Introduction

The latest routine international evaluation for udder traits took place as scheduled at the Interbull Centre. Data from thirty-three (33) countries were included in this evaluation.

International genetic evaluations for udder health traits of bulls from Australia, Austria-Germany, Belgium, Canada, Croatia, Czech Republic, Denmark-Finland-Sweden, Estonia, France, Hungary, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, South Africa, Slovak Republic, Spain, Switzerland, the United Kingdom, the United States of America, Poland, Lithuania, Latvia, Croatia, Slovenia, Portugal and Uruguay were computed.
Brown Swiss, Holstein, Red Dairy Cattle, Guernsey, Jersey and Simmental breed data were included in this evaluation.

Countries sending real MAS data (other countries participate to the MAS evaluation using SCS data as predictor):

HOL : DFS, NLD, FRA, CAN, ITA, CHE, USA, DEU, GBR, AUS
RDC : DFS, NLD, CAN, GBR, AUS
BSW : NLD, FRA, CHE, GBR, USA
JER : DFS, NLD, CAN, GBR, AUS, USA
SIM : NLD, CHE, GBR
GUE : No evaluation for MAS yet

Changes in national procedures

Changes in the national genetic evaluation of conformation traits are as follows:

USA (ALL)	Both traits all breeds: Separate groups for unknown foreign parents were removed because most such animals are now from countries with no domestic U.S. descendants. In addition, for trait mas for BSW, JER and HOL: New VC estimated, affecting overall heritabilities and repeatability. Weights applied were updated from 0/1 to value estimated from VC, and used to standardize genetic variance across differing parities that have different heritabilities
AUS (ALL)	Decrease in information due to the pedigree correction and herd-year minimum edits for RDC,GUE,SIM and JER breeds.
NLD (ALL)	Some decrease in information due to pedigree, data updates and change in bulls' status which made bulls no longer qualifying for inclusion.
CHE (ALL)	Base change. Minor update of the EDC calculation.
FRA (ALL)	Drop of information due to changes in the groups of fixed effects regions and level (geographical) and edits in database. Base change
ITA (SIM)	Base change
ITA (HOL)	Base change. Drop in information due to the pedigree editing.
IRL (HOL,JER)	Base change. Drop in information due to the yearly data cut-off for phenotypes.
EST (HOL)	Drop in information because ancestry errors are being corrected on an on-going basis as the genotypes come in.
DEU (ALL)	Drop in information due to the pedigree update and/or new location of some daughters in different dairy farms of owners.
POL (HOL)	Base change. For HOL, drop in information causing some bulls to drops below the required threshold of 10 herds
CAN (ALL)	Drop in information due to the data edits.
NZL (HOL,JER,RDC)	Base change
ITA (BSW)	Drop in information due to the DNA parentage testing.
GBR (HOL,JER,RDC,BSW)	Base change
BEL (HOL)	Drop in information due to the pedigree updates and clean up and data edits (mainly for scs).
	Drop in information due to few pedigree correction

INTERBULL CHANGES COMPARED TO THE PREVIOUS ROUTINE RUN

In 2020 new post-processing windowsâ\200\231 correlations for all breeds and traits have been applied: the upper bounds have been set to 0.99 as these were judged to have very little effect on evaluations while the lower values have been reduced to the 10th percentile. This reduction would provide post-processed correlations to be closer to the real estimated ones. The previoulsy lower value adopted (based on the 25th percentile) had been found too high causing estimated and post-processed correlations to differ significantly from each other. It is a recommendation from the Interbull Technical Committee to review such windows every 5 years. The weight assigned to the magnitude of the changes tested by each country has also been revised. The new weight will allow post-processed correlations to take more in consideration the value of the new estimated ones even when no changes are applied by the countries. More information can be read on https://interbull.org/ib/rg_procedure

Since 2021 a new trait group has been added to the MACE evaluation, called stcm (SNP Training for clinical mastitis) evaluating the trait cma (pure clinical mastitis). New trait group codes have been issued as follows: 041 for international ebv files (.itb), 071 for parent average (ipr).

DATA AND METHOD OF ANALYSIS

Data were national genetic evaluations of AI sampled bulls with at least
10 daughters or 10 EDC (for clinical mastitis and maternal calving traits at least
50 daughters or 50 EDC, and for direct calving traits at least 50 calvings or 50 EDC) in at
least 10 herds. Table 1 presents the amount of data included
in this Interbull evaluation for all breeds.

National proofs were first de-regressed within country and then analysed
jointly with a linear model including the effects of evaluation country,
genetic group of bull and bull merit. Heritability estimates used in both
the de-regression and international evaluation were as in each country's
national evaluation.

Table 2 presents the date of evaluation as supplied by each country

Estimated genetic parameters and sire standard deviations are shown in APPENDIX I
and the corresponding number of common bulls are listed in APPENDIX II.

