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
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 udder health traits are as follows:

AUS (HOL,JER,RDC)	Data editing causing some decrease in daughters and EDC
NOR (RDC)	Delivered RBV's for all traits. The scaling is according to a rolling base that change somewhat at each evaluation. Therefore percentage changes in sire standard deviations between evaluations may solely be due to changes in the standard deviation in the rolling base.
JPN (HOL)	Some changes in proofs caused by additional records and in EDCs caused by modification of pedigree.
DFS (ALL)	Changes in number of information mainly caused by the fact that each single observation is checked with informations coming from calvings. If there is a conflict the observation is dropped.
NZL (ALL)	Drops in information due to continuous DNA parenting testing
SVN (ALL)	Base change
DEA (SIM)	After inclusion of the Slovakian Fleckvieh population to the joined evaluation, inconsistencies in parts of the historical Slovakian data (mid 90's) have been detected. Therefore some Slovakian herds with production data in the years 1995 to 1997 were excluded from evaluation. This causes an decrease in number of daughters, herds and edc statistics for bulls with affected daughters.
EST (HOL,RDC)	Decrease in number of daughters/EDC-s of some bulls due to deletion of incorrect first lactation information of some cows.
ESP (HOL)	Base change
CZE (HOL)	Made changes in herd book related to bulls category. No foreign information for BVs are used therefore all previous ToP "21" appear now as 11 or 12 as all information comes from domestic daughters.

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.

The window so far applied for MAS evaluation have been found too high compared to the
within-country genetic correlation between mastitis and SCS available from the literature.
It has been an ITC recommendation to adjust the windows for MAS in this test run to make them more in line with the
values available from the literature. The recommendation has been approved by the Steering committee.
Also, according to the decision taken by ITC in Orlando (2015) to review all windows every five (5) years, an overall
review of the windows for all traits will take place during the first half of 2020 with the aim of implementation set for the September 2020 test run.

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

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 (August Routine Evaluation 2020).
Number of records for milk somatic cells by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS		139	8368	1671	761	
BEL			2098			
CAN	245	101	12915	791	836	
CHE	3028		3528	89		3347
CZE			4386			
DEA	5730					23005
DEU			22419		270	
DFS			13577	2236	7951	
ESP			4066			
EST			1196		450	
FRA	404		17415			471
FRM						4455
GBR	134	292	6965	714	527	83
HUN			2991			181
IRL			2698			
ISR			1524			
ITA	1983		9779			1635
JPN			6384			
KOR			1399			
LTU			1210		435	
LVA			527		564	

NLD	201		16121	189	91	439
NOR					4203	
NZL	55	57	7992	4669	1340	
POL			10875			
PRT			2433			
SVK			1123			584
SVN	386		595			659
URY			1810			
USA	1103	711	39567	4766	699	70
ZAF			1195	587	124	
HRV			771			852
MEX						
CAM					43	
No.Records	13269	1300	205927	15712	18294	35781
Pub. Proofs	10755	1012	153620	12836	17575	31950

^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	6.15									
FRA	0.92	1.03								
NLD	0.90	0.92	4.02							
USA	0.91	0.91	0.88	0.21						
CHE	0.91	0.94	0.94	0.88	10.40					
DEA	0.92	0.96	0.92	0.88	0.97	11.92				
NZL	0.87	0.87	0.86	0.86	0.87	0.88	0.31			
ITA	0.89	0.90	0.89	0.89	0.95	0.91	0.87	16.33		
GBR	0.91	0.96	0.95	0.91	0.94	0.95	0.86	0.90	12.28	
SVN	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.89	0.89	10.33

BSW mas

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	6.14									
FRA	0.90	1.05								
NLD	0.85	0.86	4.03							
USA	0.86	0.84	0.84	0.21						
CHE	0.92	0.89	0.88	0.86	13.53					
DEA	0.93	0.84	0.88	0.86	0.91	11.92				
NZL	0.70	0.67	0.76	0.70	0.74	0.75	0.31			
ITA	0.88	0.85	0.85	0.85	0.89	0.92	0.71	16.32		
GBR	0.88	0.88	0.85	0.84	0.91	0.87	0.66	0.86	2.15	
SVN	0.87	0.86	0.84	0.85	0.86	0.87	0.77	0.87	0.87	10.34

