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, IRL, GBR
RDC : DFS, NLD, CAN, GBR
BSW : NLD, FRA, CHE, GBR
JER : DFS, NLD, CAN, GBR
SIM : NLD, CHE, GBR
GUE : No evaluation for MAS yet

Changes in national procedures

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

NOR (RDC)	Base changed to a rolling cow base, based on cows born 3 to 8 years ago. Std is based on bulls born 5 to 12 years ago, but the limits will be updated only every second year.
JPN (HOL)	Small changes in information due to additional records and pedigree changes
CHE (JER)	The change of herd-year-season assignment for certain data records is causing a very small change in EDC for certain bulls.
CHE (BSW)	Based on manual data edits and the removal of data errors, the number of herds and the number of daughters for very few bulls decreased. The change of herd-year-season assignment of certain data records might explain the very s
BEL (HOL)	Definition of genetic groups were updated/improved. Genetic groups are always based on selection path, type of breed, degree of Holsteinisation, origin (North-America vs Europe) and time. Periods of time were updated and improv
LTU (HOL)	Correction of base definition
SVN (ALL)	Small drop in information due to changes in data base related to the pedigree completness as well as phenotypic data improvement
ESP (HOL)	Drops in information for some bulls higher than usual due to updating the database used for extracting the data.
ITA (SIM)	Estimated new genetic parameters considering all the data set (and not only a sample like before), using the same repeatability model. Changed also the solver moving from blupf90 to mix99. Regarding the edc,
GBR (ALL)	Minor data updates

INTERBULL CHANGES COMPARED TO THE PREVIOUS 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 2019).
Number of records for milk somatic cells by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS		136	8152	1633	732	
BEL			2055			
CAN	235	101	12686	763	823	
CHE	2981		3454	86		3284
CZE			4002			
DEA	5640					22641
DEU			27985		441	
DFS			13276	2144	7861	
ESP			3956			
EST			1165		439	
FRA	393		17246			465
FRM						4369
GBR	126	291	6811	702	519	83
HUN			2886			173
IRL			2569			
ISR			1471			
ITA	1943		9907			1567
JPN			6187			
KOR			1318			
LTU			1181		435	
LVA			527		564	
NLD	198		15854	173	88	422
NOR					4177	
NZL	52	57	7967	4654	1335	
POL			10744			
PRT			2427			
SVK			1119			573
SVN	376		570			634
URY			1780			
USA	1084	705	38884	4659	685	64
ZAF			1195	587	124	
HRV			774			852
MEX						
CAM					40	
No.Records	13028	1290	208148	15401	18263	35127
Pub. Proofs	10568	1003	157216	12664	17434	31431

^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	6.16									
FRA	0.91	1.04								
NLD	0.89	0.92	3.81							

USA	0.90	0.91	0.88	0.21						
CHE	0.91	0.94	0.94	0.88	10.49					
DEA	0.92	0.96	0.92	0.88	0.97	11.94				
NZL	0.87	0.87	0.87	0.86	0.87	0.88	0.36			
ITA	0.89	0.90	0.89	0.89	0.95	0.91	0.87	16.56		
GBR	0.90	0.96	0.95	0.91	0.94	0.95	0.89	0.90	12.39	
SVN	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.89	0.89	10.43

BSW mas

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	6.15									
FRA	0.92	1.05								
NLD	0.89	0.88	3.82							
USA	0.88	0.88	0.88	0.21						
CHE	0.92	0.90	0.91	0.90	12.59					
DEA	0.93	0.88	0.89	0.88	0.91	11.94				
NZL	0.89	0.89	0.89	0.87	0.91	0.87	0.36			
ITA	0.89	0.88	0.89	0.88	0.89	0.91	0.87	16.56		
GBR	0.89	0.89	0.88	0.89	0.92	0.90	0.89	0.89	2.16	
SVN	0.89	0.89	0.89	0.89	0.90	0.89	0.88	0.89	0.90	10.44