SCIENTIFIC LITERATURE

The international genetic evaluation procedure is based on international work
described in the following scientific publications:

International genetic evaluation computation:
- Schaeffer. 1994. J. Dairy Sci. 77:2671-2678
- Klei, 1998. Interbull Bulletin 17:3-7

Verification and Genetic trend validation:
- Klei et al., 2002. Interbull Bulletin 29:178-182.
- Boichard et al., 1995. J. Dairy Sci. 78:431-437

Weighting factors:
- Fikse and Banos, 2001. J. Dairy Sci. 84:1759-1767

De-regression:
- Sigurdsson and G. Banos. 1995. Acta Agric. Scand. 45:207-219
- Jairath et al. 1998. J. Dairy Sci. Vol. 81:550-562

Genetic parameter estimation:
- Klei and Weigel, 1998, Interbull Bulletin 17:8-14
- Sullivan, 1999. Interbull Bulletin 22:146-148

Post-processing of estimated genetic correlations:
- Mark et al., 2003, Interbull Bulletin 30:126-135
- Jorjani et al., 2003. J. Dairy Sci. 86:677-679
- https://wiki.interbull.org/public/rG%20procedure?action=print

Time edits
- Weigel and Banos. 1997. J. Dairy Sci. 80:3425-3430

International reliability estimation
- Harris and Johnson. 1998. Interbull Bulletin 17:31-36

NEXT ROUTINE INTERNATIONAL EVALUATION

Dates for the next routine evaluation can be found on
http://www.interbull.org/ib/servicecalendar.

NEXT TEST INTERNATIONAL EVALUATION

Dates for the next test run can be found on
http://www.interbull.org/ib/servicecalendar.

PUBLICATION OF INTERBULL ROUTINE RUN

Results were distributed by the Interbull Centre to designated representatives in each country. The international evaluation file comprised international proofs expressed on the base and unit of each country included in the analysis. Such records readily provide more information on bull performance in various countries, thereby minimizing the need to resort to conversions.

At the same time, all recipients of Interbull results are expected to honor the agreed code of practice, decided by the Interbull Steering Committee, and only publish international evaluations on their own country scale. Evaluations expressed on another country scale are confidential and may only be used internally for research and review purposes.

PUBLICATION OF INTERBULL TEST RUN

Test evaluation results are meant for review purposes only and should not be published.

^LTable 1. National evaluation data considered in the Interbull evaluation for udder health (April Routine Evaluation 2024).
Number of records for milk somatic cells by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS		153	8912	1776	844	
BEL			2340			
CAN	284	109	14091	900	890	
CHE	3257		3440	102		3697
CZE			4878			
DEA	6121					25201
DEU			24558		308	
DFS			14596	2364	8338	
ESP			4654			
EST			1426		493	
FRA	502		18708			491
FRM						4866
GBR	160	313	7671	789	608	110
HUN			3164			190
IRL			3082			
ISR			1755			
ITA	2207		9379	59		1860
JPN			7109			
KOR			1710			
LTU			898		362	
LVA			1373		674	
NLD	241		17346	281	111	537
NOR					4374	
NZL	79	57	9151	5251	1476	
POL			13003			
PRT			2966			
SVK			1199			
SVN	348		718			702
URY			2147			
USA	1205	749	42637	5355	780	114
ZAF			1205	620	125	
HRV			985			1069
CAM					49	
No.Records	14404	1381	225101	17497	19432	38837
Pub. Proofs	11449	1065	160811	14149	18264	34816

^LAPPENDIX I. Sire standard deviations in diagonal and genetic correlations below diagonal

BSW scs

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	6.79									
FRA	0.91	1.02								
NLD	0.90	0.93	3.70							
USA	0.88	0.90	0.85	0.21						
CHE	0.89	0.94	0.93	0.80	10.56					
DEA	0.87	0.97	0.92	0.85	0.96	11.92				
NZL	0.71	0.76	0.77	0.67	0.72	0.64	0.38			
ITA	0.88	0.90	0.89	0.83	0.96	0.91	0.67	15.40		
GBR	0.93	0.96	0.94	0.90	0.93	0.94	0.80	0.89	11.45	
SVN	0.80	0.80	0.80	0.79	0.79	0.78	0.68	0.81	0.82	10.79

BSW mas

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	6.69									
FRA	0.81	0.97								
NLD	0.80	0.73	4.08							
USA	0.81	0.84	0.75	2.94						
CHE	0.87	0.87	0.86	0.80	11.43					
DEA	0.89	0.69	0.88	0.71	0.90	11.92				
NZL	0.68	0.64	0.65	0.64	0.69	0.74	0.38			
ITA	0.85	0.72	0.81	0.67	0.88	0.92	0.70	15.39		
GBR	0.83	0.83	0.83	0.80	0.82	0.73	0.64	0.74	2.19	
SVN	0.79	0.72	0.73	0.72	0.71	0.82	0.76	0.83	0.76	10.80

GUE scs

	CAN	GBR	USA	AUS	NZL
CAN	6.07				
GBR	0.92	13.71			
USA	0.93	0.90	0.25		
AUS	0.81	0.87	0.77	0.23	
NZL	0.75	0.81	0.69	0.89	0.62