GUE scs

	CAN	GBR	USA	AUS	NZL
CAN	6.09				
GBR	0.91	13.60			
USA	0.92	0.90	0.25		
AUS	0.87	0.92	0.86	0.23	
NZL	0.87	0.86	0.86	0.91	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	10.93																											
DEU	0.93	0.94	12.87																										
DFS	0.93	0.93	0.96	11.84																									
EST	0.88	0.89	0.94	0.93	13.45																								
FRA	0.94	0.94	0.96	0.97	0.91	1.19																							
GBR	0.94	0.94	0.95	0.94	0.90	0.96	12.78																						
NLD	0.91	0.94	0.96	0.94	0.91	0.93	0.96	4.59																					
USA	0.94	0.88	0.89	0.88	0.91	0.90	0.90	0.88	0.20																				
ISR	0.85	0.86	0.86	0.84	0.87	0.85	0.84	0.84	0.88	0.24																			
ITA	0.90	0.89	0.95	0.93	0.94	0.93	0.90	0.89	0.89	0.85	5.81																		
AUS	0.86	0.87	0.86	0.86	0.86	0.86	0.89	0.87	0.86	0.76	0.86	0.25																	
HUN	0.88	0.90	0.92	0.90	0.91	0.91	0.89	0.88	0.91	0.89	0.93	0.86	1.43																
BEL	0.91	0.93	0.96	0.96	0.96	0.95	0.94	0.93	0.89	0.85	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	0.96	0.94	0.94	0.96	0.93	0.91	0.91	0.89	0.95	0.86	0.93	0.96	0.88	11.55													
ZAF	0.90	0.89	0.92	0.90	0.89	0.93	0.92	0.88	0.89	0.87	0.92	0.86	0.90	0.91	0.88	0.95	26.30												
NZL	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.76	0.86	0.91	0.86	0.86	0.86	0.86	0.86	0.37											
IRL	0.87	0.88	0.90	0.88	0.88	0.88	0.90	0.88	0.86	0.81	0.87	0.91	0.86	0.88	0.86	0.88	0.88	0.90	0.11										
CZE	0.88	0.88	0.90	0.89	0.88	0.89	0.88	0.88	0.88	0.84	0.90	0.86	0.89	0.90	0.88	0.91	0.88	0.86	0.86	16.35									
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	0.86	0.94	0.86	0.94	0.96	0.88	0.95	0.90	0.86	0.87	0.90	0.91	10.80							
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	0.92	0.88	0.89	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	0.86	0.89	0.94	0.88	0.89	0.88	0.86	0.87	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	0.89	0.88	0.88	0.88	0.88	0.84	0.89	0.86	0.88	0.89	0.88	0.90	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	0.85	0.88	0.86	0.88	0.89	0.88	0.88	0.88	0.86	0.87	0.88	0.88	0.88	0.88	0.89	0.88	0.88	10.52		
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	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	7.60																												
CHE	0.90	12.49																											
DEU	0.93	0.89	10.09																										
DFS	0.94	0.89	0.92	12.45																									
EST	0.85	0.83	0.85	0.86	13.45																								