GUE scs

	CAN	GBR	USA	AUS	NZL
CAN	5.96				
GBR	0.90	13.58			
USA	0.90	0.90	0.26		
AUS	0.87	0.92	0.86	0.27	
NZL	0.87	0.89	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	URY
CAN	5.74																												
CHE	0.89	11.12																											
DEU	0.93	0.94	12.68																										
DFS	0.93	0.93	0.96	11.85																									
EST	0.88	0.89	0.94	0.93	13.58																								
FRA	0.94	0.93	0.95	0.97	0.91	1.19																							
GBR	0.94	0.94	0.95	0.94	0.90	0.96	12.80																						
NLD	0.91	0.94	0.95	0.94	0.91	0.94	0.96	4.23																					
USA	0.94	0.88	0.89	0.88	0.90	0.90	0.90	0.88	0.21																				
ISR	0.85	0.85	0.85	0.84	0.87	0.85	0.84	0.84	0.88	0.24																			
ITA	0.90	0.89	0.94	0.93	0.94	0.93	0.90	0.89	0.89	0.85	5.82																		
AUS	0.86	0.91	0.88	0.88	0.86	0.90	0.93	0.91	0.86	0.84	0.86	0.29																	
HUN	0.88	0.90	0.92	0.90	0.91	0.91	0.89	0.88	0.91	0.88	0.93	0.86	1.43																
BEL	0.91	0.93	0.96	0.96	0.95	0.95	0.94	0.94	0.89	0.84	0.94	0.86	0.92	0.52															
JPN	0.88	0.88	0.88	0.88	0.88	0.90	0.88	0.88	0.88	0.84	0.88	0.86	0.88	0.88	0.42														
ESP	0.93	0.91	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	11.52													
ZAF	0.90	0.89	0.92	0.90	0.89	0.93	0.92	0.89	0.89	0.87	0.92	0.88	0.90	0.91	0.88	0.95	26.32												
NZL	0.86	0.86	0.86	0.86	0.86	0.86	0.89	0.86	0.86	0.83	0.85	0.96	0.86	0.86	0.86	0.86	0.86	0.40											
IRL	0.87	0.90	0.93	0.90	0.88	0.90	0.92	0.90	0.86	0.83	0.87	0.91	0.86	0.90	0.86	0.89	0.88	0.90	0.11										
CZE	0.88	0.88	0.90	0.88	0.88	0.89	0.88	0.88	0.88	0.84	0.90	0.86	0.89	0.89	0.88	0.91	0.88	0.86	0.86	16.85									
SVK	0.88	0.89	0.91	0.89	0.88	0.90	0.88	0.88	0.88	0.85	0.90	0.86	0.96	0.91	0.88	0.91	0.88	0.86	0.86	0.88	0.42								
POL	0.90	0.92	0.96	0.95	0.94	0.93	0.91	0.91	0.88	0.85	0.94	0.86	0.94	0.96	0.88	0.95	0.90	0.86	0.88	0.90	0.91	10.05							
LTU	0.88	0.89	0.90	0.88	0.92	0.88	0.88	0.88	0.88	0.86	0.88	0.86	0.88	0.93	0.88	0.90	0.88	0.86	0.86	0.88	0.89	0.90	0.36						
LVA	0.88	0.90	0.94	0.93	0.94	0.90	0.90	0.90	0.88	0.83	0.92	0.87	0.88	0.94	0.88	0.89	0.88	0.86	0.88	0.88	0.88	0.93	0.93	0.48					
PRT	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.85	0.88	0.86	0.88	0.88	0.88	0.88	0.88	0.86	0.86	0.88	0.88	0.88	0.88	0.88	0.46				
KOR	0.88	0.88	0.88	0.90	0.88	0.88	0.88	0.88	0.88	0.84	0.89	0.86	0.88	0.90	0.88	0.91	0.88	0.86	0.86	0.88	0.88	0.92	0.88	0.90	0.88	0.34			
SVN	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	0.89	0.88	0.88	0.88	0.86	0.87	0.88	0.88	0.88	0.89	0.88	0.88	10.64			
HRV	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	0.86	0.86	0.88	0.88	0.88	0.88	0.88	0.88	0.88	11.73		
