Summary of Mace Pilot-runs for Somatic Cell Count and Clinical Mastitis

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Introduction

A total of 10 countries and two breeds participated in this project. This summary will mainly focus on results from Mace pilot-runs for somatic cell count (SCC) and clinical mastitis (CM) carried out by Interbull in August 2000. A detailed report describing the project is inunder preparation; some details on estimation of genetic correlations were presented during the Interbull meeting in Bled, and are published in the proceedings.

Materials and methods

National genetic evaluation results of Holstein bulls for SCC were obtained from Canada (CAN), Germany (DEU), Denmark (DNK), Finland (FIN), France (FRA), the United Kingdom (GBR), the Netherlands (NLD), Sweden (SWE) and the United States (USA). Furthermore, national genetic evaluation results of Holstein bulls for clinical mastitis were made available from Denmark, Finland and Sweden. For Ayrshire, national genetic evaluation results for SCC were available from Finland and Sweden, whereas mastitis evaluations were available from Finland, Norway (NOR) and Sweden. Trait definitions and national genetic evaluation procedures are described in Appendix A.

Data edits for Holsteins considered AI bulls born since 1982 with minimum 10 and 50 daughters for SCC and CM, respectively. The number of bulls after editing is shown in Table 1.

Table 1. Number of Holstein bulls from each country included in Mace

Trait	Country	Time for genetic evaluation	# Bulls included
SCC	CAN	Aug. 1999	4,380
	DEU	July 1999	7,663
	DNK	Oct. 1999	3,361
	FIN	Sept. 1998	542
	FRA	June 1999	7,095
	GBR	July 1999	1,068
	NLD	July 1999	4,637
	SWE	Apr. 1998	1,204
	USA	Aug. 1999	15.061
CM	DNK	Oct. 1999	1,849
	FIN	Sept. 1998	508
	SWE	Apr. 1998	1,162

For Ayrshire, data edits considered AI bulls born since 1978 with minimum 10 and 50 daughters for SCC and CM, respectively. The number of bulls included in Mace for Ayrshire is shown in Table 2.

Table 2. Number of Ayrshire bulls from each country included in Mace

Trait	Country	Time for genetic evaluation	# Bulls included
SCC	FIN	April 2000	2,639
	SWE	April 2000	2,493
CM	FIN	April 2000	2,508
	NOR	May 2000	2,185
	SWE	April 2000	2,386

Mace was used to combine deregressed national genetic evaluation results into international evaluations. Three different sets of international evaluations were computed for Holsteins, combing different traits, as illustrated in Table 3.

Table 3. Description of three separate Mace runs for SCC and CM for Holsteins

Country	RUN1	RUN2	RUN3
CAN	SCC	SCC	
DEU	SCC	SCC	
DNK	SCC	CM	CM
FIN	SCC	CM	CM
FRA	SCC	SCC	
GBR	SCC	SCC	
NLD	SCC	SCC	
SWE	SCC	CM	CM
USA	SCC	SCC	

The objective of RUN1 was to compare SCC results from the nine participating countries. The objective of RUN2 was to compare mastitis results from the 3 Nordic countries and also with SCC evaluations from the other 6 countries. The objective of RUN3 was to compare mastitis results from the 3 Nordic countries using information from these countries only.

Two separate runs were conducted for Ayrshire data from Finland, Norway and Sweden as illustrated in Table 4.

Table 4. Description of two separate Mace runs for SCC and CM for Ayrshire

Country	RUN1	RUN2
FIN	SCC	CM
NOR		CM
SWE	SCC	CM

Sire variances and genetic correlations used in Mace are in Appendix B. Sire variances were estimated based on the method of Sullivan, and genetic correlations were derived from estimates based on the method of Klei & Weigel. For Holsteins, correlations for all nine traits in RUN1 were estimated simultaneously. Correlations between CM in the Nordic countries and SCC in the other countries were taken from several batches, each batch including different sets of countries. from Mark et al. (2000, Interbull Bulletin 25: 154) was used. Some genetic correlations between SCC and mastitis were difficult to obtain: T. The estimated correlation between SCC in Germany and mastitis in Finland was not used, and the lowest correlation between mastitis in Finland and SCC in one of the other countries was assigned to it instead. For Ayrshire, the correlations used were taken from several batches, each batch including different sets of countries. These estimates have not been presented earlier, but they can be found in the report that is in preparation.