HOL scs

	CAN	CHE	DEU	DFS	EST	FRA	GBR	NLD	USA	ISR	ITA	AUS	HUN	BEL	JPN	ESP	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN	HRV	URY
CAN	5.73																												
CHE	0.90	10.82																											
DEU	0.94	0.95	12.89																										
DFS	0.93	0.92	0.97	11.78																									
EST	0.89	0.88	0.94	0.92	18.70																								
FRA	0.95	0.94	0.96	0.96	0.90	1.14																							
GBR	0.94	0.93	0.96	0.94	0.90	0.96	12.89																						
NLD	0.92	0.95	0.97	0.95	0.91	0.95	0.96	4.23																					
USA	0.94	0.84	0.89	0.87	0.90	0.90	0.91	0.87	0.20																				
ISR	0.85	0.82	0.84	0.81	0.85	0.82	0.80	0.80	0.86	0.24																			
ITA	0.90	0.89	0.94	0.93	0.93	0.94	0.91	0.90	0.88	0.81	5.83																		
AUS	0.79	0.85	0.81	0.81	0.74	0.83	0.87	0.84	0.74	0.65	0.77	0.25																	
HUN	0.88	0.88	0.93	0.90	0.91	0.91	0.89	0.88	0.91	0.86	0.93	0.73	1.36																
BEL	0.92	0.92	0.97	0.96	0.94	0.96	0.93	0.94	0.89	0.81	0.94	0.79	0.92	0.52															
JPN	0.86	0.79	0.83	0.85	0.81	0.89	0.84	0.81	0.85	0.75	0.80	0.73	0.78	0.83	0.45														
ESP	0.93	0.90	0.96	0.94	0.92	0.96	0.93	0.91	0.91	0.85	0.95	0.77	0.93	0.96	0.82	11.57													
ZAF	0.90	0.88	0.91	0.89	0.87	0.93	0.91	0.88	0.89	0.80	0.92	0.82	0.90	0.91	0.84	0.94	26.30												
NZL	0.76	0.81	0.78	0.79	0.72	0.80	0.83	0.81	0.69	0.63	0.73	0.90	0.67	0.75	0.77	0.74	0.81	0.41											
IRL	0.80	0.90	0.86	0.86	0.81	0.85	0.87	0.88	0.77	0.74	0.80	0.81	0.82	0.86	0.75	0.84	0.82	0.81	0.12										
CZE	0.87	0.82	0.91	0.89	0.86	0.89	0.86	0.85	0.86	0.77	0.90	0.70	0.89	0.90	0.83	0.92	0.89	0.70	0.75	15.48									
SVK	0.85	0.86	0.91	0.89	0.87	0.89	0.84	0.84	0.85	0.81	0.90	0.70	0.94	0.92	0.77	0.91	0.89	0.65	0.81	0.89	0.40								
POL	0.90	0.90	0.96	0.94	0.93	0.93	0.91	0.91	0.88	0.84	0.93	0.76	0.94	0.96	0.80	0.94	0.88	0.72	0.83	0.90	0.89	10.87							
LTU	0.82	0.86	0.90	0.88	0.90	0.87	0.84	0.86	0.79	0.81	0.85	0.70	0.87	0.92	0.77	0.88	0.84	0.68	0.79	0.86	0.87	0.90	0.36						
LVA	0.86	0.90	0.93	0.93	0.93	0.90	0.90	0.90	0.84	0.79	0.91	0.80	0.91	0.94	0.79	0.90	0.88	0.78	0.84	0.87	0.86	0.94	0.90	482.19					
PRT	0.77	0.78	0.80	0.78	0.77	0.79	0.79	0.78	0.77	0.75	0.78	0.67	0.80	0.80	0.77	0.80	0.80	0.67	0.75	0.79	0.77	0.80	0.78	0.78	0.45				
KOR	0.88	0.82	0.88	0.90	0.86	0.87	0.89	0.85	0.86	0.79	0.87	0.78	0.85	0.88	0.81	0.88	0.83	0.74	0.71	0.80	0.79	0.90	0.81	0.87	0.77	0.33			

SVN	0.79	0.83	0.87	0.86	0.83	0.85	0.84	0.83	0.77	0.74	0.84	0.75	0.82	0.88	0.77	0.83	0.79	0.70	0.87	0.77	0.81	0.86	0.81	0.88	0.77	0.78	10.69		
HRV	0.78	0.78	0.80	0.78	0.84	0.77	0.78	0.78	0.78	0.77	0.80	0.67	0.84	0.82	0.77	0.80	0.78	0.60	0.74	0.78	0.78	0.84	0.81	0.84	0.77	0.78	0.79	11.64	
URY	0.78	0.80	0.83	0.80	0.79	0.80	0.78	0.80	0.78	0.76	0.78	0.77	0.79	0.81	0.77	0.79	0.82	0.76	0.76	0.78	0.79	0.81	0.77	0.78	0.77	0.78	0.78	0.78	0.20

