Introduction

The latest routine international evaluation for **udder traits** took place as scheduled at the Interbull Centre. Data from thirty-two (32) 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 and Portugal were computed.
Brown Swiss, Holstein, Red Dairy Cattle, Guernsey, Jersey and Simmental breed data were included in this evaluation.

Changes in national procedures

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

DFS (HOL) HOL and RED HOL (RED) have merged. Cows with min 87 % HOL genes and and bulls with min 93 % HOL genes have been converted to HOL.
Animals with less % HOL genes will no longer be a part of the evaluation

NLD (ALL) Minor data editing for mastitis.

SVN (ALL) Some bulls losing informations mostly as a consequence of changes in data base related to the pedigree completness as well as phenotypic data improvement

PRT (HOL) Implemented new changes to evaluation model: random contemporary groups, genetic groups and new variance components

DEU (RDC) Few bulls whose ownership has been corrected, they are now foreign AI bulls, therefore their Type of Proof changed and some of these are not publishable anymore.

CHE (ALL) Decreases in herds/daughters/EDC due to continuous work on the raw data by herd-book organizations.

JPN (HOL) Small changes in proofs caused by additional records and in EDCs caused by modification of pedigree

ITA (HOL) First time with mastitis: composite index derived by an alternative way of using SCC information. The single traits derived to create the composite are those that were
strongly correlated with presence of clinical mastitis in a testing-data set.
Only first parity cows are considered. Bulls considered for pubblication are those
that are publishable for SCS and that have at least 10 daugthers for the new mas-trait. The fixed effect model used is the following: HYS+Age_at_calving+ Number_of_testdays_within lacatation

HRV (HOL,SIM) Some decrease in information due to pedigree changes and completedness

DEA (SIM,BSW) Base change

EST (HOL,RDC) Updated definition for fixed lactation curves

CAM (RDC) First time inclusion of Canadian Milking Shorthorn with population code CAM

INTERBULL CHANGES COMPARED TO THE DECEMBER ROUTINE RUN

Subsetting:

As decided by the ITC in Orlando, new subsetting was introduced in the september test run. Sub-setting is necessary for operational purposes and restrictions of time scales. To minimize the effect of subsetting, larger subsets with 10-12 countries and with 4 link providing countries have been applied.

Window:

According to the decision taken by ITC in Orlando, the following changes have been introduced in regards to the windows used for post processing:

The upper bounds have been set to 0.99 as these were judged to have very little effect on evaluations. The lower values have been set to about the 25% percentile value. The largest changes are for

the lower values for conformation traits, with the lowest window being 40% for OFL otherwise it is about 50% for all other confirmation traits. It is anticipated that these low values may not have large impact on evaluations since there were very few countries combinations whose estimated correlations fell between the old limit of 0.30 and these new limits.

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 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 (December Routine Evaluation 2017).
Number of records for milk somatic cells by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS		125	7371	1484	654	
BEL			1114			
CAN	214	95	11651	680	777	
CHE	2816		3181			3087
CZE			3726			
DEA	5409					21530
DEU			26799		416	
DFS			12729	2065	7634	
ESP			3570			
EST			1065		404	
FRA	365		16631			438
FRM						4114
GBR	107	267	6331	658	480	82
HUN			2638			157
IRL			2306			
ISR			1345			
ITA	1826		9506			1395
JPN			5717			
KOR			1158			
LTU			734		425	
LVA			528		564	
NLD	178		15008	140	69	326
NOR					4000	
NZL	46	57	7017	4194	1225	
POL			9796			
PRT			2251			
SVK			1069			547
SVN	350		487			574
URY						
USA	1032	679	36080	4231	652	43
ZAF			1158	548	122	
HRV			702			783
MEX						
CAM					37	
No.Records	12343	1223	191668	14000	17459	33076
Pub. Proofs	10085	956	148975	11622	16746	29799

^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	0.24									
FRA	0.94	1.02								
NLD	0.90	0.93	3.77							
USA	0.92	0.91	0.88	0.21						
CHE	0.92	0.94	0.93	0.88	10.37					
DEA	0.93	0.96	0.92	0.88	0.97	11.89				
NZL	0.87	0.87	0.87	0.86	0.87	0.87	0.37			
ITA	0.90	0.90	0.88	0.88	0.95	0.91	0.87	17.29		
GBR	0.93	0.96	0.96	0.90	0.94	0.95	0.89	0.89	12.81	
SVN	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.89	0.89	10.65