FRA	0.96	0.91	0.92	0.94	0.84	1.19																							
GBR	0.88	0.89	0.85	0.87	0.84	0.88	2.47																						
NLD	0.86	0.90	0.86	0.87	0.90	0.87	0.85	5.16																					
USA	0.84	0.80	0.85	0.81	0.76	0.86	0.80	0.80	2.16																				
ISR	0.79	0.75	0.77	0.80	0.81	0.79	0.79	0.81	0.71	0.24																			
ITA	0.86	0.87	0.85	0.86	0.86	0.86	0.86	0.87	0.80	0.81	6.03																		
AUS	0.81	0.80	0.80	0.80	0.71	0.80	0.80	0.80	0.81	0.69	0.80	0.13																	
HUN	0.86	0.85	0.84	0.86	0.89	0.86	0.86	0.90	0.73	0.86	0.90	0.73	1.43																
BEL	0.87	0.91	0.88	0.87	0.92	0.87	0.87	0.93	0.74	0.81	0.88	0.76	0.93	0.52															
JPN	0.83	0.84	0.80	0.83	0.83	0.83	0.84	0.84	0.73	0.80	0.86	0.73	0.86	0.87	0.42														
ESP	0.87	0.91	0.86	0.87	0.92	0.88	0.87	0.92	0.73	0.86	0.88	0.74	0.93	0.96	0.87	11.54													
ZAF	0.85	0.86	0.82	0.84	0.85	0.85	0.86	0.88	0.73	0.84	0.87	0.77	0.90	0.92	0.87	0.95	26.05												
NZL	0.66	0.69	0.66	0.65	0.71	0.66	0.66	0.75	0.63	0.69	0.70	0.81	0.71	0.79	0.80	0.78	0.82	0.37											
IRL	0.82	0.85	0.83	0.82	0.85	0.82	0.82	0.88	0.66	0.79	0.83	0.81	0.86	0.92	0.86	0.91	0.90	0.89	0.11										
CZE	0.86	0.86	0.83	0.85	0.86	0.86	0.86	0.88	0.73	0.81	0.88	0.73	0.90	0.90	0.87	0.92	0.89	0.72	0.86	16.35									
SVK	0.85	0.82	0.83	0.84	0.87	0.85	0.85	0.88	0.76	0.79	0.88	0.72	0.95	0.90	0.85	0.90	0.87	0.70	0.83	0.88	0.42								
POL	0.86	0.88	0.86	0.87	0.92	0.86	0.86	0.92	0.73	0.83	0.86	0.73	0.95	0.96	0.86	0.95	0.89	0.75	0.89	0.90	0.90	10.77							
LTU	0.84	0.77	0.84	0.85	0.88	0.85	0.84	0.86	0.71	0.78	0.84	0.71	0.87	0.90	0.85	0.88	0.84	0.70	0.84	0.86	0.87	0.89	0.35						
LVA	0.82	0.79	0.81	0.84	0.91	0.83	0.82	0.87	0.72	0.76	0.85	0.72	0.87	0.92	0.85	0.87	0.85	0.75	0.87	0.86	0.84	0.92	0.90	0.48					
PRT	0.84	0.84	0.80	0.84	0.85	0.85	0.84	0.83	0.73	0.81	0.84	0.73	0.86	0.87	0.86	0.87	0.86	0.72	0.84	0.86	0.85	0.85	0.86	0.85	0.45				
KOR	0.86	0.86	0.81	0.86	0.84	0.86	0.85	0.84	0.73	0.78	0.84	0.72	0.87	0.89	0.86	0.90	0.86	0.70	0.82	0.86	0.85	0.91	0.85	0.86	0.86	0.34			
SVN	0.83	0.83	0.82	0.86	0.83	0.84	0.84	0.85	0.71	0.78	0.84	0.72	0.85	0.88	0.85	0.87	0.84	0.72	0.87	0.85	0.82	0.87	0.84	0.83	0.86	0.83	10.55		
HRV	0.82	0.77	0.80	0.83	0.85	0.82	0.84	0.83	0.71	0.79	0.84	0.71	0.86	0.86	0.84	0.87	0.84	0.70	0.81	0.85	0.84	0.86	0.85	0.86	0.86	0.83	0.84	11.53	
URY	0.84	0.80	0.80	0.84	0.84	0.84	0.84	0.82	0.73	0.80	0.84	0.73	0.86	0.87	0.86	0.86	0.87	0.79	0.85	0.86	0.85	0.85	0.85	0.85	0.86	0.86	0.84	0.85	0.20