HOL mas

	CAN	CHE	DEU	DFS	EST	FRA	GBR	NLD	USA	ISR	ITA	AUS	HUN	BEL	JPN	ESP	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN	HRV	URY
CAN	7.57																												
CHE	0.93	11.06																											
DEU	0.91	0.88	9.38																										
DFS	0.94	0.89	0.90	12.35																									
EST	0.80	0.87	0.84	0.84	18.70																								
FRA	0.96	0.95	0.91	0.93	0.82	1.15																							
GBR	0.88	0.90	0.82	0.84	0.76	0.88	2.37																						
NLD	0.84	0.91	0.80	0.85	0.83	0.87	0.83	5.05																					
USA	0.87	0.83	0.86	0.83	0.78	0.90	0.81	0.80	2.50																				
ISR	0.74	0.77	0.75	0.78	0.87	0.75	0.69	0.76	0.73	0.24																			
ITA	0.79	0.88	0.70	0.76	0.83	0.79	0.75	0.89	0.66	0.76	6.13																		
AUS	0.64	0.68	0.64	0.64	0.71	0.63	0.64	0.64	0.64	0.67	0.64	0.12																	
HUN	0.84	0.88	0.77	0.82	0.90	0.82	0.82	0.87	0.74	0.86	0.89	0.68	1.36																
BEL	0.87	0.94	0.84	0.87	0.93	0.88	0.83	0.89	0.76	0.82	0.88	0.74	0.93	0.52															
JPN	0.74	0.83	0.68	0.72	0.77	0.73	0.69	0.79	0.68	0.76	0.83	0.68	0.80	0.84	0.45														
ESP	0.85	0.91	0.77	0.85	0.89	0.86	0.83	0.87	0.75	0.85	0.87	0.71	0.93	0.96	0.84	11.57													
ZAF	0.83	0.89	0.78	0.77	0.83	0.84	0.79	0.84	0.74	0.81	0.85	0.74	0.90	0.93	0.86	0.95	26.03												
NZL	0.62	0.70	0.63	0.62	0.72	0.62	0.62	0.62	0.62	0.72	0.65	0.75	0.71	0.77	0.77	0.77	0.82	0.41											
IRL	0.77	0.86	0.76	0.78	0.86	0.78	0.77	0.78	0.66	0.79	0.81	0.76	0.86	0.94	0.82	0.91	0.91	0.90	0.11										
CZE	0.83	0.87	0.74	0.81	0.85	0.82	0.78	0.84	0.72	0.79	0.88	0.68	0.90	0.92	0.85	0.92	0.90	0.72	0.84	15.48									
SVK	0.83	0.87	0.81	0.80	0.89	0.84	0.79	0.86	0.77	0.82	0.87	0.68	0.93	0.92	0.78	0.91	0.89	0.71	0.85	0.90	0.40								
POL	0.86	0.90	0.79	0.86	0.93	0.84	0.83	0.86	0.74	0.84	0.85	0.69	0.95	0.97	0.82	0.95	0.89	0.74	0.91	0.91	0.89	10.83							
LTU	0.79	0.82	0.78	0.82	0.88	0.82	0.76	0.79	0.71	0.79	0.78	0.68	0.87	0.92	0.76	0.86	0.83	0.71	0.83	0.86	0.88	0.89	0.36						
LVA	0.78	0.83	0.73	0.81	0.92	0.79	0.79	0.83	0.72	0.80	0.83	0.73	0.91	0.94	0.77	0.90	0.86	0.79	0.91	0.87	0.87	0.95	0.90	479.43					
PRT	0.73	0.81	0.70	0.74	0.78	0.74	0.70	0.75	0.68	0.77	0.73	0.68	0.82	0.84	0.77	0.81	0.82	0.71	0.81	0.82	0.77	0.81	0.81	0.81	0.45				
KOR	0.79	0.82	0.69	0.80	0.84	0.78	0.76	0.74	0.69	0.77	0.73	0.69	0.85	0.88	0.83	0.89	0.83	0.74	0.83	0.82	0.78	0.91	0.83	0.87	0.77	0.33			
SVN	0.78	0.81	0.73	0.80	0.81	0.79	0.77	0.75	0.68	0.74	0.76	0.69	0.80	0.89	0.77	0.83	0.79	0.73	0.89	0.79	0.79	0.87	0.83	0.88	0.79	0.77	10.71		
HRV	0.69	0.77	0.69	0.69	0.83	0.70	0.75	0.76	0.70	0.78	0.75	0.68	0.85	0.84	0.77	0.81	0.80	0.71	0.79	0.78	0.79	0.84	0.86	0.85	0.77	0.77	0.79	11.41	
URY	0.69	0.74	0.73	0.69	0.80	0.68	0.69	0.71	0.68	0.76	0.71	0.68	0.80	0.83	0.77	0.80	0.84	0.78	0.85	0.77	0.82	0.83	0.78	0.81	0.77	0.77	0.77	0.77	0.20

JER scs

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE	ITA
CAN	6.05									
DFS	0.91	12.40								
GBR	0.92	0.92	11.45							
NLD	0.92	0.95	0.95	4.01						
USA	0.90	0.83	0.88	0.84	0.17					
AUS	0.77	0.83	0.83	0.85	0.72	0.23				
ZAF	0.86	0.87	0.86	0.89	0.84	0.80	20.88			
NZL	0.67	0.72	0.76	0.78	0.65	0.89	0.73	0.38		
CHE	0.87	0.85	0.85	0.90	0.81	0.72	0.81	0.67	13.36	
ITA	0.87	0.91	0.87	0.88	0.86	0.73	0.87	0.65	0.85	6.46