URY	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.85	0.88	0.86	0.88	0.88	0.88	0.88	0.88	0.86	0.86	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	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	7.58																												
CHE	0.92	12.03																											
DEU	0.91	0.94	12.68																										
DFS	0.94	0.91	0.91	12.57																									
EST	0.87	0.91	0.90	0.87	13.57																								
FRA	0.96	0.93	0.91	0.94	0.86	1.20																							
GBR	0.88	0.91	0.88	0.88	0.88	0.88	2.50																						
NLD	0.88	0.93	0.91	0.88	0.91	0.88	0.88	4.80																					
USA	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	2.25																				
ISR	0.83	0.84	0.85	0.83	0.86	0.83	0.84	0.83	0.84	0.24																			
ITA	0.88	0.90	0.89	0.88	0.88	0.88	0.88	0.88	0.88	0.84	5.99																		
AUS	0.89	0.89	0.89	0.89	0.86	0.89	0.89	0.89	0.89	0.83	0.87	0.29																	
HUN	0.87	0.91	0.90	0.88	0.90	0.87	0.88	0.91	0.88	0.87	0.90	0.86	1.43																
BEL	0.87	0.94	0.92	0.88	0.94	0.88	0.88	0.94	0.88	0.83	0.89	0.88	0.93	0.52															
JPN	0.87	0.88	0.88	0.87	0.87	0.87	0.88	0.87	0.88	0.83	0.88	0.86	0.88	0.88	0.42														
ESP	0.87	0.94	0.92	0.88	0.93	0.88	0.88	0.92	0.88	0.88	0.89	0.86	0.93	0.96	0.88	11.52													
ZAF	0.87	0.90	0.90	0.87	0.88	0.87	0.88	0.89	0.88	0.87	0.88	0.89	0.91	0.92	0.88	0.95	26.06												
NZL	0.87	0.88	0.88	0.88	0.85	0.87	0.89	0.88	0.89	0.82	0.86	0.96	0.85	0.86	0.86	0.86	0.86	0.40											
IRL	0.88	0.90	0.93	0.88	0.89	0.88	0.89	0.89	0.89	0.84	0.87	0.92	0.87	0.91	0.87	0.90	0.89	0.91	0.11										
CZE	0.87	0.89	0.89	0.87	0.88	0.87	0.88	0.88	0.88	0.83	0.88	0.86	0.90	0.90	0.88	0.92	0.89	0.85	0.87	16.77									
SVK	0.87	0.89	0.90	0.87	0.89	0.87	0.88	0.89	0.88	0.86	0.89	0.86	0.96	0.91	0.87	0.90	0.89	0.85	0.87	0.88	0.41								
POL	0.88	0.93	0.92	0.88	0.93	0.88	0.88	0.92	0.88	0.85	0.89	0.86	0.95	0.96	0.88	0.95	0.90	0.86	0.89	0.90	0.91	10.05							
LTU	0.88	0.90	0.89	0.88	0.91	0.88	0.88	0.88	0.88	0.85	0.88	0.86	0.89	0.92	0.88	0.89	0.88	0.86	0.88	0.88	0.90	0.90	0.35						
LVA	0.87	0.89	0.91	0.87	0.94	0.87	0.88	0.89	0.88	0.83	0.88	0.87	0.88	0.94	0.88	0.88	0.87	0.85	0.89	0.88	0.88	0.93	0.93	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	0.86	0.87	0.88	0.88	0.88	0.88	0.88	0.45				
KOR	0.87	0.90	0.88	0.87	0.87	0.87	0.88	0.87	0.88	0.83	0.88	0.86	0.88	0.90	0.88	0.91	0.88	0.85	0.87	0.88	0.87	0.92	0.88	0.90	0.88	0.34			
SVN	0.87	0.88	0.88	0.87	0.87	0.87	0.88	0.87	0.88	0.83	0.88	0.86	0.87	0.89	0.87	0.87	0.87	0.85	0.88	0.87	0.87	0.88	0.88	0.89	0.88	0.87	10.63		
HRV	0.87	0.87	0.88	0.87	0.87	0.87	0.88	0.88	0.88	0.83	0.88	0.86	0.88	0.88	0.87	0.88	0.87	0.85	0.87	0.88	0.87	0.88	0.88	0.89	0.88	0.87	0.87	11.74	
URY	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.85	0.88	0.86	0.88	0.88	0.88	0.88	0.88	0.86	0.87	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.20