BSW mas

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0.24									
FRA	0.89	1.08								
NLD	0.87	0.87	3.57							
USA	0.88	0.87	0.88	0.21						
CHE	0.91	0.88	0.89	0.88	10.37					
DEA	0.91	0.85	0.89	0.87	0.97	11.89				
NZL	0.88	0.87	0.88	0.86	0.86	0.86	0.37			
ITA	0.90	0.88	0.89	0.88	0.95	0.91	0.86	17.29		
GBR	0.88	0.88	0.88	0.89	0.89	0.90	0.89	0.89	2.98	
SVN	0.90	0.89	0.89	0.89	0.89	0.89	0.88	0.89	0.89	10.65

GUE scs

	CAN	GBR	USA	AUS	NZL
CAN	0.24				
GBR	0.93	13.53			
USA	0.93	0.90	0.25		
AUS	0.87	0.93	0.86	28.99	
NZL	0.87	0.88	0.86	0.95	0.63

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
CAN	0.27																											
CHE	0.88	10.90																										
DEU	0.93	0.93	12.70																									
DFS	0.92	0.93	0.96	11.96																								
EST	0.88	0.89	0.93	0.92	13.62																							
FRA	0.94	0.93	0.95	0.97	0.90	1.19																						
GBR	0.93	0.94	0.94	0.94	0.90	0.96	12.77																					
NLD	0.91	0.94	0.95	0.94	0.90	0.94	0.96	4.19																				
USA	0.94	0.88	0.89	0.88	0.90	0.90	0.90	0.88	0.21																			
ISR	0.85	0.83	0.85	0.84	0.86	0.85	0.83	0.82	0.87	0.24																		
ITA	0.89	0.89	0.94	0.92	0.93	0.92	0.90	0.88	0.89	0.85	5.83																	
AUS	0.86	0.91	0.88	0.89	0.85	0.90	0.93	0.92	0.86	0.82	0.85	30.26																
HUN	0.88	0.89	0.92	0.91	0.90	0.91	0.89	0.88	0.92	0.88	0.93	0.85	1.43															
BEL	0.91	0.93	0.97	0.96	0.95	0.96	0.94	0.94	0.89	0.83	0.94	0.88	0.92	0.50														
JPN	0.88	0.87	0.87	0.89	0.87	0.90	0.88	0.88	0.88	0.82	0.87	0.85	0.87	0.87	0.42													
ESP	0.92	0.92	0.95	0.94	0.94	0.96	0.93	0.91	0.91	0.88	0.95	0.86	0.93	0.96	0.88	11.58												
ZAF	0.90	0.90	0.91	0.90	0.88	0.93	0.92	0.89	0.90	0.87	0.92	0.88	0.91	0.91	0.87	0.95	26.57											
NZL	0.86	0.86	0.86	0.86	0.85	0.86	0.88	0.87	0.85	0.82	0.84	0.96	0.85	0.85	0.85	0.85	0.86	0.40										
IRL	0.88	0.93	0.93	0.94	0.89	0.93	0.96	0.94	0.86	0.81	0.88	0.95	0.86	0.94	0.86	0.92	0.91	0.92	0.11									
CZE	0.88	0.88	0.90	0.89	0.89	0.89	0.88	0.88	0.88	0.85	0.90	0.86	0.90	0.90	0.88	0.91	0.88	0.86	0.86	14.32								
SVK	0.88	0.88	0.90	0.88	0.87	0.89	0.87	0.87	0.88	0.83	0.89	0.84	0.95	0.90	0.87	0.91	0.88	0.85	0.85	0.88	0.42							
POL	0.90	0.92	0.96	0.95	0.94	0.93	0.91	0.91	0.88	0.86	0.94	0.86	0.94	0.95	0.88	0.95	0.91	0.86	0.89	0.90	0.90	9.91						
LTU	0.88	0.86	0.88	0.87	0.87	0.86	0.87	0.87	0.87	0.82	0.87	0.84	0.87	0.88	0.87	0.88	0.86	0.84	0.85	0.88	0.86	0.88	0.35					
LVA	0.88	0.88	0.94	0.92	0.93	0.89	0.89	0.88	0.87	0.81	0.91	0.86	0.88	0.94	0.87	0.89	0.87	0.84	0.89	0.88	0.86	0.93	0.89	0.48				
PRT	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.84	0.88	0.86	0.88	0.88	0.88	0.88	0.88	0.85	0.86	0.88	0.88	0.88	0.88	0.88	0.46			
KOR	0.88	0.87	0.88	0.89	0.87	0.88	0.88	0.87	0.88	0.82	0.89	0.84	0.87	0.89	0.87	0.90	0.87	0.85	0.85	0.88	0.87	0.92	0.86	0.89	0.88	0.34		
SVN	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.83	0.87	0.85	0.87	0.88	0.87	0.87	0.87	0.85	0.86	0.88	0.87	0.88	0.86	0.87	0.88	0.87	10.77	
HRV	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.82	0.87	0.84	0.87	0.87	0.87	0.87	0.87	0.84	0.84	0.88	0.86	0.89	0.87	0.87	0.88	0.86	0.87	11.86