JER mas

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE	ITA
CAN	7.47									
DFS	0.92	11.89								
GBR	0.78	0.84	1.94							
NLD	0.82	0.83	0.81	4.54						
USA	0.79	0.76	0.73	0.71	2.55					
AUS	0.64	0.65	0.64	0.72	0.64	0.11				
ZAF	0.72	0.71	0.71	0.82	0.70	0.72	20.84			
NZL	0.63	0.63	0.63	0.67	0.63	0.71	0.76	0.38		
CHE	0.82	0.81	0.75	0.79	0.75	0.70	0.80	0.73	13.31	
ITA	0.76	0.73	0.74	0.85	0.67	0.69	0.83	0.70	0.83	6.46

RDC scs

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	6.07													
DFS	0.93	12.93												
GBR	0.94	0.91	11.68											
NOR	0.85	0.91	0.80	13.60										
USA	0.92	0.85	0.88	0.79	0.23									
DEU	0.94	0.96	0.95	0.90	0.88	14.16								
AUS	0.80	0.84	0.86	0.82	0.71	0.83	0.26							
EST	0.89	0.89	0.89	0.84	0.85	0.93	0.80	19.06						
ZAF	0.82	0.86	0.85	0.87	0.86	0.91	0.75	0.87	25.30					
NZL	0.76	0.76	0.80	0.74	0.70	0.78	0.89	0.74	0.77	0.43				
LTU	0.82	0.88	0.84	0.90	0.79	0.89	0.80	0.87	0.86	0.75	0.37			
LVA	0.86	0.88	0.90	0.85	0.83	0.92	0.82	0.94	0.87	0.77	0.89	436.10		
NLD	0.92	0.95	0.94	0.86	0.86	0.96	0.84	0.87	0.88	0.79	0.85	0.87	4.13	
CAM	0.88	0.88	0.88	0.87	0.83	0.88	0.85	0.87	0.88	0.82	0.87	0.87	0.89	6.21

RDC mas

	CAN	DFS	GBR	NOR	USA	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	8.36												
DFS	0.88	13.43											
GBR	0.87	0.82	2.15										
NOR	0.81	0.70	0.73	13.60									
USA	0.79	0.73	0.78	0.79	0.23								
AUS	0.65	0.64	0.65	0.77	0.67	0.12							
EST	0.81	0.72	0.78	0.83	0.80	0.72	19.06						
ZAF	0.84	0.81	0.83	0.87	0.80	0.73	0.84	25.38					
NZL	0.64	0.63	0.65	0.75	0.70	0.78	0.80	0.77	0.43				
LTU	0.75	0.74	0.76	0.85	0.77	0.73	0.90	0.85	0.78	0.36			
LVA	0.78	0.72	0.79	0.86	0.76	0.72	0.94	0.86	0.81	0.91	435.86		
NLD	0.83	0.80	0.85	0.84	0.84	0.70	0.83	0.84	0.69	0.81	0.82	4.72	
CAM	0.83	0.83	0.83	0.87	0.81	0.88	0.88	0.87	0.87	0.87	0.87	0.85	6.21

SIM scs

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA
FRM	1.06										
FRA	0.89	1.07									
ITA	0.87	0.88	12.28								
NLD	0.91	0.94	0.84	3.98							
CHE	0.93	0.93	0.86	0.93	10.41						
DEA	0.92	0.96	0.84	0.92	0.89	12.24					
HUN	0.88	0.91	0.91	0.89	0.88	0.89	16.33				
SVN	0.82	0.81	0.80	0.81	0.83	0.79	0.82	9.24			
GBR	0.91	0.96	0.87	0.95	0.90	0.93	0.89	0.84	10.83		
HRV	0.86	0.78	0.78	0.78	0.79	0.78	0.82	0.78	0.78	9.71	
USA	0.83	0.90	0.87	0.87	0.84	0.80	0.91	0.78	0.90	0.79	0.20

SIM mas

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA
FRM	1.08										
FRA	0.87	1.00									
ITA	0.90	0.82	12.26								
NLD	0.88	0.87	0.79	4.23							
CHE	0.81	0.88	0.86	0.82	9.93						
DEA	0.92	0.91	0.84	0.89	0.72	12.24					
HUN	0.86	0.82	0.88	0.86	0.83	0.86	16.33				
SVN	0.81	0.80	0.79	0.77	0.79	0.80	0.81	9.24			
GBR	0.71	0.88	0.74	0.81	0.88	0.75	0.81	0.75	2.54		
HRV	0.83	0.77	0.78	0.70	0.76	0.77	0.82	0.78	0.74	9.71	
USA	0.82	0.89	0.70	0.84	0.81	0.80	0.74	0.69	0.80	0.72	0.20

^LAPPENDIX II. Number of common bulls

BSW

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	98	59	195	155	166	32	147	69	35
FRA	90	0	97	136	197	264	30	233	66	53
NLD	54	83	0	93	118	174	35	150	42	49
USA	193	101	84	0	337	352	37	248	97	42
CHE	132	156	108	316	0	664	37	519	79	81
DEA	148	216	163	322	558	0	53	747	82	109
NZL	32	24	28	33	30	48	0	46	23	13
ITA	130	197	124	178	463	645	39	0	83	101
GBR	68	56	35	94	61	56	20	62	0	20
SVN	31	51	48	33	76	99	12	95	15	0

