Mace For Conformation Ayrshires

Bert Klei and Tom Lawlor
Holstein USA, Brattleboro, United States

Introduction

Since August 1999, Interbull supplies routine genetic evaluations for conformation traits for Holsteins based on Mace methodology. This service was extended to include the Jersey breed in May 2001. This report shows results of a study supported by the World Federation of Ayrshire Breed Societies that was initiated to determine the feasibility of Mace for conformation for the Ayrshire breed. Results of the correlation estimation step are reported in this article. However, the discussion centers on the question of how to proceed with Mace for conformation for the Ayrshire breed.

Material and Methods

Pedigree and cross-reference files were obtained from the Interbull Centre. Conformation files with information on 18 different traits (Table 1) were supplied by each of the nine participating countries. These were: Australia, Canada, Denmark, Finland, Great Britain, Norway, New Zealand, Sweden, and the United States. Countries were asked to supply data in the 015 format to enable the use of the Mace software that is being used for the other breeds. Denmark and Great Britain were unable to supply Effective Daughter Contributions (EDC). For these two countries, the actual number of daughters was used in the analysis. Standard Interbull guidelines for colored breeds were used for editing the data (http://www.interbull.org).

To calculate the correlations, a well-connected subset of the data was used. This set includes bulls with evaluations in more than one country as well bulls that are members of ¾-sib groups that have members evaluated in more than one country. The number of bulls qualifying from each country for this subset is in Table 2. The distribution of the bulls over country combinations is in Table 3.

Table 1. Traits included in Mace for conformation for Ayrshire

Stature	Fore Udder Attachment
Chest Width	Rear Udder Height
Body Depth	Udder Support
Dairy Form	Udder Depth
Rump Angle	Teat Placement
Rump Width	Teat Length
Rear Legs Side	Overall Conformation
Foot Angle	Overall Udder
Rear Legs Rear	Overall Feet and Legs

Table 2. Number of bull records submitted, after edits, and those contained in the subset used for variance component estimation

Country	Submitted	After Edits	Subset
AUS	148	148	8
CAN	966	456	102
DNK	841	829	15
FIN	3368	1362	58
GBR	191	188	33
NOR	1732	1611	20
NZL	1401	296	29
SWE	590	515	54
USA	224	154	70

Correlations were subsequently estimated with an EM algorithm for Restricted Maximum Likelihood (Klei and Weigel, 1998).

Results and Discussion

For the calculation of Mace, two types of parameters are needed. The first is the within country variances. These are based on all bull evaluations in a country and can be estimated quite accurately.

The second set is the correlations, which are based on the common bulls and ¾ sibs. In general it is believed that correlations close to unity are reasonable and low ones, those close to zero, are inaccurate.

Table 3. Number of bulls in common (below diagonal) and number of bulls in common 3/4 sib families (above diagonal) for each country combination

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE	USA
AUS		8	0	0	2	0	3	1	5
CAN	8		2	3	20	0	17	4	60
DNK	0	2		4	0	1	2	11	0
FIN	0	3	4		1	3	4	28	1
GBR	2	25	0	1		0	11	1	11
NOR	0	0	1	2	0		0	9	0
NZL	3	15	3	4	12	0		6	10
SWE	1	4	11	23	1	6	6		0
USA	5	51	0	1	11	0	9	0	

Correlation estimates can differ from unity for a variety of reasons:

1. Genotype by environment interaction.
2. Differences in trait definition.
3. Differences in national data evaluations.
4. Non-randomness of the bulls included in the well-connected subset.

For the first three reasons the true correlation is likely to be less than unity. However, the more alike the countries are in their way of collecting and analyzing data, the closer the correlations should be to one.

Reason number four has been shown to be an issue in the Jersey population (Klei and Lawlor, 2000). They showed that the addition of just a few common bulls for a country pair had a dramatic impact on the correlation estimate. Table 2 shows that the number of bulls qualifying for this analysis is quite limited for most countries but in particular Australia, Denmark, Norway and New Zealand (< 30). As a result, sampling can become an issue and should be considered when interpreting the results.