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
CAN	7.59																											
CHE	0.85	10.88																										
DEU	0.86	0.93	12.70																									
DFS	0.94	0.85	0.87	12.04																								
EST	0.84	0.87	0.92	0.85	13.64																							
FRA	0.95	0.85	0.86	0.93	0.83	1.22																						
GBR	0.87	0.89	0.89	0.88	0.88	0.88	2.50																					
NLD	0.87	0.88	0.93	0.87	0.90	0.87	0.88	4.84																				
USA	0.88	0.88	0.88	0.88	0.88	0.87	0.88	0.89	0.21																			
ISR	0.79	0.81	0.82	0.79	0.83	0.79	0.83	0.82	0.84	0.24																		
ITA	0.87	0.88	0.91	0.87	0.89	0.87	0.88	0.89	0.88	0.83	6.07																	
AUS	0.83	0.91	0.88	0.83	0.83	0.82	0.90	0.88	0.85	0.79	0.85	30.26																
HUN	0.86	0.88	0.92	0.87	0.89	0.86	0.88	0.90	0.91	0.85	0.91	0.85	1.43															
BEL	0.86	0.93	0.97	0.87	0.93	0.87	0.89	0.94	0.89	0.80	0.91	0.87	0.92	0.50														
JPN	0.85	0.87	0.87	0.85	0.85	0.85	0.88	0.86	0.88	0.80	0.88	0.85	0.87	0.87	0.42													
ESP	0.86	0.91	0.95	0.87	0.91	0.88	0.89	0.92	0.91	0.85	0.92	0.85	0.93	0.96	0.87	11.58												
ZAF	0.86	0.89	0.91	0.86	0.86	0.86	0.89	0.88	0.89	0.84	0.90	0.88	0.91	0.91	0.87	0.95	26.48											
NZL	0.84	0.86	0.85	0.86	0.83	0.84	0.89	0.86	0.85	0.80	0.85	0.96	0.85	0.85	0.85	0.85	0.85	0.40										
IRL	0.85	0.92	0.92	0.86	0.87	0.86	0.90	0.89	0.86	0.80	0.87	0.94	0.86	0.93	0.85	0.91	0.90	0.92	0.11									
CZE	0.85	0.87	0.90	0.85	0.87	0.85	0.88	0.88	0.88	0.81	0.89	0.84	0.89	0.89	0.87	0.91	0.87	0.84	0.85	14.32								
SVK	0.84	0.87	0.90	0.85	0.86	0.85	0.88	0.87	0.86	0.79	0.88	0.83	0.94	0.89	0.86	0.89	0.86	0.83	0.84	0.87	0.42							
POL	0.87	0.91	0.96	0.88	0.92	0.88	0.89	0.92	0.88	0.83	0.91	0.86	0.94	0.95	0.88	0.95	0.90	0.86	0.89	0.90	0.89	9.91						
LTU	0.82	0.84	0.87	0.83	0.84	0.81	0.87	0.85	0.85	0.78	0.86	0.82	0.85	0.85	0.84	0.86	0.83	0.82	0.82	0.85	0.84	0.87	0.35					
LVA	0.83	0.86	0.92	0.84	0.91	0.83	0.88	0.88	0.86	0.78	0.88	0.84	0.86	0.91	0.86	0.87	0.84	0.82	0.86	0.85	0.84	0.91	0.86	0.48				
PRT	0.88	0.88	0.88	0.88	0.86	0.88	0.88	0.87	0.88	0.82	0.88	0.85	0.88	0.88	0.88	0.88	0.88	0.85	0.86	0.88	0.87	0.88	0.86	0.87	0.46			
KOR	0.85	0.86	0.87	0.85	0.84	0.86	0.88	0.86	0.87	0.79	0.88	0.84	0.87	0.88	0.87	0.90	0.87	0.84	0.84	0.86	0.86	0.91	0.84	0.87	0.87	0.34		
SVN	0.84	0.86	0.86	0.85	0.85	0.84	0.87	0.86	0.86	0.81	0.87	0.84	0.86	0.87	0.86	0.86	0.86	0.83	0.85	0.86	0.85	0.87	0.83	0.85	0.87	0.85	10.77	
HRV	0.82	0.85	0.87	0.82	0.85	0.82	0.88	0.86	0.86	0.79	0.87	0.84	0.86	0.86	0.86	0.86	0.85	0.83	0.83	0.86	0.84	0.88	0.85	0.86	0.87	0.83	0.86	11.86