JER scs

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE
CAN	6.08								
DFS	0.91	12.40							
GBR	0.92	0.91	11.15						
NLD	0.92	0.95	0.94	3.98					
USA	0.90	0.88	0.89	0.88	0.17				
AUS	0.87	0.88	0.89	0.88	0.86	0.24			
ZAF	0.89	0.89	0.89	0.89	0.88	0.87	21.34		
NZL	0.86	0.86	0.86	0.86	0.86	0.90	0.86	0.35	
CHE	0.89	0.91	0.91	0.93	0.88	0.88	0.89	0.87	12.38

JER mas

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE
CAN	7.44								
DFS	0.94	12.29							
GBR	0.85	0.86	1.87						
NLD	0.86	0.84	0.82	4.26					
USA	0.83	0.82	0.81	0.81	2.46				
AUS	0.81	0.82	0.81	0.81	0.82	0.12			
ZAF	0.82	0.81	0.75	0.85	0.74	0.77	21.34		
NZL	0.67	0.66	0.66	0.74	0.66	0.81	0.81	0.35	
CHE	0.86	0.84	0.76	0.80	0.78	0.76	0.86	0.73	12.25

RDC scs

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	5.67													
DFS	0.94	12.87												
GBR	0.93	0.92	11.47											
NOR	0.92	0.91	0.89	14.12										
USA	0.92	0.88	0.90	0.89	0.23									
DEU	0.93	0.96	0.95	0.91	0.89	13.98								
AUS	0.86	0.89	0.89	0.89	0.86	0.88	0.27							
EST	0.89	0.93	0.91	0.90	0.90	0.94	0.88	12.12						
ZAF	0.89	0.89	0.90	0.93	0.89	0.92	0.87	0.91	25.06					
NZL	0.86	0.86	0.86	0.87	0.86	0.87	0.91	0.88	0.87	0.38				
LTU	0.90	0.90	0.89	0.91	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	0.88	0.96	0.89	0.88	0.91	0.44		
NLD	0.91	0.95	0.95	0.89	0.88	0.96	0.88	0.91	0.89	0.86	0.89	0.90	4.15	
CAM	0.94	0.94	0.94	0.93	0.90	0.94	0.94	0.94	0.93	0.89	0.93	0.93	0.94	6.46

RDC mas

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	7.63													
DFS	0.90	13.72												
GBR	0.88	0.88	2.14											
NOR	0.90	0.85	0.86	14.12										
USA	0.84	0.82	0.83	0.85	0.23									
DEU	0.90	0.86	0.87	0.90	0.87	13.58								
AUS	0.82	0.81	0.81	0.81	0.76	0.79	0.13							
EST	0.87	0.84	0.87	0.88	0.86	0.92	0.75	12.15						
ZAF	0.87	0.86	0.87	0.92	0.84	0.88	0.76	0.89	25.18					
NZL	0.67	0.66	0.70	0.80	0.71	0.78	0.79	0.81	0.78	0.38				
LTU	0.86	0.84	0.87	0.89	0.85	0.89	0.79	0.91	0.89	0.80	0.34			
LVA	0.86	0.84	0.87	0.89	0.84	0.92	0.76	0.95	0.88	0.85	0.91	0.44		
NLD	0.87	0.87	0.85	0.86	0.85	0.88	0.81	0.90	0.89	0.77	0.87	0.88	4.64	
CAM	0.91	0.91	0.91	0.92	0.87	0.93	0.83	0.93	0.92	0.87	0.92	0.93	0.90	6.46

SIM scs

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV	USA
FRM	1.09											
FRA	0.93	1.01										
ITA	0.93	0.90	13.84									
NLD	0.91	0.93	0.88	4.24								
CHE	0.93	0.93	0.90	0.94	10.41							
DEA	0.92	0.93	0.88	0.90	0.89	12.23						
HUN	0.93	0.91	0.93	0.89	0.90	0.94	15.64					
SVK	0.89	0.89	0.89	0.90	0.90	0.88	0.94	0.39				
SVN	0.90	0.89	0.88	0.89	0.90	0.88	0.90	0.89	8.93			
GBR	0.91	0.96	0.90	0.95	0.91	0.93	0.89	0.89	0.88	11.54		
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	0.89	0.91	0.89	0.89	0.90	0.88	0.20