BSW

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	87	56	60	78	164	32	145	32	35
FRA	80	0	74	27	81	227	24	203	32	52
NLD	49	64	0	20	59	155	35	137	22	48
USA	61	26	18	0	31	52	15	45	19	12
CHE	71	65	56	27	0	267	18	225	20	65
DEA	148	179	144	46	234	0	53	746	41	108
NZL	32	21	28	14	16	48	0	46	12	13
ITA	129	169	112	36	198	645	39	0	44	101
GBR	31	28	18	18	17	29	9	34	0	14
SVN	31	49	47	11	61	99	12	95	12	0

GUE

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	GBR	USA	AUS	NZL
CAN	0	35	78	56	14
GBR	30	0	93	47	13
USA	70	95	0	76	29
AUS	54	40	74	0	26
NZL	11	11	29	26	0

GUE

HOL

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	CHE	DEU	DFS	EST	FRA	GBR	NLD	USA	ISR	ITA	AUS	HUN	BEL	JPN	ESP	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN	HRV	URY
CAN	0	973	2729	1806	342	1733	1873	1915	4139	171	2022	1668	1122	940	1547	1492	505	867	589	1330	473	1864	300	569	1261	809	239	355	907
CHE	899	0	1242	805	200	799	765	1020	1101	71	794	696	455	669	523	620	257	457	406	566	250	793	145	272	566	304	148	223	353
DEU	2203	1174	0	3052	538	2775	2255	3854	3931	197	2812	1846	1323	1379	1575	1729	549	1102	861	2081	727	3169	554	814	1451	717	390	730	911
DFS	1636	763	2376	0	411	1943	1753	2539	2532	179	1765	1477	1001	1010	1129	1221	505	954	752	1478	448	2069	361	544	1133	574	285	494	755
EST	225	119	402	281	0	320	327	475	452	65	361	266	231	236	246	250	113	168	144	335	138	456	102	196	241	145	104	153	178
FRA	1302	745	1736	1233	173	0	1714	2347	2767	147	1747	1450	1041	1121	1343	1414	503	903	725	1437	479	2131	290	486	1148	616	231	395	694
GBR	2118	732	1768	1389	202	1191	0	2000	2500	175	1632	1562	931	969	1158	1192	507	1003	953	1195	401	1660	321	479	1080	561	221	385	785
NLD	1878	1020	3708	2316	352	1690	1790	0	2964	192	1969	1659	1064	1458	1239	1330	514	1219	899	1764	591	2413	367	579	1275	578	307	530	805
USA	4738	1036	3038	2107	331	1650	2311	2701	0	264	2905	2224	1429	1102	2193	1768	633	1241	822	1924	593	2802	403	768	1590	984	274	453	1329
ISR	120	42	151	134	37	92	127	151	254	0	170	138	124	97	136	125	66	134	109	158	58	194	56	86	124	76	52	78	109
ITA	1811	734	2122	1516	226	1162	1343	1770	2434	119	0	1246	1047	874	1230	1403	405	703	550	1390	413	2136	340	590	1138	660	290	444	747
AUS	1700	619	1427	1107	142	1040	1377	1468	2292	87	991	0	802	838	1017	1000	481	1328	735	965	334	1283	265	436	944	519	182	338	781
HUN	1066	383	1079	835	139	780	816	922	1418	86	925	612	0	600	795	858	395	548	430	1015	335	1099	250	394	833	511	165	300	569

BEL	942	686	1430	957	150	1157	954	1683	995	63	887	741	524	0	620	770	337	576	510	748	319	974	187	315	765	349	179	308	402
JPN	883	369	773	672	96	561	636	726	1115	64	671	600	467	418	0	1015	428	632	439	966	340	1186	230	411	833	635	178	270	662
ESP	1044	519	1168	971	123	1190	958	1216	1225	76	1054	734	700	759	527	0	448	609	499	993	349	1348	244	425	982	559	215	337	599
ZAF	465	216	428	389	56	399	444	439	618	42	325	419	320	287	299	399	0	367	294	408	180	418	106	165	442	267	72	158	328
NZL	856	384	850	692	88	594	869	1114	1199	107	549	1334	426	468	354	469	298	0	744	702	270	795	191	280	656	343	134	255	616
IRL	521	388	700	592	74	569	911	799	704	82	458	605	347	473	275	449	246	612	0	526	210	652	146	213	480	230	106	194	378
CZE	1026	432	1670	1060	217	993	877	1619	1595	125	1067	661	942	605	490	748	287	524	388	0	538	1640	297	468	931	547	237	429	651
SVK	334	129	547	239	57	273	231	423	404	24	258	167	235	194	131	180	97	164	98	461	0	505	106	170	351	219	82	159	255
POL	1712	694	3003	1792	340	1602	1472	2326	2855	154	1872	1019	1011	909	689	1022	316	621	514	1417	363	0	418	698	1263	679	320	566	813
LTU	171	59	515	217	46	122	171	227	283	25	186	121	152	91	77	100	40	91	69	193	48	325	0	207	245	159	72	166	186
LVA	361	140	657	345	110	260	275	391	671	55	381	221	283	184	185	233	96	157	117	311	79	566	134	0	452	275	123	278	304
PRT	1324	516	1362	1055	164	1051	1006	1291	1704	81	1103	794	835	779	532	957	396	534	402	784	236	1296	153	352	0	545	178	366	642
KOR	796	219	505	433	71	390	413	431	1123	40	554	382	412	262	406	403	198	254	152	395	132	575	71	167	467	0	116	173	439
SVN	185	106	382	229	62	174	160	266	223	36	251	123	124	140	98	156	51	90	80	173	38	285	31	71	141	73	0	128	108
HRV	218	148	754	398	110	288	275	486	350	54	341	214	219	248	129	256	108	153	131	327	79	516	113	216	300	82	102	0	216
URY	877	278	676	546	100	467	652	668	1626	63	565	614	460	314	401	478	294	515	291	475	150	680	105	172	552	349	57	132	0