JER scs

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL
CAN	0.22							
DFS	0.91	12.52						
GBR	0.91	0.91	11.18					
NLD	0.92	0.95	0.95	3.80				
USA	0.91	0.88	0.89	0.88	0.19			
AUS	0.87	0.89	0.89	0.92	0.86	29.11		
ZAF	0.89	0.88	0.89	0.91	0.88	0.89	21.31	
NZL	0.88	0.87	0.88	0.87	0.85	0.96	0.86	0.38

JER mas

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL
CAN	7.29							
DFS	0.93	12.36						
GBR	0.87	0.88	1.85					
NLD	0.88	0.88	0.89	4.07				
USA	0.88	0.88	0.88	0.89	0.19			
AUS	0.86	0.86	0.89	0.89	0.86	29.13		
ZAF	0.87	0.87	0.88	0.89	0.88	0.89	21.32	
NZL	0.88	0.87	0.89	0.89	0.86	0.96	0.86	0.38

RDC scs

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU
LVA	NLD	CAM									
CAN	0.24										
DFS	0.94	12.71									
GBR	0.93	0.92	11.49								
NOR	0.92	0.93	0.89	13.54							
USA	0.93	0.88	0.89	0.89	0.24						
DEU	0.93	0.95	0.94	0.90	0.89	13.35					
AUS	0.89	0.92	0.92	0.92	0.86	0.90	30.96				
EST	0.89	0.94	0.91	0.90	0.91	0.94	0.91	12.05			
ZAF	0.89	0.90	0.90	0.93	0.89	0.92	0.88	0.90	25.01		
NZL	0.87	0.88	0.88	0.89	0.85	0.86	0.96	0.88	0.86	0.41	
LTU	0.90	0.88	0.89	0.90	0.89	0.89	0.86	0.91	0.91	0.87	0.34
LVA	0.90	0.89	0.90	0.90	0.89	0.94	0.90	0.96	0.89	0.88	0.90
0.44											
NLD	0.91	0.94	0.96	0.90	0.88	0.95	0.92	0.92	0.90	0.87	0.89
0.90	3.91										
CAM	0.94	0.94	0.94	0.93	0.90	0.94	0.93	0.94	0.93	0.90	0.93
0.93	0.94	0.17									

RDC mas

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU
LVA	NLD	CAM									
CAN	7.76										
DFS	0.91	13.10									
GBR	0.88	0.88	2.00								
NOR	0.91	0.88	0.90	13.54							
USA	0.88	0.88	0.88	0.89	0.24						
DEU	0.86	0.85	0.89	0.90	0.88	13.35					
AUS	0.85	0.82	0.90	0.90	0.86	0.89	31.02				
EST	0.85	0.84	0.89	0.90	0.89	0.93	0.87	12.05			
ZAF	0.88	0.88	0.89	0.93	0.89	0.92	0.88	0.89	25.11		
NZL	0.86	0.86	0.89	0.91	0.85	0.87	0.96	0.86	0.87	0.41	
LTU	0.85	0.83	0.89	0.89	0.88	0.88	0.87	0.90	0.89	0.86	0.34
LVA	0.85	0.82	0.89	0.90	0.87	0.93	0.89	0.95	0.87	0.88	0.90
0.44											
NLD	0.88	0.88	0.88	0.90	0.89	0.93	0.88	0.91	0.89	0.87	0.88
0.89	3.98										
CAM	0.93	0.93	0.93	0.93	0.90	0.94	0.92	0.94	0.93	0.92	0.93
0.94	0.94	0.17									