SIM mas

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVK	SVN	GBR	HRV	USA
FRM	1.08											
FRA	0.91	1.00										
ITA	0.95	0.87	13.85									
NLD	0.87	0.87	0.85	4.19								
CHE	0.91	0.92	0.90	0.92	11.31							
DEA	0.91	0.92	0.88	0.87	0.88	12.23						
HUN	0.92	0.87	0.90	0.90	0.90	0.93	15.64					
SVK	0.87	0.88	0.89	0.87	0.90	0.87	0.94	0.39				
SVN	0.89	0.87	0.88	0.84	0.89	0.87	0.88	0.87	8.93			
GBR	0.87	0.88	0.86	0.85	0.91	0.88	0.87	0.87	0.86	2.75		
HRV	0.91	0.87	0.87	0.82	0.87	0.86	0.88	0.87	0.87	0.85	9.87	
USA	0.86	0.87	0.85	0.86	0.86	0.86	0.82	0.85	0.81	0.84	0.81	0.20

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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	84	51	172	134	143	24	126	61	35
FRA	72	0	83	120	161	214	22	189	53	60
NLD	48	68	0	80	95	150	26	127	41	47
USA	162	80	71	0	318	319	29	225	83	43
CHE	110	116	88	296	0	589	26	454	68	83
DEA	123	156	145	285	487	0	36	643	69	109
NZL	22	18	19	26	21	31	0	30	18	12
ITA	108	147	107	159	395	540	23	0	71	103
GBR	54	42	30	73	50	46	15	48	0	23
SVN	31	58	48	35	78	102	11	102	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	78	49	172	40	143	24	126	28	35
FRA	68	0	69	106	45	199	19	178	26	60
NLD	44	58	0	74	26	137	26	118	20	44
USA	162	72	64	0	39	318	29	223	36	43
CHE	35	34	25	28	0	123	8	103	9	38
DEA	123	148	130	285	116	0	36	638	32	109
NZL	22	16	19	26	8	31	0	30	11	12
ITA	108	142	98	159	95	539	23	0	34	103
GBR	26	21	15	33	5	23	8	25	0	12