JER scs

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE
CAN	6.15								
DFS	0.90	12.37							
GBR	0.91	0.91	11.27						
NLD	0.90	0.95	0.95	3.74					
USA	0.89	0.88	0.89	0.88	0.19				
AUS	0.88	0.89	0.90	0.91	0.86	0.27			
ZAF	0.88	0.89	0.89	0.90	0.88	0.87	21.31		
NZL	0.88	0.88	0.89	0.88	0.86	0.95	0.86	0.38	
CHE	0.89	0.91	0.91	0.93	0.88	0.89	0.89	0.87	12.09

JER mas

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE
CAN	7.62								
DFS	0.94	12.28							
GBR	0.88	0.89	1.89						
NLD	0.88	0.88	0.88	3.96					
USA	0.88	0.88	0.88	0.89	0.19				
AUS	0.89	0.89	0.89	0.89	0.86	0.27			
ZAF	0.88	0.88	0.88	0.89	0.88	0.89	21.32		
NZL	0.89	0.89	0.89	0.89	0.86	0.95	0.86	0.38	
CHE	0.90	0.89	0.89	0.90	0.89	0.87	0.89	0.87	12.09

RDC scs

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	5.62													
DFS	0.94	12.86												
GBR	0.93	0.92	11.35											
NOR	0.92	0.91	0.89	14.07										
USA	0.92	0.88	0.89	0.89	0.23									
DEU	0.93	0.96	0.95	0.90	0.89	13.58								
AUS	0.88	0.91	0.92	0.92	0.86	0.90	0.30							
EST	0.89	0.93	0.91	0.90	0.91	0.95	0.90	12.23						
ZAF	0.89	0.89	0.90	0.93	0.89	0.92	0.88	0.90	25.22					
NZL	0.88	0.88	0.89	0.90	0.86	0.87	0.95	0.88	0.87	0.41				
LTU	0.90	0.90	0.89	0.90	0.89	0.90	0.87	0.91	0.91	0.87	0.34			
LVA	0.90	0.89	0.90	0.90	0.89	0.93	0.89	0.96	0.89	0.89	0.91	0.43		
NLD	0.91	0.95	0.95	0.89	0.88	0.95	0.92	0.92	0.89	0.87	0.89	0.90	3.89	
CAM	0.94	0.94	0.94	0.93	0.90	0.94	0.93	0.94	0.93	0.91	0.93	0.93	0.94	5.66

RDC mas

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	7.68													
DFS	0.91	13.79												
GBR	0.89	0.89	2.13											
NOR	0.92	0.88	0.89	14.07										
USA	0.88	0.88	0.88	0.89	0.23									
DEU	0.89	0.88	0.89	0.91	0.89	13.58								
AUS	0.90	0.89	0.89	0.92	0.87	0.90	0.30							
EST	0.88	0.87	0.89	0.90	0.90	0.93	0.87	12.23						
ZAF	0.89	0.89	0.89	0.93	0.89	0.91	0.88	0.90	25.35					
NZL	0.89	0.88	0.90	0.89	0.86	0.87	0.95	0.88	0.87	0.41				
LTU	0.89	0.87	0.89	0.90	0.89	0.89	0.87	0.92	0.90	0.87	0.34			
LVA	0.88	0.87	0.90	0.90	0.89	0.93	0.89	0.96	0.89	0.88	0.92	0.43		
NLD	0.88	0.88	0.88	0.89	0.89	0.92	0.90	0.91	0.90	0.89	0.89	0.90	4.34	
CAM	0.93	0.93	0.93	0.93	0.90	0.94	0.93	0.94	0.93	0.92	0.93	0.94	0.94	6.14

SIM scs

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV	USA
FRM	1.10											
FRA	0.93	1.01										
ITA	0.93	0.90	14.01									
NLD	0.91	0.93	0.88	4.00								
CHE	0.93	0.93	0.90	0.93	10.59							
DEA	0.92	0.93	0.88	0.90	0.89	12.21						
HUN	0.93	0.91	0.93	0.88	0.90	0.94	16.23					
SVK	0.89	0.89	0.89	0.91	0.90	0.88	0.94	0.38				
SVN	0.90	0.89	0.88	0.89	0.90	0.88	0.90	0.89	8.92			
GBR	0.91	0.96	0.90	0.95	0.91	0.93	0.89	0.89	0.88	11.60		
HRV	0.93	0.88	0.88	0.88	0.89	0.88	0.89	0.89	0.89	0.88	9.87	
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	14.01									
NLD	0.88	0.88	0.88	3.84								
CHE	0.93	0.93	0.91	0.93	11.59							
DEA	0.91	0.92	0.88	0.88	0.89	12.21						
HUN	0.93	0.88	0.91	0.91	0.92	0.94	16.23					
SVK	0.89	0.89	0.89	0.89	0.92	0.88	0.94	0.38				
SVN	0.90	0.89	0.88	0.89	0.90	0.88	0.90	0.89	8.92			
GBR	0.90	0.88	0.88	0.89	0.92	0.90	0.88	0.89	0.89	2.59		