SIM scs

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV
USA											
FRM	1.09										
FRA	0.93	1.02									
ITA	0.95	0.90	13.82								
NLD	0.91	0.93	0.88	3.97							
CHE	0.93	0.93	0.90	0.92	10.36						
DEA	0.92	0.93	0.88	0.90	0.89	12.16					
HUN	0.93	0.91	0.93	0.88	0.90	0.93	15.67				
SVK	0.89	0.89	0.89	0.90	0.90	0.87	0.94	0.38			
SVN	0.90	0.88	0.89	0.89	0.89	0.88	0.89	0.89	9.13		
GBR	0.92	0.96	0.89	0.95	0.91	0.92	0.89	0.88	0.88	11.71	
HRV	0.92	0.88	0.88	0.88	0.88	0.87	0.89	0.88	0.88	0.88	10.01
USA	0.89	0.90	0.89	0.88	0.89	0.90	0.92	0.89	0.89	0.90	0.88
0.22											

SIM mas

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV
USA											
FRM	1.08										
FRA	0.92	1.00									
ITA	0.95	0.88	13.82								
NLD	0.88	0.88	0.89	3.81							
CHE	0.92	0.87	0.90	0.88	10.36						
DEA	0.91	0.92	0.88	0.88	0.89	12.16					
HUN	0.92	0.88	0.92	0.90	0.89	0.93	15.67				
SVK	0.88	0.88	0.90	0.89	0.89	0.87	0.94	0.38			
SVN	0.90	0.88	0.89	0.88	0.89	0.88	0.89	0.89	9.13		
GBR	0.90	0.88	0.89	0.89	0.89	0.90	0.88	0.89	0.88	2.55	
HRV	0.91	0.87	0.88	0.86	0.88	0.87	0.89	0.88	0.88	0.88	10.01
USA	0.89	0.88	0.89	0.89	0.89	0.90	0.92	0.89	0.89	0.89	0.88
0.22											

^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	76	47	156	117	122	20	108	57	27
FRA	65	0	79	116	150	196	19	170	50	49
NLD	44	65	0	73	87	135	21	115	37	38
USA	143	78	63	0	302	297	25	209	76	36
CHE	91	113	78	285	0	533	21	398	63	69
DEA	99	147	128	262	432	0	29	568	65	93
NZL	18	15	14	23	16	24	0	24	16	6
ITA	89	137	95	145	342	474	18	0	65	86
GBR	52	40	29	71	48	44	13	46	0	19
SVN	24	48	39	29	66	87	5	85	14	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	69	43	156	117	122	20	108	28	27
FRA	59	0	63	102	147	179	16	156	26	48
NLD	37	51	0	66	78	113	20	99	18	33
USA	143	70	52	0	302	297	25	209	34	36
CHE	91	111	69	285	0	533	21	398	31	69
DEA	99	135	100	262	432	0	29	568	30	93
NZL	18	13	13	23	16	24	0	24	9	6
ITA	89	128	76	145	342	474	18	0	32	86
GBR	24	20	13	32	25	22	6	24	0	12
SVN	24	47	33	29	66	87	5	85	9	0