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  SVN   31   58   45   35   37  102   11  102   10    0
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GUE
--------
 common bulls below diagonal
 common three quarter sib group above diagonal
       CAN  GBR  USA  AUS  NZL
 ------------------------------------------------------------------------------
  CAN    0   30   71   46   14
  GBR   25    0   87   36   13
  USA   62   89    0   64   29
  AUS   45   31   60    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  900 2316 1483  257 1496 1596 1563 3436  135 1757 1442 1051  819 1375 1314  502  740  501 1145  428 1394  299  207 1026  677  212  294  770
  CHE  761    0 1141  734  165  688  692  917 1020   60  744  628  444  607  487  577  266  401  362  545  236  683  178  138  505  262  142  200  321
  DEU 1717 1012    0 2583  410 2334 1941 3225 3393  164 2567 1619 1243 1207 1407 1520  538  928  756 1829  675 2416  605  296 1197  604  319  597  757
  DFS 1270  652 1875    0  290 1651 1526 2155 2121  151 1629 1304  923  870  986 1048  498  824  670 1280  410 1616  365  206  931  476  258  388  643
  EST  154   90  292  174    0  257  245  363  344   48  277  213  201  196  211  206  106  135  117  260  115  321  115   87  194  116   98  121  137
  FRA  992  595 1205  865  121    0 1507 1985 2493  125 1696 1273  947  935 1213 1163  469  792  643 1256  421 1648  295  186  925  508  207  284  601
  GBR 1807  633 1450 1150  138  918    0 1721 2153  142 1533 1378  865  855 1035 1064  503  885  828 1054  373 1311  302  180  928  480  216  320  664
  NLD 1487  887 2978 1896  261 1225 1485    0 2532  160 1761 1484  987 1291 1080 1142  510 1021  788 1538  543 1847  397  227 1050  468  271  426  671
  USA 3813  905 2371 1605  226 1307 1886 2216    0  190 2633 1918 1343  975 1983 1566  629 1058  702 1676  540 2064  405  260 1290  836  247  366 1100
  ISR   95   38  127  111   30   65   96  122  176    0  146  112  115   83  108  110   64  107   89  127   48  143   57   28  101   60   46   65   91
  ITA 1418  664 1717 1232  154  902 1167 1461 1836   99    0 1209 1045  821 1202 1291  472  721  578 1289  394 1628  335  223 1000  585  246  376  675
  AUS 1441  542 1198  938  107  843 1177 1291 1898   72  886    0  744  762  911  905  476 1191  644  868  309 1037  260  167  782  436  181  286  664
  HUN  983  360  983  742  122  637  757  839 1305   78  895  558    0  552  737  786  391  500  394  946  314  977  229  140  708  445  165  252  522
  BEL  817  615 1249  818  123  920  846 1495  867   55  803  663  480    0  563  685  333  510  452  669  299  819  211  144  657  290  181  262  355
  JPN  725  318  634  550   76  440  547  585  923   49  573  513  427  366    0  922  423  563  401  860  319 1007  219  149  711  547  172  218  584
  ESP  845  458  987  781   99  839  847 1025 1009   65  944  640  624  671  445    0  444  539  450  879  315 1066  237  167  828  470  194  278  528
  ZAF  458  215  420  379   54  327  436  430  610   42  370  411  314  281  295  391    0  360  286  401  180  410  116   99  428  257   98  149  321
  NZL  748  337  705  578   68  469  756  935 1000   88  533 1197  389  415  306  412  291    0  639  614  252  644  182  114  561  303  130  212  514
  IRL  443  338  599  515   57  456  778  689  585   64  457  521  321  425  242  404  232  514    0  466  191  536  149   94  410  193  110  161  332
  CZE  849  396 1413  865  165  787  760 1399 1314   95  917  576  869  539  405  642  280  451  335    0  499 1352  318  191  790  469  221  347  561
  SVK  304  122  501  217   53  225  215  380  358   21  240  155  224  187  120  159   96  152   92  427    0  453  135   96  317  201   86  140  241
  POL 1170  558 2143 1303  230 1047 1091 1700 1934  109 1246  771  867  753  542  748  305  488  410 1123  314    0  438  251 1009  561  261  444  637