Results and discussion

Holstein

For the purpose of validation of international evaluations it is of interest to see how well international genetic evaluations results correspond to national genetic evaluations results, which are the foundation for Mace. In Table 5 are international and national genetic SCC evaluation results for Holstein RUN1 and RUN2 compared, and the average reliability of international proofs is shown for both bulls of domestic and foreign origin.

Generally, there was good agreement between national and international genetic evaluation results. The largest deviation found in RUN1 was for a bull evaluated in the Netherlands for which the deviation was 2.3 times the standard deviation of national proofs. Single extreme bulls are not representative for the do not give a good picture of what is happening for the majority of bulls, but can they give an good indication of the range of differences that can bewas found.

International proofs for bulls of domestic origin had higher reliabilities on average compared with international proofs for bulls of foreign origin, except for the United Kingdom and the USA (RUN1). The U.K. and the USA had strong genetic ties to Canada, where the heritability for SCC was relatively high (.29). The average reliability of Canadian bulls in the U.K. and the USA SCC scales were 76% and 72%, respectively. International proofs obtained in RUN1 had higher reliabilities compared with those from RUN2 (especially for foreign bulls), as expected.

In Table 6 are international and national genetic mastitis evaluation results for Holstein RUN2 and RUN3 compared.

Table 5. Comparison of international (I.prf) and national genetic SCC evaluation results (N.prf) for RUN1 and RUN2 (Holsteins). Scales for each trait were transformed to obtain similar sire variances and direction of expression

RUN	Country	I.prf - N.prf		St. deviation		Correlation[1]	#Bulls	REL_{Dom}[3]	REL_{For}[4]	std_{For}/std_{Dom}[5]
		Mean	Max[2]	N.prf	I.prf					
1	CAN	.01	35.3	21.5	21.6	.994	4,227	78.8	64.8	.925
	DEU	.04	25.6	20.7	20.8	.997	7,401	78.8	63.8	.887
	DNK	-.01	7.16	9.84	9.87	.998	3,289	75.7	60.1	.928
	FIN	-.05	4.71	15.1	15.1	1.000	526	89.3	64.4	.775
	FRA	-.08	21.7	21.6	21.8	.996	6,901	75.9	67.2	.926
	GBR	.15	8.69	8.79	8.95	.991	843	67.7	68.6	.955
	NLD	-.50	86.1	37.6	37.9	.994	4,451	80.8	66.3	.888
	SWE	.02	10.3	8.42	8.46	.997	1,119	80.4	60.4	.853
	USA	.02	25.8	16.4	16.5	.995	14,975	65.8	67.2	1.025
2	CAN	.01	35.6	21.5	21.6	.994	4,227	78.8	62.1	.904
	DEU	.03	25.8	20.7	20.8	.997	7,401	78.8	60.8	.863
	FRA	-.05	21.8	21.6	21.8	.996	6,901	75.9	63.7	.896
	GBR	.18	8.54	8.79	8.94	.991	843	67.7	65.4	.927
	NLD	-.46	85.4	37.6	37.9	.994	4,451	80.8	63.1	.861
	USA	.00	25.9	16.4	16.5	.995	14,975	65.8	62.6	.982

1) Correlation between national and international evaluation results for those bulls that have a nat'l evaluation. 2) Maximum of the absolute value of the difference between national and international evaluation results for a particular bull. 3) Average reliability of int'l proofs for all bulls that have an evaluation in both RUN1 and RUN2 and are of domestic origin according int'l ID. 4) Do. for bulls of foreign origin. 5) std. of int'l proofs for bulls of foreign origin relative to std. of int'l proofs for bulls of domestic origin.

Table 6. Comparison of international (I.prf) and national genetic mastitis evaluation results (N.prf) for RUN2 and RUN3 (Holsteins). Scales for each trait were transformed to obtain similar sire variances and direction of expression

RUN	Country	I.prf - N.prf		St. deviation		Correlation[1]	#Bulls	REL_{Dom}[3]	REL_{For}[4]	std_{For}/std_{Dom}[5]
		Mean	Max[2]	N.prf	I.prf					
2	DNK	-1.17	285	260	263	.989	1,785	52.9	41.2	.944
	FIN	-.26	14.4	131	131	1.000	492	73.9	21.1	.536
	SWE	.00	1.01	1.03	1.02	.991	1,077	56.1	41.3	.780
3	DNK	-.47	262	260	263	.996	1,785	52.6	40.2	.945
	FIN	-.24	24.1	131	131	1.000	492	73.9	18.6	.534
	SWE	-.01	.92	1.03	1.03	.995	1,077	55.9	39.7	.761