GUE

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	GBR	USA	AUS	NZL
CAN	0	27	64	42	13
GBR	22	0	82	32	13
USA	55	84	0	57	29
AUS	40	27	53	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
CAN	0	739	2149	1191	207	1272	1328	1244	2803	97	1476	1158	845	441	1186	1128	453	610	399	898	389	1096	196	192	893	554	169	239
CHE	579	0	1047	632	143	590	600	789	869	54	651	524	401	380	426	498	250	346	310	460	213	583	104	139	470	220	125	178
DEU	1316	895	0	2574	366	2393	1878	3218	3328	147	2427	1519	1147	732	1394	1426	559	877	693	1638	692	2076	441	307	1158	534	263	551
DFS	884	555	1570	0	253	1503	1370	1881	1836	129	1485	1136	810	518	890	912	478	742	587	1075	385	1374	269	207	863	411	215	345
EST	108	80	251	147	0	227	216	316	299	45	237	190	177	109	183	178	98	118	105	224	104	268	68	90	172	89	80	107
FRA	761	513	1141	724	102	0	1382	1809	2298	116	1647	1137	854	586	1127	1033	451	723	578	1081	397	1430	201	187	856	432	176	248
GBR	1447	551	1294	963	121	809	0	1534	1846	115	1393	1190	757	511	932	951	480	793	714	868	343	1110	218	179	861	415	182	287
NLD	1078	763	2806	1531	225	1036	1261	0	2220	138	1609	1298	865	756	971	1004	490	911	685	1268	505	1526	256	228	969	404	217	387
USA	2793	769	2071	1257	192	1146	1520	1839	0	148	2406	1628	1151	546	1774	1385	604	946	595	1407	503	1727	286	259	1186	719	200	318
ISR	60	36	119	100	28	61	76	111	133	0	124	94	99	53	93	98	55	97	73	103	46	121	36	28	94	49	41	56
ITA	992	575	1473	1015	130	791	985	1222	1453	89	0	1102	947	512	1110	1177	477	690	517	1144	385	1400	248	224	949	512	211	337
AUS	1080	458	1034	760	89	727	973	1090	1516	61	734	0	633	471	796	774	446	1043	555	722	286	877	183	163	707	361	156	247
HUN	735	325	885	621	107	551	659	703	1094	73	781	471	0	333	653	694	372	447	344	791	297	833	174	139	658	388	143	224
BEL	395	353	666	443	64	540	452	811	431	32	426	383	263	0	333	419	232	325	294	372	184	457	94	100	418	178	121	166
JPN	554	276	543	463	66	383	465	490	770	45	487	428	379	205	0	829	403	498	348	729	293	883	164	149	653	469	147	187
ESP	633	405	886	658	85	727	755	876	847	62	841	541	546	391	385	0	426	476	393	733	297	918	180	166	765	392	166	246
ZAF	382	204	428	359	49	309	414	411	574	38	362	380	297	185	280	372	0	346	274	341	172	388	92	99	407	239	89	133
NZL	599	293	659	500	62	405	669	825	872	80	490	1030	352	249	264	361	275	0	567	506	231	567	139	113	511	258	112	186
IRL	321	286	539	439	53	403	658	586	472	52	395	441	276	262	205	358	222	447	0	371	167	451	106	94	379	160	91	139
CZE	575	306	1149	639	140	606	532	1064	997	73	721	427	681	251	303	474	216	326	229	0	412	1126	206	182	689	401	183	298
SVK	260	108	517	199	49	210	195	342	325	19	223	143	212	97	111	150	91	138	84	315	0	406	81	96	302	182	75	117
POL	793	467	1701	1038	186	837	859	1309	1524	95	997	607	718	381	446	629	283	412	331	857	271	0	289	250	912	479	213	396
LTU	89	39	409	137	32	47	94	132	179	17	121	68	101	31	46	75	35	60	43	125	37	209	0	73	177	112	45	121
LVA	110	79	207	129	63	87	102	150	207	20	152	78	99	56	66	93	58	55	52	118	47	186	50	0	190	99	44	115
PRT	882	409	1045	744	117	714	786	964	1216	68	868	545	644	394	399	726	362	412	317	548	205	909	108	143	0	411	147	283
KOR	501	149	348	280	46	245	303	273	813	31	408	261	325	109	282	277	179	182	101	277	110	396	52	59	346	0	85	114
SVN	119	94	248	179	49	123	134	185	150	31	176	113	110	95	86	125	63	78	66	135	43	191	19	27	116	50	0	88
HRV	121	118	567	265	76	148	203	347	237	42	258	154	172	133	89	193	89	109	95	216	60	348	80	90	228	51	71	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									
CAN	0	471	1149	579	120	645	665	607	1372	60	861	592	522	293	657	695	226	305
219	565	213	770	137	112	545	373	124	174									
CHE	382	0	1043	558	140	501	558	744	866	54	585	522	401	380	425	496	250	345
309	458	211	583	104	137	467	219	125	178									
DEU	799	894	0	2344	364	1780	1649	2979	3318	147	2021	1514	1147	732	1392	1422	556	871
693	1637	679	2074	439	305	1146	529	263	551									
DFS	522	485	1321	0	233	1114	1145	1572	1687	124	1171	1057	762	482	845	871	466	701
567	993	342	1264	259	192	813	382	205	323									
EST	69	80	251	130	0	185	195	300	296	45	212	188	176	107	180	176	95	115
103	223	101	267	68	89	169	88	80	106									
FRA	446	430	787	547	88	0	1007	1314	1593	95	1193	879	731	495	850	858	364	558
474	925	308	1235	176	156	732	363	158	216									
GBR	623	529	1206	813	114	627	0	1339	1638	114	1154	1078	725	484	839	883	445	713
662	826	315	1060	203	160	808	393	176	272									
NLD	559	700	2474	1158	214	740	1083	0	2063	131	1256	1238	822	731	918	950	469	882
668	1205	474	1443	243	212	913	390	207	360									
USA	1350	769	2069	1070	192	710	1371	1610	0	148	1987	1625	1149	546	1772	1383	600	938
595	1406	494	1726	284	258	1170	713	200	318									
ISR	42	36	119	90	28	55	74	105	133	0	109	94	99	53	93	98	55	97
73	103	45	121	35	28	94	49	41	56									
ITA	608	519	1164	790	120	585	839	906	1245	72	0	923	857	457	983	1051	422	571
438	1048	344	1262	220	198	860	481	197	297									
AUS	597	458	1034	665	89	585	885	1011	1516	61	644	0	632	471	796	774	445	1039
555	721	277	877	181	162	700	357	156	247									
HUN	489	325	885	574	107	474	640	647	1093	73	712	471	0	333	653	694	371	446
344	790	293	833	174	138	652	387	143	224									
BEL	276	353	666	400	64	450	435	765	431	32	384	383	263	0	333	419	232	325
294	372	179	457	94	99	418	178	121	166									
JPN	422	276	543	417	66	336	452	455	770	45	453	428	379	205	0	829	402	495
348	728	287	883	163	147	647	466	147	187									
ESP	412	405	886	611	85	633	731	797	847	62	717	541	546	391	385	0	426	475
393	732	292	918	178	165	763	392	166	246									
ZAF	207	204	428	343	49	264	397	384	574	38	327	380	297	185	280	372	0	345
274	341	169	386	91	98	406	237	89	132									
NZL	273	293	658	460	61	330	577	788	872	80	435	1030	352	249	264	361	275	0
566	505	226	566	139	111	507	255	112	186									
IRL	214	286	539	408	53	360	628	556	472	52	347	441	276	262	205	358	222	447
0	371	165	450	106	93	378	160	91	139									
CZE	392	306	1149	567	140	482	522	986	997	73	663	427	681	251	303	474	216	326
229	0	409	1125	205	182	685	398	183	298									
SVK	143	108	516	170	49	155	187	322	324	19	204	142	211	97	111	150	91	138
84	314	0	402	81	95	297	182	75	116									
POL	624	467	1701	911	186	729	842	1217	1524	95	891	607	718	381	446	629	283	412
331	857	271	0	288	250	909	479	213	396									
LTU	73	39	409	127	32	42	90	118	179	17	97	68	101	31	46	75	35	60
43	125	37	209	0	72	175	110	45	120									
LVA	70	79	207	115	63	77	95	130	207	20	125	78	99	56	66	93	58	54
52	118	47	186	50	0	188	99	44	115									
PRT	538	408	1045	685	117	623	753	899	1213	68	795	545	643	394	399	726	362	412
317	548	204	909	108	143	0	408	147	281									
KOR	348	149	348	255	46	211	292	253	813	31	387	261	325	109	282	277	179	182
101	277	110	396	52	59	346	0	85	114									
SVN	92	94	248	163	49	110	134	175	150	31	161	113	110	95	86	125	63	78
66	135	43	191	19	27	116	50	0	88									
HRV	103	118	567	237	76	133	200	316	237	42	203	154	172	133	89	193	89	109
95	216	60	348	80	90	228	51	71	0									