HRV 0.92 0.88 0.88 0.88 0.90 0.88 0.89 0.89 0.89 0.88 9.87
USA 0.89 0.88 0.89 0.89 0.89 0.90 0.90 0.89 0.89 0.89 0.89 0.22

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^LAPPENDIX II. Number of common bulls

BSW

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common bulls below diagonal
common three quarter sib group above diagonal

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	83	51	165	130	137	23	121	60	34
FRA	72	0	83	120	160	211	21	186	53	56
NLD	48	68	0	79	94	149	24	127	41	44
USA	156	80	70	0	314	312	28	221	82	42
CHE	106	116	87	293	0	574	24	443	68	79
DEA	116	156	143	277	474	0	33	627	69	104
NZL	21	17	17	25	19	28	0	27	17	10
ITA	104	145	107	156	387	525	20	0	71	98
GBR	54	42	30	73	50	46	15	48	0	23
SVN	30	55	45	34	75	97	9	97	17	0

BSW

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common bulls below diagonal
common three quarter sib group above diagonal

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	77	49	165	37	137	23	121	28	34
FRA	68	0	69	105	42	196	18	174	26	56
NLD	44	58	0	71	24	133	24	115	19	40
USA	156	72	61	0	37	311	28	219	36	42
CHE	32	34	23	27	0	111	6	95	9	35
DEA	116	148	125	277	107	0	33	621	32	104
NZL	21	15	17	25	6	28	0	27	10	10
ITA	104	140	95	156	89	523	20	0	34	98
GBR	26	21	15	33	5	23	8	25	0	12
SVN	30	55	41	34	34	97	9	97	10	0

GUE

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common bulls below diagonal
common three quarter sib group above diagonal

	CAN	GBR	USA	AUS	NZL
CAN	0	30	71	45	14
GBR	25	0	87	36	13
USA	62	89	0	63	29
AUS	44	31	59	0	26
NZL	11	11	29	26	0

GUE

HOL

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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	868	2457	1396	247	1453	1537	1498	3317	122	1712	1384	1011	795	1333	1282	502	730	468	1042	425	1357	285	207	1019	644	204	294	753
CHE	728	0	1163	701	160	663	670	884	985	58	717	599	432	590	463	557	266	392	341	492	229	663	166	138	498	246	139	200	312
DEU	1727	1013	0	2760	412	2559	2049	3548	3662	155	2588	1684	1244	1262	1487	1549	578	974	755	1752	728	2432	612	306	1236	593	305	604	783
DFS	1167	619	1815	0	280	1608	1483	2045	2014	140	1599	1250	882	847	952	1006	497	809	637	1161	406	1556	353	206	919	452	246	388	630
EST	144	88	291	166	0	249	237	347	332	46	270	207	192	188	201	197	105	133	111	243	112	307	108	87	191	106	93	120	133
FRA	954	576	1308	821	114	0	1481	1953	2453	123	1714	1243	924	921	1195	1135	469	783	619	1156	419	1618	279	186	918	481	202	285	592