1) Correlation between national and international evaluation results for those bulls that have a national evaluation. 2) Maximum of the absolute value of the difference between national and international evaluation results for a particular bull. 3) Average reliability of int'l proofs for all bulls that have an evaluation in both RUN2 and RUN3 and are of domestic origin according int'l ID. 4) Do. for bulls of foreign origin. 5) std. of int'l proofs for bulls of foreign origin relative to std. of int'l proofs for bulls of domestic origin.

International mastitis evaluations deviated more from national evaluations, when SCC information on bulls from Non-Nordic countries were included in the analyses compared to a tri-variate evaluation, as expected. This is in agreement with the fact that evaluation results from RUN2 have higher reliabilities compared with results from RUN3.

The correlations presented in Tables 5 and 6 were only concerned with bulls that had a national evaluation in the country of interest (domestically proven bulls). In Table 7 compares are bulls with international SCC evaluations from both RUN1 and RUN2 compared for the non-Nordic SCC-scales.

Table 7. Comparison of SCC evaluations from RUN1 and RUN2

Country-scales	Corre-lation[1]	REL_{RUN1}[2]	REL_{RUN2}[2]	std_{RUN1}/std_{RUN2}[3]	Max. rel. difference[4]	Explanation for max. rel. diff.[5]		
						REL_{RUN1}	REL_{RUN2}	Origin[6]
CAN	.976	66.1	63.7	1.02	3.06	81	23	FIN
DEU	.974	66.3	63.8	1.02	3.30	73	30	DNK
FRA	.972	68.2	65.2	1.03	3.38	79	26	DNK
GBR	.972	68.6	65.4	1.03	3.32	83	10	FIN
NLD	.973	67.8	64.9	1.03	3.38	80	9	FIN
USA	.972	66.6	63.9	1.03	3.04	76	23	FIN

1)Correlation between international evaluation results of RUN1 with those from RUN2. 2) Average reliability of int'l proofs. 3) Proportion of std of proofs from RUN1 relative to std of proofs from RUN2. 4) Rel. diff.= $(proof_{RUN1}/std_{RUN1})-(proof_{RUN2}/std_{RUN2})$. 5) For the particular bull with the largest rel. difference. 6) National origin of bull according to unique int'l ID. Std refer to standard deviation of proofs from a particular evaluation.

Evaluations from the three Nordic countries, which provided mastitis information for RUN2 makes the correlations between RUN1 and RUN2 decrease for the non-Nordic countries SCC scales. If only bulls of domestic origin according to the international ID were considered, then correlations between RUN1 and RUN2 for the non-Nordic SCC scales were very close to unity (.999-1.000). When only bulls of Danish origin were considered, the correlation between RUN1 and RUN2 for the non-Nordic scales ranged between .59-.63. Prediction of international proofs for Nordic bull were based on quite different information sources in RUN1 compared with RUN2, which explains these findings.

The average reliability was higher for international proofs obtained in RUN1 compared with RUN2. This can be explained by higher heritability for SCC compared with mastitis (see Appendix A1). This also explains the higher spread of proofs obtained in RUN1 compared to RUN2.

In Table 8 are mastitis evaluations from RUN2 and RUN3 compared.

Table 8. Comparison of mastitis evaluations from RUN2 and RUN3

Country-scales	Correlation[1]	REL_{RUN2}[2]	REL_{RUN3}[2]	std_{RUN2}/std_{RUN3}[3]	Max. rel. difference[4]	Explanation for max. rel. diff.[5]		
						REL_{RUN2}	REL_{RUN3}	Origin[6]
DNK	.988	47.3	46.8	1.0025	1.18	70	58	CAN
FIN	.928	28.7	26.5	1.0002	1.90	45	31	USA
SWE	.978	45.7	44.5	1.0049	1.53	66	53	USA

1) Correlation between international evaluation results of RUN2 with those from RUN3. 2) Average reliability of int'l proofs. 3) Proportion of std of proofs from RUN1 relative to std of proofs from RUN2. 4) Rel. diff.= $(proof_{RUN2}/std_{RUN2})$-$(proof_{RUN3}/std_{RUN3})$. 5) For the particular bull with the largest rel. difference. 6) National origin according to unique int'l ID.