  LTU  160   79  560  214   59  106  154  246  272   28  181  115  139  108   76  102   47   83   70  217   69  344    0  101  235  144   81  164  175
  LVA  131   78  204  126   62   86  103  149  208   20  151   79  100   91   66   95   58   55   52  126   47  186   73    0  190   99   43  115  119
  PRT 1071  445 1097  824  136  778  858 1053 1349   74  936  626  704  664  445  796  383  459  345  662  221 1009  150  143    0  456  165  309  548
  KOR  646  182  407  342   58  292  349  331  941   35  471  316  365  213  337  325  192  219  128  341  124  465   63   59  384    0  101  137  376
  SVN  154  101  306  209   57  143  157  233  187   36  206  126  124  146   96  146   70   93   82  165   47  233   44   26  130   62    0  106  106
  HRV  171  127  611  296   87  168  227  384  275   45  284  176  188  214  102  212   98  124  107  252   68  392  113   90  247   58   82    0  181
  URY  743  238  539  454   82  349  544  539 1365   48  490  515  427  281  335  419  281  418  252  409  145  532   99   80  489  294   64  109    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  120  626  732  154  800  836  850 1030   78 1101  774  658  512  799  837  247  382  295  688  233  952  187  107  616  463  155  192  435
  CHE  109    0  116  111   29  107  114  141  111    9  121  113   60  106   91   95   38   82   71   80   35  118   30    9   75   61   41   31   49
  DEU  456  106    0  795  191  683  655  950  563   73  832  548  489  493  461  595  186  328  279  608  193  998  248  121  443  253  210  325  276
  DFS  721  102  654    0  262 1238 1252 1828  847  137 1260 1156  846  776  927  983  483  763  636 1177  338 1461  325  187  863  429  236  347  533
  EST   97   12  135  156    0  217  222  347  190   47  247  206  195  188  205  201  103  130  115  255  101  306  106   83  186  111   97  118  125
  FRA  590   96  436  670  107    0 1124 1512  780  105 1291  985  817  785  948 1000  381  624  536 1083  313 1431  239  153  795  419  185  240  441
  GBR  838  104  521  963  132  729    0 1559  951  140 1276 1201  820  787  932  994  462  799  770 1002  325 1236  259  154  857  439  202  291  561
  NLD  869  128  909 1490  252  960 1360    0  995  157 1474 1418  961 1247 1067 1123  502 1006  786 1515  494 1787  354  216 1020  447  261  396  591
```

USA	1185	97	452	828	136	595	1022	1017	0	129	1167	837	773	513	903	782	343	474	377	830	246	1076	217	153	707	548	166	184	593
ISR	53	2	51	97	30	58	93	121	122	0	131	107	112	83	106	110	62	106	89	127	47	141	51	28	101	59	46	61	83
ITA	878	108	593	971	147	710	1018	1233	1132	84	0	999	952	717	1077	1151	398	590	483	1152	332	1462	283	190	893	535	222	305	556
AUS	822	104	420	792	106	673	1037	1225	893	69	771	0	715	724	892	884	457	1150	634	845	284	998	228	157	753	411	178	266	586
HUN	619	46	368	674	122	559	730	822	815	76	833	542	0	539	729	778	380	494	390	941	295	959	212	136	692	426	163	240	462
BEL	531	100	494	714	122	764	807	1449	492	55	727	644	479	0	550	671	329	499	449	658	277	793	192	136	642	281	180	253	331
JPN	532	71	269	496	76	389	530	578	701	49	547	504	427	366	0	922	419	557	401	860	297	993	200	144	689	522	169	202	511
ESP	530	79	402	717	99	742	823	1002	610	65	820	625	623	671	445	0	439	538	449	879	290	1055	220	161	817	457	191	264	475
ZAF	230	32	144	363	54	284	419	425	381	42	327	400	313	281	295	391	0	358	284	397	170	401	107	95	419	243	97	138	299
NZL	349	75	261	521	67	391	657	923	441	88	473	1146	389	413	306	412	290	0	638	612	242	640	167	109	551	292	129	201	470
IRL	293	67	247	468	57	409	741	686	362	64	407	511	321	425	242	404	232	514	0	466	182	532	141	92	406	187	108	156	308
CZE	514	59	447	759	165	631	740	1370	758	95	825	558	869	539	405	642	280	451	335	0	472	1338	292	184	775	451	220	329	503
SVK	169	12	110	185	52	173	206	370	166	21	216	150	222	184	120	159	95	151	92	427	0	414	111	89	300	186	82	127	216