HOL

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	CHE	DEU	DFS	EST	FRA	GBR	NLD	USA	ISR	ITA	AUS	HUN	BEL	JPN	ESP	ZAF	NZL	IRL	CZE	SVK	POL	LTU	LVA	PRT	KOR	SVN	HRV	URY
CAN	0	295	804	976	223	1001	1059	424	1449	115	1377	985	743	618	946	989	251	490	345	844	264	1272	217	370	812	578	192	249	551
CHE	263	0	286	276	81	284	268	182	270	28	298	258	134	236	195	227	64	165	134	177	72	302	63	89	186	125	80	73	113
DEU	639	258	0	1070	273	929	842	628	778	98	1057	698	566	614	582	734	200	427	332	771	236	1444	259	428	611	319	286	430	363
DFS	997	253	945	0	372	1464	1464	849	1161	167	1334	1336	926	895	1051	1133	488	887	694	1353	366	1839	326	469	1039	525	263	452	636
EST	151	45	200	257	0	276	303	205	278	64	301	259	223	224	240	245	110	163	134	329	121	438	97	183	230	141	102	151	164
FRA	806	257	695	938	153	0	1315	600	977	125	1300	1157	915	955	1075	1202	414	720	591	1246	358	1844	242	404	974	521	213	336	531
GBR	1081	250	695	1180	195	955	0	636	1261	174	1355	1419	889	897	1060	1126	466	920	853	1145	348	1566	287	417	1003	521	215	360	682
NLD	407	172	572	862	145	501	622	0	439	100	582	542	405	594	406	495	208	518	371	736	183	975	167	251	514	218	159	304	299
USA	1668	237	658	1190	217	788	1377	397	0	196	1563	1131	876	616	1106	971	351	619	439	1051	294	1664	245	500	963	694	207	252	785
ISR	78	13	67	120	37	76	125	78	193	0	145	134	121	96	134	125	64	133	97	158	56	191	52	77	124	76	51	76	103
ITA	1189	263	825	1158	197	892	1150	530	1612	97	0	1051	920	737	1071	1223	321	581	448	1186	332	1816	282	455	979	590	253	357	603
AUS	1061	227	562	976	143	863	1265	470	1245	86	882	0	786	811	1013	1000	464	1296	698	959	307	1251	244	396	918	500	181	323	709
HUN	720	104	445	771	139	670	795	342	931	84	833	608	0	580	786	847	383	543	413	1011	312	1074	235	373	810	493	163	288	512
BEL	653	231	627	847	148	967	909	618	596	63	768	739	520	0	597	753	329	560	487	731	290	936	172	295	741	340	179	297	374
JPN	668	147	367	611	96	496	620	302	875	64	621	599	467	418	0	1015	425	625	432	966	314	1171	215	389	808	610	177	258	590
ESP	696	177	526	891	123	986	932	469	799	76	910	733	699	759	527	0	442	608	479	992	319	1328	227	400	964	547	211	326	547
ZAF	236	51	155	373	56	326	429	184	393	42	268	413	319	287	299	399	0	363	283	402	169	408	99	162	430	254	72	149	307
NZL	442	142	345	631	87	493	775	468	594	107	483	1297	425	465	354	469	296	0	714	701	257	774	181	265	641	333	134	246	571
IRL	343	132	298	527	72	481	832	349	424	70	392	575	339	461	271	437	234	586	0	507	190	608	141	200	458	226	101	184	352
CZE	658	125	598	931	217	812	862	705	996	125	938	657	942	605	490	748	287	524	366	0	507	1618	278	442	910	530	237	414	592
SVK	188	28	140	205	56	215	223	103	208	24	221	164	231	188	131	180	96	161	96	461	0	451	93	157	328	205	78	147	229
POL	1218	256	1476	1566	335	1385	1429	974	1884	153	1651	1013	1001	894	689	1021	315	616	485	1417	343	0	391	623	1208	652	313	541	732
LTU	136	22	210	205	45	110	167	106	178	25	158	122	150	90	77	100	40	89	66	193	46	315	0	189	226	141	69	155	167
LVA	227	34	338	283	104	202	250	155	417	49	279	196	272	175	176	221	94	147	107	292	78	502	127	0	423	257	117	267	275
PRT	851	162	542	963	163	895	973	517	1068	81	987	787	827	777	532	957	395	531	393	784	229	1265	151	332	0	527	177	346	590
KOR	568	98	232	399	71	346	398	159	761	40	514	377	408	262	406	403	197	250	157	395	130	563	68	157	464	0	115	161	396
SVN	149	55	278	210	62	163	157	127	166	35	221	124	124	140	98	156	51	90	74	173	38	281	31	68	141	73	0	126	105
HRV	162	47	417	366	110	248	272	273	203	54	273	210	219	245	129	255	108	153	127	327	79	509	112	214	297	81	101	0	200
URY	532	84	271	486	100	381	618	238	869	63	504	611	450	312	401	478	291	512	293	475	149	663	105	164	544	340	57	131	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE	ITA
CAN	0	144	187	55	515	294	162	212	44	28
DFS	139	0	204	185	238	182	164	189	62	33
GBR	190	199	0	113	271	250	176	255	75	37
NLD	49	189	106	0	122	90	83	107	43	24
USA	544	221	297	126	0	541	304	426	76	37
AUS	303	153	254	80	590	0	246	484	61	36
ZAF	158	147	179	79	320	236	0	215	58	34
NZL	222	167	260	102	500	539	223	0	58	30
CHE	38	61	73	36	77	51	51	49	0	24
ITA	23	32	36	20	35	30	29	28	24	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE	ITA
CAN	0	56	90	22	103	143	76	101	26	20
DFS	51	0	130	150	75	145	142	159	60	30
GBR	88	124	0	79	98	183	139	183	67	37
NLD	15	145	75	0	46	82	79	96	39	24
USA	95	65	99	45	0	186	129	142	42	22
AUS	131	111	187	75	197	0	241	479	57	35
ZAF	69	121	141	76	140	235	0	210	55	34
NZL	93	133	186	92	143	532	220	0	54	30
CHE	24	57	64	34	36	50	50	48	0	24
ITA	15	28	34	20	21	29	29	28	24	0