Trends observed for mastitis were similar to those for SCC. If only bulls of domestic origin according to the international ID were considered, then correlations between RUN2 and RUN3 for the Nordic mastitis scales were very close to unity (.993-1.000). When only bulls of USA origin were considered, the correlation between RUN2 and RUN3 for the Nordic scales ranged between .71-.93.

Separate analyses of SCC and mastitis from one country is not optimal, but it is necessary with current methodology. Implementation of methods that are able to account for residual correlations different than zero such as those presented by Sullivan and Madsen et al. will allow for simultaneous multi-trait-multi-country analysis, which theoretically will utilize information in a more optimal way.

Ayrshire

In Table 9 are international genetic SCC evaluation results for Ayrshire RUN1 as well as mastitis evaluations from RUN2 compared with their corresponding national genetic evaluations.

Table 9. Comparison of international (I.prf) and national genetic mastitis evaluation results (N.prf) for RUN1 (SCC) and RUN2 (CM) Ayrshire. Scales for each trait were transformed to obtain similar sire variances and direction of expression

Trait	Country	I.prf - N.prf		St. deviation		Correlation[1]	#Bulls	REL_{Dom}[3]	REL_{For}[4]	std_{For}/std_{Dom}[5]
		Mean	Max[2]	N.prf	I.prf					
SCC	FIN	-.03	25.2	140	140	1.000	2,639	89.6	51.7	.772
	SWE	.00	1.89	8.09	8.08	1.000	2,475	79.4	58.0	.809
CM	FIN	-.04	21.2	100	101	1.000	2,508	74.8	41.5	.742
	NOR	.04	19.9	70.7	71.9	1.000	2,170	73.7	31.9	.654
	SWE	.00	.25	.713	.710	.998	2,363	55.7	54.8	.988

1) Correlation between national and international evaluation results for those bulls that have a national evaluation. 2) Maximum of the absolute value of the difference between national and international evaluation results for a particular bull. 3) Average reliability of int'l proofs for all bulls that have an evaluation in both RUN1 and RUN2 and are of domestic origin according int'l ID. 4) Do for bulls of foreign origin. 5) std. of int'l proofs for bulls of foreign origin relative to std. of int'l proofs for bulls of domestic origin.

For Ayrshire, the agreement between national and international evaluations were very high and higher than for Holstein, which can be explained by the fact that genetic correlations among countries were lower and the fact that genetic ties among countries were weaker for Ayrshire compared with Holsteins. This was especially the case for Finland and Norway, where the correlation between national and international evaluation results was 1.000.

Conclusion

The feasibility of international genetic evaluations have been demonstrated for nine Holstein populations and three Ayrshire populations and results were explainable. Run1 and Run2 are envisioned to comprise international genetic evaluation for udder health traits. for final test-runs and subsequently for immediate implementation of routine evaluations for Holsteins and Ayrshire, if the results of these test-runs are in agreement with those obtained in This study. When methodology that appropriately handles more than one trait from one country have been developed and validated, SCC and mastitis should be analysed simultaneously in a multi-trait-multi-country model to use the information related to udder health in a closer to optimal way.

Appendix A: Trait definitions and national genetic evaluation procedures

Table A1. Summary of national genetic evaluation procedures for SCC and mastitis (CM) used in various countries[1].

Trait	Country	Trait definition	Data from	Days of lact. included	#Parities	Method of evaluation[2]	h^2
SCC	CAN	$\log_2$ test-day SCC	1988	5-305	3	MT RR TDM	.29
	DEU	$\log_2$ test-day SCC	1990	4-365	3	MT FR TDM	.12
	DNK	Lact. mean of $\log_e$ test-day SCC	1990	10-180	1	ST[3] SM	.11
	FIN	Lact. mean of $\log_{10}$ test-day SCC	1978	5-305	3	ST AM RP	.15
	FRA	Lact. mean of $\log_2$ test-day SCC	1989	5-350	3	ST AM RP	.15
	GBR	Lact. mean of $\log_e$ test-day SCC	1991	5-305	5	ST AM RP	.11
	NLD	Lact. mean of $\log_2$ test-day SCC	1990	5-305	3	ST AM RP	.15
	SWE	Lact. mean of $\log_{10}$ test-day SCC	1983	5-150	1[4]1[4]	ST SM	.080
	USA	Lact. mean of $\log_2$ test-day SCC	1987	6-305	5	ST AM RP	.10
CM	DNK	Clinical mastitis[5] scored in 2 categories	1990	-10-180	1[6]1[6]	ST[3] SM	.040
	FIN	Clinical mastitis and culling due to udder diseases scored in 2 categories	1983	-7-150	3	ST SM RP	.050
	NOR	Clinical mastitis[5] scored in two categories.	1978	-15-120	1[7]1[7]	ST SM	.032
	SWE	Clinical mastitis and culling due to udder diseases scored in 2 categories	1983	-10-150	1	ST SM	.020