POL	866	96	975	1138	227	924	1062	1654	1190	109	1156	746	859	743	542	746	304	486	410	1123	305	0	407	237	971	534	255	421	569
LTU	116	13	210	199	58	96	148	236	156	28	159	111	138	107	76	102	47	82	70	217	66	332	0	95	211	125	77	146	151
LVA	72	4	105	114	62	76	96	146	127	20	125	78	99	91	66	95	58	54	52	126	47	179	73	0	182	95	43	107	106
PRT	625	69	397	758	135	691	823	1040	769	74	866	609	698	662	445	796	381	458	345	662	217	991	146	142	0	436	163	285	498
KOR	442	49	179	310	58	257	335	325	600	35	452	303	361	213	337	325	191	215	128	341	122	455	59	59	381	0	100	121	331
SVN	117	30	197	186	57	133	155	228	131	36	186	123	124	145	96	146	70	93	82	165	47	231	44	26	130	62	0	102	101
HRV	119	15	310	266	87	156	224	369	143	45	231	171	188	212	102	212	98	124	107	252	68	387	112	88	245	57	81	0	164
URY	425	32	203	400	82	286	510	523	655	47	461	505	417	280	335	419	278	415	252	409	144	518	98	76	479	285	64	108	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE
CAN	0	109	156	39	438	260	150	173	37
DFS	102	0	168	124	195	154	150	143	59
GBR	155	160	0	87	230	213	162	213	68
NLD	35	126	79	0	87	72	71	73	40
USA	459	175	248	94	0	487	277	357	64
AUS	265	124	216	64	532	0	222	428	52
ZAF	145	132	160	67	292	214	0	195	55
NZL	180	120	212	66	427	472	202	0	50
CHE	30	57	64	34	64	43	48	41	0

JER

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE
CAN	0	41	68	17	76	113	66	78	22
DFS	36	0	101	95	48	122	123	122	56
GBR	64	93	0	56	73	144	119	143	62
NLD	11	89	50	0	28	68	68	67	37
USA	69	39	72	24	0	135	101	99	32
AUS	103	87	147	61	144	0	213	418	49
ZAF	60	101	118	64	112	209	0	191	53
NZL	71	95	143	59	100	461	200	0	47
CHE	19	52	56	32	25	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	169	77	7	202	13	101	2	70	84	17	7	7	0
DFS	172	0	98	129	191	49	185	105	51	162	103	91	55	0
GBR	77	91	0	51	103	14	82	7	38	78	26	11	35	0
NOR	6	103	54	0	73	14	68	21	0	39	25	17	44	0
USA	188	187	97	74	0	20	130	19	59	115	34	14	42	24
DEU	12	40	14	13	20	0	36	21	1	16	29	28	14	0

AUS	101	158	77	58	131	36	0	31	34	139	43	28	33	12
EST	2	94	6	21	18	21	29	0	0	8	25	36	17	0
ZAF	72	48	34	0	53	1	33	0	0	34	5	1	4	0
NZL	82	160	72	39	116	16	138	7	30	0	27	13	21	12
LTU	16	98	24	22	29	28	42	25	5	25	0	36	16	0
LVA	7	59	11	15	10	22	25	28	1	10	32	0	9	0
NLD	7	54	34	44	40	14	31	16	4	21	14	8	0	0
CAM	0	0	0	0	24	0	12	0	0	12	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	72	27	3	73	8	31	0	35	32	13	4	3	0
DFS	71	0	71	131	178	73	195	105	46	160	102	92	54	0
GBR	26	66	0	47	72	17	50	5	25	54	21	9	25	0
NOR	3	103	49	0	73	20	64	21	0	39	25	17	38	0
USA	73	173	71	74	0	28	115	19	54	113	34	14	39	24
DEU	8	62	17	19	27	0	43	27	2	22	38	30	18	0
AUS	30	171	48	54	118	42	0	31	31	130	40	27	28	10
EST	0	94	5	21	18	26	29	0	0	8	25	36	17	0
ZAF	36	46	24	0	52	2	33	0	0	32	5	1	3	0
NZL	32	156	52	39	116	22	130	7	30	0	27	13	19	12
LTU	12	97	19	22	29	35	40	25	5	25	0	36	15	0
LVA	4	59	9	15	10	24	25	28	1	10	32	0	8	0
NLD	3	52	25	38	38	18	26	16	3	19	13	7	0	0
CAM	0	0	0	0	24	0	10	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	170	122	204	241	2	63	17	65	2	52
FRA	1	0	151	72	12	265	6	57	57	0	93	1
ITA	203	136	0	219	93	898	16	148	125	44	239	28
NLD	146	69	213	0	90	324	7	69	63	48	109	22
CHE	256	9	96	94	0	326	2	33	5	51	2	28
DEA	270	224	804	333	284	0	34	387	210	47	548	27
HUN	0	5	13	7	1	22	0	10	10	0	17	0
SVK	58	46	126	59	26	392	9	0	50	11	94	7
SVN	17	54	121	61	5	195	9	48	0	0	80	0
GBR	82	0	48	48	58	50	0	6	0	0	0	19
HRV	1	83	224	105	2	572	15	74	67	0	0	2
USA	67	1	33	24	27	28	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	159	104	4	214	2	57	17	25	2	35
FRA	1	0	85	31	1	159	3	39	34	0	58	1
ITA	192	75	0	205	4	897	16	147	125	18	239	27
NLD	126	30	199	0	4	298	7	66	58	18	102	21
CHE	4	1	4	4	0	45	0	0	0	1	0	2
DEA	257	122	804	307	40	0	34	386	210	19	548	26
HUN	0	2	13	7	0	22	0	10	10	0	17	0
SVK	56	31	125	57	0	391	9	0	50	4	94	6
SVN	17	29	121	56	0	195	9	48	0	0	80	0
GBR	33	0	22	20	1	24	0	4	0	0	0	16
HRV	1	51	224	98	0	572	15	74	67	0	0	2

USA	50	1	32	23	2	28	0	4	0	21	2	0