RDC

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	0	197	98	8	226	14	108	3	70	97	22	10	8	0
DFS	203	0	133	147	222	68	221	143	51	199	103	132	69	0
GBR	98	127	0	74	135	16	105	15	40	99	26	16	49	0
NOR	7	122	78	0	87	17	81	32	0	55	19	20	55	0
USA	214	220	130	88	0	27	153	28	59	139	37	25	52	32
DEU	13	59	16	16	25	0	48	33	1	23	28	36	21	0
AUS	109	193	100	70	156	47	0	46	34	172	44	40	49	13
EST	2	131	13	32	27	33	42	0	0	22	22	53	26	0
ZAF	72	48	35	0	53	1	34	0	0	35	5	2	3	0
NZL	95	195	94	55	140	23	172	20	30	0	22	19	31	13
LTU	21	89	24	18	33	27	41	22	5	22	0	44	15	0
LVA	10	91	16	18	22	30	36	45	2	16	40	0	18	0
NLD	8	67	48	54	51	20	47	25	3	30	14	17	0	0
CAM	0	0	0	0	32	0	13	0	0	13	0	0	0	0

RDC

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NOR	USA	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	0	89	33	3	84	35	0	35	39	18	7	3	0
DFS	89	0	91	147	214	234	143	46	197	102	126	65	0
GBR	32	87	0	62	95	67	9	27	67	20	14	36	0
NOR	3	121	66	0	87	80	32	0	55	19	19	51	0
USA	84	212	94	88	0	141	28	54	136	37	25	49	32
AUS	35	210	66	69	145	0	46	31	163	41	38	44	12
EST	0	131	9	32	27	42	0	0	22	22	49	22	0
ZAF	36	46	26	0	52	33	0	0	33	5	2	2	0
NZL	39	191	67	55	140	164	20	30	0	22	18	27	13
LTU	17	88	18	18	33	39	22	5	22	0	44	14	0
LVA	7	84	14	17	22	35	41	2	15	40	0	14	0
NLD	3	63	36	50	49	42	21	2	26	13	13	0	0
CAM	0	0	0	0	32	12	0	0	13	0	0	0	0

SIM

common bulls below diagonal
common three quarter sib group above diagonal

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA
FRM	0	2	192	136	247	277	2	11	67	2	92
FRA	1	0	144	82	15	263	4	55	0	105	3
ITA	217	128	0	272	103	1041	19	159	46	343	39
NLD	161	78	266	0	94	413	9	89	49	175	32

CHE	299	12	105	98	0	372	2	2	53	2	34
DEA	315	220	951	433	340	0	39	279	49	739	40
HUN	0	3	15	9	1	24	0	10	0	20	1
SVN	10	51	150	82	2	263	9	0	0	135	2
GBR	84	0	50	49	60	52	0	0	0	0	20
HRV	1	94	326	169	2	774	17	125	0	0	5
USA	107	3	46	33	33	43	1	2	27	5	0

SIM

common bulls below diagonal
common three quarter sib group above diagonal

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA
FRM	0	2	158	105	5	228	2	11	25	2	37
FRA	1	0	83	31	2	161	3	25	0	58	1
ITA	183	71	0	259	10	1041	19	159	18	343	39
NLD	128	30	254	0	9	381	8	83	18	165	32
CHE	5	2	10	9	0	103	0	0	1	0	5
DEA	276	124	951	400	97	0	39	279	20	739	40
HUN	0	2	15	8	0	24	0	10	0	20	1
SVN	10	22	150	78	0	263	9	0	0	135	2
GBR	34	0	23	20	1	25	0	0	0	0	17
HRV	1	51	326	161	0	774	17	125	0	0	5
USA	52	1	46	33	5	43	1	2	23	5	0