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL
CAN	0	74	135	31	358	218	129	155
DFS	58	0	131	85	148	118	120	112
GBR	137	118	0	70	202	178	145	181
NLD	24	83	64	0	70	60	63	61
USA	370	117	221	74	0	428	250	321
AUS	221	82	187	50	460	0	199	374
ZAF	124	97	147	58	261	191	0	176
NZL	165	84	186	52	391	417	184	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL
CAN	0	30	59	10	128	88	53	60
DFS	24	0	83	59	134	105	109	103
GBR	54	74	0	40	152	128	108	122
NLD	4	52	36	0	56	49	55	49
USA	119	95	160	61	0	428	250	321
AUS	78	67	128	45	460	0	199	373
ZAF	48	84	106	51	261	191	0	176
NZL	59	72	122	41	391	416	184	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	135	73	5	182	15	88	2	69	76	15	7	6	0
DFS	135	0	90	105	165	67	155	84	50	150	112	91	42	0
GBR	73	84	0	37	96	19	69	6	36	66	25	11	26	0
NOR	5	78	38	0	64	19	52	14	0	38	27	16	31	0
USA	168	160	90	66	0	27	107	14	58	102	35	14	33	21
DEU	14	57	18	19	27	0	40	25	2	20	39	29	14	0
AUS	88	128	65	43	107	39	0	23	31	118	43	27	23	10
EST	2	74	5	14	13	24	22	0	0	6	25	36	12	0
ZAF	71	47	32	0	52	2	31	0	0	32	5	1	3	0
NZL	74	147	62	37	102	19	120	5	28	0	27	13	15	10
LTU	14	95	23	22	28	35	39	24	5	23	0	38	15	0
LVA	7	59	11	14	11	23	25	28	1	10	32	0	9	0
NLD	6	42	24	30	32	14	21	11	3	15	13	8	0	0
CAM	0	0	0	0	21	0	10	0	0	10	0	0	0	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	64	22	3	66	8	28	0	35	28	11	4	3	0
DFS	64	0	58	107	155	67	173	84	45	147	111	92	39	0
GBR	22	55	0	34	61	16	44	4	22	44	18	9	18	0
NOR	3	79	35	0	63	19	52	14	0	38	27	16	27	0
USA	65	153	59	65	0	27	105	14	53	99	34	14	31	21
DEU	8	57	16	19	27	0	40	25	2	20	39	29	14	0
AUS	28	148	42	43	106	39	0	23	29	117	43	27	22	10
EST	0	74	4	14	13	24	22	0	0	6	25	36	11	0
ZAF	36	45	21	0	51	2	31	0	0	30	5	1	2	0
NZL	28	142	43	37	102	19	119	5	28	0	27	13	13	10
LTU	10	94	16	22	27	35	39	24	5	23	0	38	14	0
LVA	4	59	9	14	11	23	25	28	1	10	32	0	8	0
NLD	3	39	17	26	30	14	20	10	2	13	12	7	0	0
CAM	0	0	0	0	21	0	10	0	0	10	0	0	0	0