Table 3 shows that a number of country combinations do not have bulls or ¾ sib families in common. This means that correlations for these combinations are completely based on links through a third country.

Correlations estimates for Ayrshires are listed in the Appendix. A number of these results might be hard to explain even though the results are valid given the data.

The unexpected results fall into two groups. The first being those in which certain country combinations have lower values than was expected based on correlations of each individual country with a third. For example, for Angularity the correlation between CAN and DNK is .81, the one between CAN and USA is .78, but the one between DNK and USA is .36. Similarly for Foot Angle the correlation between FIN and SWE is .80 between NOR and SWE is .84 while the one between FIN and NOR was estimated to be .39.

The higher values expected are based on the assumption that the correlation between B and C should be close to the product of correlation AB and BC. In the two examples, values close to .63 and .67 were expected, respectively. The EM-REML method used for variance component estimation requires the resulting co-variance matrix to be positive definite. For the Angularity example, the valid range of correlations is .27 to .99, while for the Foot Angle example, correlations between .36 and .99 are valid.

The second set of unexpected results is those correlation matrices in which negative signs appear. Some of these can be explained by the way traits are observed. An example for this is Teat Length in DNK. Long teats get low scores while short teats get low scores in other countries. As a result the correlation is expected to be negative. The inconsistency comes in when no clear pattern of positive and negative correlations is exhibited. This can for instance be observed for Chest Width, Body Depth, and Rear Leg Set, among other traits. This again can be explained by the requirement of positive definiteness and the lack of ties.

What is Ayrshire to do?

Throughout this discussion one has to keep in mind that the goal of any genetic evaluation should be to supply accurate genetic information to the users. The accuracy of these evaluations is only guaranteed for the data structure for which they were designed.

Mace was developed to supply genetic evaluations in situations where previously established genetic ties would help to predict the performance of current young bulls. In the Ayrshire population these connections are limited and one might question the use of Mace as a method of choice for comparing bulls across countries. On the other hand there is clearly a desire among Ayrshire breeders to be able to make across country comparisons, allowing them to determine which bulls in the world can be of use to the national breeding program.

It is useful to take a look at what Interbull does for other traits, and what is being done for conformation in the other breeds.

In the Interbull documentation on production and udder health traits a set of rules can be found on what to do when no "reasonable" correlations can be estimated from the data. This is step 2 of the genetic correlation estimation procedure (http://www.interbull.org). The options in order in which they are applied for these traits are listed below:

1) Estimates from another breed for the country pair are used, if applicable.
2) Product moment correlations of common bulls, adjusted for national evaluation accuracy are used.
3) Estimates from the low end of the correlation distribution are assigned.

A similar set of rules is not being used for conformation.

The Technical Committee for Type (ITC) advised against the use of this practice for conformation traits since it is hard to define what "reasonable" estimates for subjectively scored traits are (personal communication). These can be different for any trait and country combination. So far, the practice for conformation has been to exclude from the analysis a trait from a country for which estimates are close to zero or when negative estimates are obtained when positive ones can reasonably be expected. This "rule" has been used in two situations.

In a discussion with Ayrshire representatives from the countries in this study a number of options on how to proceed were given:

1. Update the Mace methodology to a Bayesian framework in which prior information on co-variances can be used.
2. Use the rules as used for production and udder health.
3. Hold off on Mace for conformation for Ayrshires until more genetic ties can be established.
4. Use Mace for a subset of these countries. These could be chosen based on either the existence of "sufficient" ties or "reasonable" correlations. Other countries can join at a later date.

Proposal 1 has the appeal that it would allow one to blend prior information with data. The disadvantage is that it will take time to develop this type of co-variance estimation methodology for the Mace framework. This method is most appealing from a theoretical point of view.

Proposal 2 is appealing since it is already being used for other traits. The biggest problem appears to be the definition of "reasonable". Also other breeds do not always have estimates for certain countries (NOR is not included in either Jersey and Holstein evaluations). Also, in countries where breeds have separate classification programs there maybe little harmonization among them.