GBR	1742	611	1492	1099	133	897	0	1662	2069	132	1513	1329	836	837	1006	1036	503	873	786	948	366	1267	289	180	922	458	205	320	648
NLD	1414	858	3255	1764	250	1186	1420	0	2459	150	1741	1433	955	1264	1050	1101	509	1010	751	1388	535	1796	380	227	1041	443	256	425	660
USA	3630	872	2444	1473	216	1272	1789	2120	0	174	2613	1837	1281	950	1924	1530	629	1045	661	1530	531	2012	390	260	1282	797	238	367	1077
ISR	89	36	126	108	28	64	88	119	160	0	138	103	106	82	98	107	63	105	85	112	47	135	53	28	99	55	46	65	89
ITA	1351	635	1677	1169	150	893	1128	1429	1741	99	0	1197	1021	821	1180	1269	483	746	551	1216	395	1593	326	223	1006	563	235	375	679
AUS	1369	524	1207	876	101	816	1124	1242	1790	66	859	0	713	744	885	876	476	1178	614	790	306	1003	242	167	776	409	174	286	649
HUN	939	346	975	697	117	617	730	799	1233	77	863	531	0	542	709	763	391	493	371	858	309	940	216	140	703	426	158	251	506
BEL	786	600	1310	785	117	901	824	1460	836	54	791	645	464	0	547	666	332	505	438	603	293	799	200	143	650	273	175	261	346
JPN	690	304	620	519	71	428	524	560	879	46	547	493	409	353	0	899	421	555	381	783	313	978	207	149	703	518	164	216	569
ESP	816	446	990	746	93	814	826	985	976	64	939	620	607	653	427	0	443	533	427	796	313	1033	224	167	821	444	187	276	514
ZAF	456	215	446	379	53	327	436	429	610	42	382	411	313	280	294	390	0	360	286	361	181	410	111	99	427	255	98	149	319
NZL	735	329	751	562	67	458	740	923	983	87	543	1178	380	408	301	407	291	0	617	557	250	639	173	114	557	295	128	212	500
IRL	410	317	595	484	55	438	732	651	542	60	433	498	301	413	229	388	232	493	0	408	183	508	140	94	403	177	104	159	314
CZE	736	328	1285	735	151	669	611	1202	1140	81	820	493	754	452	348	517	230	376	259	0	438	1261	297	182	738	438	206	342	517
SVK	298	117	548	210	52	221	209	369	349	20	238	153	219	179	116	156	96	151	90	340	0	446	130	96	319	198	81	139	235
POL	1124	539	2141	1237	218	1010	1043	1644	1871	106	1198	737	833	732	521	713	304	481	382	1014	307	0	419	251	1000	536	250	444	629
LTU	153	72	576	203	55	95	144	230	260	26	174	105	133	100	68	93	44	76	64	200	66	326	0	98	228	136	73	162	165
LVA	131	78	206	126	62	86	103	149	208	20	152	79	100	91	66	95	58	55	52	118	47	186	71	0	190	99	43	115	119
PRT	1063	438	1139	814	135	775	853	1046	1338	74	943	615	698	654	437	787	383	456	340	598	221	1001	148	143	0	443	163	309	539
KOR	611	172	390	315	52	277	334	309	896	33	456	298	350	202	315	310	190	213	115	304	119	449	57	59	375	0	94	135	368
SVN	148	100	293	202	55	140	151	221	181	36	196	122	122	145	94	141	70	91	78	149	47	224	40	26	130	58	0	106	107
HRV	170	127	617	296	87	168	225	382	275	45	283	174	186	214	102	209	98	124	105	240	69	391	111	90	247	58	82	0	181
URY	738	237	569	449	83	350	540	536	1350	47	496	510	416	281	329	410	280	402	241	354	145	531	97	80	481	288	60	111	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	101	1332	685	147	759	785	793	917	73	1042	748	619	492	764	804	245	370	263	645	230	911	180	108	605	428	148	204	418
CHE	90	0	143	95	28	91	98	123	95	9	102	98	54	95	75	80	37	72	56	72	29	105	26	9	73	53	36	33	46
DEU	1033	128	0	2484	408	1925	1798	3431	1227	153	2222	1671	1219	1240	1477	1539	567	959	754	1743	705	2398	591	298	1201	559	304	600	681
DFS	656	85	1505	0	253	1200	1216	1757	759	129	1263	1143	818	758	897	949	481	745	607	1060	354	1409	329	188	855	408	230	366	519
EST	90	11	291	149	0	208	216	339	173	45	247	202	187	183	196	193	102	129	109	240	106	303	103	84	184	101	93	119	121
FRA	545	83	919	626	103	0	1092	1470	721	103	1298	972	791	764	920	964	379	610	514	1006	327	1395	233	153	789	392	180	253	423
GBR	779	87	1381	909	127	696	0	1508	838	131	1280	1194	790	778	910	970	461	788	726	899	330	1189	262	155	856	419	197	304	545
NLD	786	114	3118	1387	246	911	1300	0	903	147	1481	1412	932	1234	1037	1085	499	996	747	1365	509	1742	361	219	1017	423	249	419	580
USA	1042	85	1196	735	125	546	908	920	0	111	1075	776	709	480	813	708	338	447	330	728	237	995	201	151	687	497	160	198	561
ISR	50	2	126	94	28	57	87	118	104	0	124	102	103	82	96	107	61	104	85	112	46	134	49	28	99	54	46	64	80
ITA	810	93	1409	937	141	689	990	1206	1050	82	0	1040	942	728	1071	1156	421	624	479	1121	353	1450	289	199	915	518	222	333	563
AUS	787	92	1205	759	101	663	1021	1221	831	66	785	0	704	731	883	874	465	1171	613	784	295	991	229	161	761	389	174	284	577
HUN	577	40	973	641	117	532	700	781	745	75	809	529	0	535	701	758	380	486	370	850	299	927	205	136	691	409	158	248	446
BEL	507	87	1301	686	117	731	785	1431	458	54	725	643	464	0	540	660	329	496	437	598	284	787	192	139	640	264	175	260	325
JPN	501	61	620	467	71	371	508	552	657	46	523	493	409	353	0	899	417	548	381	779	299	967	195	144	683	493	164	216	492
ESP	506	70	989	684	93	708	799	959	568	64	825	620	607	653	427	0	439	530	427	794	302	1025	216	164	814	432	187	275	455
ZAF	228	31	446	362	53	283	419	423	372	42	343	408	311	280	294	390	0	358	284	356	175	403	107	96	418	241	98	146	294
NZL	332	64	747	499	66	375	642	912	418	87	487	1171	379	407	301	407	290	0	616	549	244	632	163	109	549	284	128	210	450
IRL	261	53	595	440	55	393	697	647	321	60	393	497	301	413	229	388	232	493	0	407	180	506	137	92	400	171	103	158	291
CZE	480	53	1283	641	151	543	592	1180	665	81	762	492	747	452	348	517	228	372	259	0	428	1245	283	177	725	416	206	337	452
SVK	160	9	543	178	52	171	199	357	158	20	219	150	217	178	116	156	95	149	90	337	0	430	120	92	307	185	80	136	212
POL	808	84	2128	1074	218	876	1004	1588	1111	106	1115	737	828	731	521	713	303	478	382	1006	302	0	407	245	979	510	250	439	562
LTU	108	9	572	186	55	83	138	221	144	26	153	104	132	100	68	93	44	75	64	197	64	321	0	94	215	120	73	156	146
LVA	72	4	204	114	62	76	96	146	124	20	128	79	99	91	66	95	58	54	52	118	47	183	71	0	185	95	43	112	106
PRT	613	68	1134	748	135	684	817	1032	748	74	878	614	693	653	437	787	381	455	340	597	218	987	145	142	0	425	162	305	488
KOR	409	43	390	286	52	244	322	303	544	33	436	292	346	202	315	310	188	209	115	300	115	437	53	59	373	0	94	129	323
SVN	109	27	292	183	55	127	149	215	126	36	185	122	122	145	94	141	70	91	78	149	47	224	40	26	130	58	0	106	101
HRV	118	14	616	266	87	155	222	373	144	45	232	174	185	214	102	209	98	123	105	238	69	388	111	89	247	57	82	0	171
URY	418	31	562	393	83	284	506	520	623	46	468	507	404	280	329	410	276	399	241	345	143	516	96	76	472	278	60	110	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE

CAN	0	77	149	36	424	252	150	172	36
DFS	62	0	139	105	152	123	126	119	53
GBR	151	126	0	76	222	205	158	201	67
NLD	32	103	69	0	82	67	69	71	38
USA	443	122	242	88	0	473	277	351	63
AUS	259	87	210	59	514	0	220	425	51
ZAF	145	102	157	65	292	211	0	194	54
NZL	179	91	204	64	421	465	201	0	49
CHE	29	48	64	32	63	42	47	40	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE
CAN	0	32	65	15	154	109	65	75	22
DFS	26	0	89	83	138	109	114	108	52
GBR	62	81	0	53	163	145	117	137	62
NLD	9	76	48	0	76	66	68	66	36
USA	144	98	174	82	0	473	277	351	63
AUS	99	71	144	58	514	0	220	424	51
ZAF	58	88	116	63	292	211	0	194	54
NZL	69	77	138	58	421	464	201	0	49
CHE	18	47	56	30	63	42	47	40	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	156	76	6	197	15	100	2	70	83	17	7	7	0
DFS	159	0	95	126	178	73	176	99	51	159	103	91	53	0
GBR	76	88	0	49	102	19	80	7	38	76	26	11	34	0
NOR	6	99	51	0	69	20	64	19	0	39	25	17	43	0
USA	182	173	97	70	0	28	124	17	59	112	34	14	39	22
DEU	14	62	18	19	27	0	43	27	2	22	38	30	19	0
AUS	99	150	75	54	125	42	0	28	34	137	43	28	30	11
EST	2	88	6	19	16	26	26	0	0	7	25	36	16	0
ZAF	72	48	34	0	53	2	33	0	0	33	5	1	4	0
NZL	80	156	71	39	112	22	136	6	29	0	26	13	19	11
LTU	16	98	24	22	29	35	42	25	5	24	0	36	16	0
LVA	7	59	11	15	10	24	25	28	1	10	32	0	9	0
NLD	7	52	33	43	37	19	28	15	4	19	14	8	0	0
CAM	0	0	0	0	22	0	11	0	0	11	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	71	27	3	72	8	33	0	35	32	13	4	3	0
DFS	70	0	70	127	167	73	195	99	46	157	102	92	50	0
GBR	26	65	0	45	73	17	51	5	25	54	21	9	24	0
NOR	3	99	47	0	69	20	64	19	0	39	25	17	36	0
USA	71	162	72	70	0	28	122	17	54	109	34	14	35	22
DEU	8	62	17	19	27	0	43	27	2	22	38	30	18	0
AUS	32	170	49	54	124	42	0	28	31	136	43	28	27	12
EST	0	88	5	19	16	26	26	0	0	7	25	36	15	0
ZAF	36	46	24	0	52	2	33	0	0	31	5	1	3	0
NZL	31	152	52	39	112	22	135	6	29	0	26	13	17	12
LTU	12	97	19	22	29	35	42	25	5	24	0	36	15	0
LVA	4	59	9	15	10	24	25	28	1	10	32	0	8	0
NLD	3	48	24	36	34	18	25	14	3	17	13	7	0	0