SIM

common bulls below diagonal
common three quarter sib group above diagonal

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV	USA
FRM	0	3	151	110	175	223	2	56	17	65	2	28
FRA	1	0	132	53	12	243	5	53	52	0	83	0
ITA	185	119	0	158	82	733	11	132	94	44	202	20
NLD	134	53	155	0	81	225	4	59	44	47	82	15
CHE	224	9	83	85	0	281	2	31	5	51	1	18
DEA	264	202	637	235	248	0	27	354	169	47	487	17
HUN	0	4	8	4	1	16	0	7	7	0	12	0
SVK	55	45	112	50	23	361	6	0	43	10	84	3
SVN	17	48	92	42	5	156	6	42	0	0	68	0
GBR	82	0	47	47	58	50	0	5	0	0	0	18
HRV	1	77	193	81	1	510	10	67	58	0	0	0
USA	43	0	27	18	19	24	0	3	0	25	0	0

SIM

common bulls below diagonal
common three quarter sib group above diagonal

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV	USA
FRM	0	2	150	95	168	210	2	56	17	24	2	28
FRA	1	0	86	29	8	159	3	39	34	0	58	0
ITA	184	75	0	135	82	733	11	132	94	18	202	20
NLD	115	28	133	0	74	186	4	53	35	17	70	15
CHE	217	5	83	76	0	281	2	31	5	20	1	18
DEA	252	122	637	196	248	0	27	354	169	18	487	17
HUN	0	2	8	4	1	16	0	7	7	0	12	0
SVK	55	31	112	44	23	361	6	0	43	4	84	3
SVN	17	29	92	35	5	156	6	42	0	0	68	0
GBR	29	0	20	18	23	22	0	4	0	0	0	16
HRV	1	51	193	70	1	510	10	67	58	0	0	0
USA	43	0	27	18	19	24	0	3	0	20	0	0