1) References are persons responsible for nat'l evaluations and Interbull (1996); 2) MT=Multi-trait (different parities were considered as different traits); ST=Single-Trait; TDM=Animal Model using test-day records; AM=Animal Model; SM=Sire Model; RP=Repeated observations; RR= Random Regression; FR= Fixed Regression; 3) Normally mastitis and SCC are analysed in a multi-trait model, but for this study both traits were analysed in uni-variate analysis. 4) Age between 22 and 36 months. 5) Not due to culling. 6) 3 parities was used for Ayrshire data and have also become common practice after Holstein data was provided for this study. 7) Are normally combined with results for later lactations after BLUP evaluation, but not for this study.

Table A2. Effects included in national evaluation models and pre-adjustment factors.

Trait	Country	Effects in model[1]	Pre-adjustments
SCC	CAN	Herd×test day, age×calving season, DIM, PE w/in lact, animal[2]	None
	DEU	Herd×test day, region, calving age, stage of lact., calving season, PE, animal	None
	DNK	Herd×year, region×season×year, calving age, sire[3]	None
	FIN	Herd×year×parity of group, herd×5-year period×parity of group, calving age×parity, calving season×year, PE, animal	Stage of lact., #lact.
	FRA	Herd×year, parity×region×year, calving month×parity×year, calving age×parity×region×year, preceding dry period length×parity×region×year, PE, animal	DIM, heterogeneous var. among parities
	GBR	HYS, age×parity, parity, calving month, herd×sire, PE, animal	None
	NLD	Herd×parity×year×season, year×calving month, PE, animal	Stage of lact.×parity (on test-day records)
	SWE	HYS, calving month, calving age, breed of dam, sire	None
	USA	Management group, animal	DIM, calving age, calving month
CM	DNK	Herd×year, region×season×year, calving age, sire[3]	None
	FIN	Herd×year, calving year×month, parity, sire	None
	NOR	Age at calv., month×year of calv., herd×year	Standardise data to a std. of 1.0 within year
	SWE	HYS, calving month, calving age, breed of dam, sire	None

1) Phantom groups were also included in all evaluations (references as in Table 5); 2) Multi-variate breeding value estimation with milk, fat and protein yield; 3) In Denmark SCC and mastitis are normally analysed simultaneously, but not for this study; DIM = Days In Milk; PE = Permanent Environment; HYS = Herd-year-season effect.

Appendix B: Genetic parameters used in Mace pilot-runs

Table B1. Genetic parameters used in Holstein runs (sire standard deviation in diagonal, genetic correlations above the diagonal).

		SCC									Mastitis		
		CAN	DEU	FRA	GBR	NLD	USA	DNK	FIN	SWE	DNK	FIN	SWE
SCC	CAN	25.78	.90	.93	.96	.93	.93	.80	.94	.83	.50	.46	.55
	DEU		26.19	.95	.94	.97	.87	.85	.88	.81	.43	.31	.62
	FRA			27.90	.98	.96	.92	.89	.94	.89	.37	.34	.56
	GBR				11.17	.97	.93	.89	.96	.91	.41	.33	.60
	NLD					45.73	.90	.88	.94	.87	.41	.31	.62
	USA						22.70	.88	.91	.91	.58	.46	.61
	DNK							13.07	.84	.93			
	FIN								16.43	.84			
	SWE									10.05			
Mastitis	DNK										407.80	.49	.86
	FIN											171.56	.41
	SWE												1.40

Table B2. Genetic parameters used in Ayrshire runs (sire standard deviation on diagonal, genetic correlations above the diagonal).

		SCC		Mastitis		
		FIN	SWE	FIN	SWE	NOR
SCC	FIN	161.28	.77			
	SWE		9.55			
Mastitis						
	FIN			137.27	.89	.60
	SWE				1.04	.88
	NOR					90.68