CAM	0	0	0	0	22	0	12	0	0	12	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	163	118	196	236	2	60	17	65	2	47
FRA	1	0	145	69	12	262	5	55	55	0	92	1
ITA	196	131	0	206	90	852	15	140	115	44	236	24
NLD	144	67	201	0	86	309	7	64	55	48	107	19
CHE	248	9	93	91	0	310	2	31	5	51	2	22
DEA	270	221	757	322	273	0	32	376	191	47	548	24
HUN	0	4	12	7	1	21	0	9	9	0	16	0
SVK	57	45	119	55	26	382	8	0	46	11	94	6
SVN	17	52	110	53	5	177	8	45	0	0	78	0
GBR	82	0	48	48	58	50	0	6	0	0	0	19
HRV	1	83	222	102	2	572	14	74	65	0	0	2
USA	62	1	30	21	21	27	0	5	0	26	2	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	157	104	3	212	2	57	17	24	2	34
FRA	1	0	85	31	1	159	3	39	34	0	58	1
ITA	191	75	0	191	3	852	15	140	115	18	236	24
NLD	126	30	186	0	3	276	7	63	49	17	99	19
CHE	3	1	3	3	0	36	0	0	0	0	0	1
DEA	257	122	757	288	31	0	32	376	191	18	548	24
HUN	0	2	12	7	0	21	0	9	9	0	16	0
SVK	57	31	119	54	0	382	8	0	46	5	94	6
SVN	17	29	110	47	0	177	8	45	0	0	78	0
GBR	32	0	22	20	0	24	0	5	0	0	0	16
HRV	1	51	222	95	0	572	14	74	65	0	0	2
USA	49	1	30	21	1	27	0	5	0	21	2	0