Proposal 3 is a long-term solution. Even if the World Ayrshire Association decides to implement a simultaneous sampling scheme to improve genetic ties, it will at least take 3 or 4 years before results can be seen.

Proposal 4 is another appealing solution. However, this does not do much for countries that want to start using foreign genetics. Also definitions of "sufficient" and "reasonable" have to be determined.

A final option might be to decide on a conservative correlation for each of the three main trait groups and applying this estimate to all countries. This would allow one to generate Mace

without having to make decision on whether certain estimates are “reasonable” or not. As an example one could use .85 for the udder traits, 0.75 for the body traits, and 0.65 for the feet and leg traits.

Literature

Klei & Lawlor. 2000. *Interbull Bulletin 26,* pages 29-32.

Klei & Weigel. 1998. *Interbull Bulletin 17,* pages 8-14.

Acknowledgements

The authors would like to thank the World Federation of Ayrshire Breed Societies for financial support for this project as well as representatives of each of the countries involved for participating in discussions on this project.

APPENDIX
Correlation Estimates

STATURE

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.67							
DNK	0.86	0.87						
FIN	0.79	0.91	0.84					
GBR	0.57	0.94	0.79	0.89				
NOR								
NZL	0.87	0.86	0.88	0.96	0.87			
SWE	0.93	0.88	0.93	0.94	0.83		0.98	
USA	0.62	0.99	0.84	0.90	0.98		0.87	0.86

CHEST WIDTH

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.48							
DNK	0.54	-0.23						
FIN								
GBR	0.67	0.78	-0.01					
NOR	0.86	0.70	0.13		0.63			
NZL								
SWE	0.96	0.51	0.54		0.53	0.90		
USA	0.53	0.73	-0.12		0.98	0.49		0.37

BODY DEPTH

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.13							
DNK	0.58	-0.44						
FIN								
GBR	0.68	0.77	-0.06					
NOR								
NZL	0.86	0.54	0.16		0.95			
SWE	0.56	-0.71	0.87		-0.21		0.09	
USA	0.58	0.86	-0.16		0.99		0.89	-0.35

ANGULARITY

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.29							
DNK	-0.01	0.81						
FIN								
GBR	0.10	0.89	0.57					
NOR								
NZL								
SWE	-0.22	0.70	0.94		0.46			
USA	0.75	0.78	0.36		0.72			0.14

RUMP ANGLE

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.82							
DNK	0.20	0.66						
FIN								
GBR	0.78	0.99	0.74					
NOR	0.24	0.70	0.99		0.77			
NZL	0.74	0.96	0.58		0.94	0.62		
SWE	0.30	0.75	0.99		0.82	0.99	0.69	
USA	0.74	0.93	0.80		0.97	0.82	0.82	0.85

RUMP WIDTH

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	-0.46							
DNK	-0.42	0.84						
FIN								
GBR	-0.28	0.88	0.96					
NOR								
NZL	-0.22	0.80	0.96		0.98			
SWE	-0.04	0.90	0.78		0.88		0.84	
USA	-0.25	0.92	0.94		0.99		0.97	0.93

REAR LEG SET

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.12							
DNK	-0.06	0.98						
FIN	0.39	0.73	0.71					
GBR	0.49	0.83	0.72	0.50				
NOR	0.40	0.72	0.69	0.99	0.50			
NZL	-0.16	0.13	0.09	-0.54	0.41	-0.54		
SWE	0.07	0.97	0.97	0.84	0.69	0.83	-0.10	
USA	-0.10	0.98	0.99	0.64	0.73	0.63	0.17	0.95

REAR LEG REAR VIEW

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN								
DNK								
FIN								
GBR								
NOR			0.76					
NZL								
SWE			0.98			0.77		
USA								

