106.4
Growth rate	100.73	2.60	93.8	108.7	101.8	101.0
Daughter fert	98.96	6.55	82.7	116.5	100.3	100.2
Mastitis	99.20	6.07	76.6	112.2	100.3	102.1
Other dis.	99.47	5.07	85.7	114.4	102.1	101.5
Udder	100.00	6.01	83.5	115.7	105.6	99.7
Legs	100.00	4.21	88.4	112.3	101.7	100.2
O1	101.42	4.71	89.1	117.9	103.8	110.3
O2	101.33	4.92	87.9	118.4	103.8	110.3
O3	101.89	5.84	87.1	122.7	105.5	111.2
TMI.2	5.64	5.52	-8.0	21.5	16.6	7.7

Table 3. Statistics for all traits recorded on 154 SLB bulls that were preselected to be progeny tested for conformation traits

					9 top bulls	9 top bulls
Trait	Mean	S.d.	Min	Max	TMI.2	O1
Protein yield	105.66	4.45	94.8	116.8	111.4	104.1
Growth rate	99.86	2.13	95.3	107.1	100.6	99.3
Daughter fert	97.68	6.35	83.8	114.5	99.5	103.2
StbD	100.68	4.62	86.4	113.1	103.4	103.6
StbM	99.91	4.88	81.3	113.8	103.4	103.2
Mastitis	100.26	5.91	77.6	116.4	106.0	102.9
Other dis.	98.57	4.61	88.1	109.1	99.0	101.3
Udder	100.00	5.49	84.5	113.3	104.2	102.0
Legs	100.00	5.74	85.0	112.4	102.7	102.6
O1	101.30	4.72	89.8	117.3	104.9	110.9
O2	101.42	5.37	86.7	117.5	106.1	111.7
O3	101.98	5.72	88.8	121.0	106.3	113.7
TMI.2	4.88	6.38	-16.2	22.9	17.8	9.0

Table 4. Means, max- and min-values for the proportion of surviving daughters, P1, P2 and P3 behind the proofs O1, O2 and O3. SRB and SLB. Number of daughters per bull at least 100 behind O3. Within brackets figures with at least 150 daughters behind O3

	SRB				SLB			
Trait	Mean	S.d.	Min	Max	Mean	S.d.	Min	Max
P1/O1	69.37	5.84	23 (44)	85 (85)	68.56	5.44	49 (51)	83 (82)
P2/O2	65.48	5.92	21 (42)	82 (82)	63.60	5.92	46 (46)	79 (78)
P3/O3	53.48	6.41	20 (36)	73 (73)	53.43	6.32	36 (36)	69 (69)

Table 5. Simple proof correlations between O1, O2, O3, TMI.1 and the subindexes for traits recorded on all progeny tested bulls

	SRB				SLB			
Traits	O1	O2	03	TMI.1	O1	O2	O3	TMI.1
Protein yield	.249	.241	.287	.856	.229	.233	.274	.808
Growth rate	.020	.012	-.003	.311	-.005	-.006	-.014	.133
Daughter fert	.218	.195	.196	.151	.177	.154	.118	.066
StillbirthsD					.156	.144	.147	.236
StillbirthsM					.256	.242	.216	.317
Mastitis	.248	.286	.238	.187	.398	.414	.390	.314
Other dis.	.219	.233	.187	.144	.176	.163	.131	.073
Multiple correlations	.478	.486	.488	1.00	.576	.573	.559	1.00

Table 6. Partial coefficients of regression with O3 and TMI.2 as dependent variables for 190 SRB and 154 SLB bulls preselected for protein proof. The coefficients of regression for TMI.2 equal to the b-values for the index

	SRB		SLB	
Traits	O3	TMI.2	O3	TMI.2
Protein yield	.34	1.00	.22	1.00
Growth rate	-.20	.50	-.12	.50
Daughter fert	.29	.30	.27	.30
StbD			.07	.20
StbM			.09	.30
Mastitis	.27	.30	.35	.35
Other dis.	.09	.15	.09	.15
Legs	.18	.20	.08	.20
Udder	-.03	.50	.09	.50
Multiple correlations	.51	1.00	.56	1.00

Table 7. Correlations between the stayability proofs O1, O2 and O3 for bulls in table 1.

	SRB		SLB	
Trait	O2	O3	O2	O3
O1	0.94	0.80	0.94	0.82
O2		0.85		0.87