FOOT ANGLE

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	-0.28							
DNK	0.60	0.47						
FIN	0.84	0.09	0.58					
GBR	0.11	0.65	0.80	0.08				
NOR	0.64	0.15	0.84	0.39	0.73			
NZL								
SWE	0.88	0.15	0.89	0.80	0.54	0.84		
USA	0.63	0.55	0.82	0.85	0.49	0.55		0.83

FORE UDDER

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.36							
DNK	0.34	0.96						
FIN	-0.20	0.31	0.42					
GBR	0.06	0.75	0.62	0.21				
NOR	-0.17	0.55	0.68	0.76	0.19			
NZL	0.26	0.24	0.27	0.73	0.36	0.26		
SWE	-0.14	0.65	0.76	0.80	0.29	0.95	0.30	
USA	0.34	0.94	0.91	0.54	0.80	0.57	0.56	0.67

REAR UDDER HEIGHT

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.73							
DNK	0.87	0.49						
FIN	-0.88	-0.45	-0.88					
GBR	0.88	0.84	0.61	-0.75				
NOR	0.89	0.65	0.93	-0.82	0.68			
NZL	0.97	0.61	0.91	-0.95	0.84	0.88		
SWE	0.68	0.68	0.76	-0.47	0.43	0.84	0.61	
USA	0.72	0.86	0.48	-0.57	0.91	0.58	0.67	0.43

UDDER SUPPORT

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.62							
DNK	-0.06	0.07						
FIN	-0.32	-0.23	0.91					
GBR	0.46	0.09	0.46	0.51				
NOR	0.49	0.55	0.65	0.36	0.33			
NZL	0.26	0.15	0.67	0.38	0.06	0.74		
SWE	-0.19	-0.10	0.98	0.97	0.46	0.53	0.60	
USA	0.75	0.66	0.34	-0.06	0.14	0.80	0.77	0.18

UDDER DEPTH

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.95							
DNK	0.89	0.98						
FIN	0.82	0.92	0.97					
GBR	0.95	0.87	0.77	0.67				
NOR								
NZL								
SWE	0.85	0.96	0.95	0.89	0.72			
USA	0.98	0.99	0.95	0.89	0.89			0.94

TEAT PLACEMENT

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.85							
DNK	0.62	0.93						
FIN	-0.12	-0.60	-0.77					
GBR	0.61	0.93	0.98	-0.82				
NOR	0.37	0.68	0.73	-0.78	0.77			
NZL	0.83	0.93	0.81	-0.58	0.83	0.66		
SWE	0.36	0.79	0.91	-0.95	0.93	0.77	0.75	
USA	0.93	0.95	0.83	-0.34	0.81	0.51	0.82	0.57

TEAT LENGTH

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN								
DNK	-0.97							
FIN	0.95		-0.99					
GBR	0.99		-0.98	0.96				
NOR	0.94		-0.94	0.90	0.96			
NZL								
SWE	0.96		-0.96	0.93	0.98	0.98		
USA	0.99		-0.98	0.96	1.00	0.96		0.98

OVERALL CONFORMATION

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.30							
DNK	0.93	0.26						
FIN								
GBR	0.97	0.46	0.93					
NOR	-0.13	0.86	-0.11		0.02			
NZL								
SWE	-0.51	0.65	-0.53		-0.38	0.88		
USA	0.85	0.75	0.77		0.91	0.39		0.01

OVERALL UDDER

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	0.49							
DNK	-0.15	0.70						
FIN								
GBR	0.94	0.75	0.13					
NOR	-0.79	-0.71	-0.34		-0.85			
NZL	0.16	0.29	0.59		0.18	-0.49		
SWE	-0.50	0.40	0.92		-0.25	-0.01	0.53	
USA								

OVERALL FEET & LEGS

	AUS	CAN	DNK	FIN	GBR	NOR	NZL	SWE
CAN	-0.89							
DNK	-0.39	0.68						
FIN								
GBR	0.63	-0.23	0.31					
NOR	-0.07	0.50	0.80		0.71			
NZL								
SWE	0.08	0.37	0.70		0.82	0.97		
USA								