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 uder traits are as
follows:

POL (HOL)	Decrease in information due to pedigree verification
JPN (HOL)	Decrease in information due to pedigree verification
FRA (HOL, SIM, FRM)	Decrease in information due to pedigree verification
CHE (ALL)	Decrease in information due to the database edits and also the change of herd-year-season assignment of certain data records
ITA (HOL, JER)	Decrease in information and missing bulls due to a four months cut-off of data. JER: Changing programming language from SAS to Python for program taking care of editing. Changed from a 5 year base to a yearly (rolling) base
ITA (SIM)	Decrease in information due to pedigree verification
AUS (ALL)	Decrease in information due to pedigree verification
DEA (ALL)	Decrease in information due to pedigree verification
ISR (HOL)	Decrease in information due to pedigree verification and to closing or combining of herds.
EST (ALL)	Decrease in information due to pedigree verification
ESP (HOL)	Base change. Some change in information due to changes in the database, in some cases there is even a change to non official proof.
ZAF (ALL)	Base change
USA (ALL)	Decrease in information due to pedigree verification and herd-year minimum edits.
DFS (ALL)	Decrease in information due to an editing procedure where only active herds are included: data might be included in an evaluation but excluded in the next.
NLD (ALL)	Some changes in Type of Proofs due to harmonisation of this record
NZL (ALL)	Base change, decrease in information due to a continuos parenting testing and herds records being updated
GBR (HOL)	Decrease in information due to updates by milk recording agents and data edits.
DEU (ALL)	overall base change: cowbase previous routine run 2504r: 201901 - 202112, cowbase current routine run 2508r: 201905 - 202204

INTERBULL CHANGES COMPARED TO THE PREVIOUS ROUTINE RUN

A new document called confdoc_DEFINITION{runid}.itb has been introduced reporting all the trait definitions applied by countries as reported in the PREP.

During 2023-2024, Interbull Centre and the Interbull Technical Committee (ITC) have worked on developing a new procedures for adjusting of the international correlations after a given test run in case
countries would decide NOT TO implement the changes tested in the next routine run.
Until now, the relative difference between the previous routineâ\200\231s and test runâ\200\231s correlations, for each pair of countries, was assessed and the average value of the two was used whenever such difference did
exceed a threshold of 0.01. Otherwise, correlations from the latest test run were used.
However, in some cases, the difference in correlations between routine/test runs were way above a 1% difference so that by using the average value the newly derived correlations would still be greatly
affected by the changes tested but not implemented. This remark has been made in few occasions by some participating countries.
A new approach proposed by Peter Sullivan, was developed and extensively tested. The new approach is based on first identifying the relative impact of the changes tested by a country during the test run

(but not implemented in a routine run) and then correcting the whole correlation matrix detracting such estimated impact.
This new approach would assure that the new correlations would be free from any effect from any changes tested but not implemented.
The new procedure has been fully developed during 2023 and extensively tested during 2024 and introduced officially in the April 2025 routine evaluation.

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
https://interbull.org/ib/servicecalendar

NEXT TEST INTERNATIONAL EVALUATION

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

From 2025 an extra MACE test run has been scheduled in May, data submissions' deadline and target for distribution of results are all reported in the above link.

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 2025).
Number of records for milk somatic cells by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS		155	9066	1816	869	
BEL			2452			
CAN	291	112	14454	944	905	
CHE	3324		3551	108		3807
CZE			4636			
DEA	6298					25870
DEU			25182		321	
DFS			15043	2422	8439	
ESP			4936			
EST			1512		505	
FRA	522		18831			508
FRM						4907
GBR	163	321	7941	828	635	111
HUN			3491			223
IRL			3277			
ISR			1870			
ITA	2289		9687	64		1976
JPN			7397			
KOR			1770			
LTU			985		363	
LVA			1487		677	
NLD	269		17766	305	115	581
NOR					4446	
NZL	85		9463	5412	1506	
POL			12264			
PRT			3184			
SVK			1223			
SVN	368		771			759
URY			2253			
USA	1232	765	43677	5578	804	121
ZAF			1206	625	125	
HRV			986			1069
CAM					50	

No.Records	14841	1353	230361	18102	19760	39932
Pub. Proofs	11676	1078	162511	14561	18450	35668

^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	6.73									
FRA	0.91	1.03								
NLD	0.89	0.93	3.64							
USA	0.88	0.90	0.84	0.21						
CHE	0.88	0.95	0.94	0.79	10.52					
DEA	0.87	0.97	0.92	0.84	0.97	11.96				
NZL	0.70	0.75	0.74	0.65	0.71	0.63	0.36			
ITA	0.88	0.90	0.89	0.82	0.95	0.91	0.66	14.90		
GBR	0.93	0.96	0.94	0.90	0.93	0.94	0.79	0.89	11.43	
SVN	0.80	0.80	0.80	0.79	0.79	0.78	0.66	0.80	0.82	11.08

BSW mas

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	6.64									
FRA	0.81	0.95								
NLD	0.80	0.73	4.09							
USA	0.82	0.83	0.75	2.75						
CHE	0.87	0.86	0.86	0.79	11.64					
DEA	0.90	0.69	0.89	0.71	0.88	11.96				
NZL	0.68	0.64	0.64	0.64	0.68	0.73	0.36			
ITA	0.86	0.73	0.82	0.74	0.89	0.92	0.69	14.91		
GBR	0.83	0.82	0.83	0.80	0.81	0.72	0.63	0.75	2.23	
SVN	0.79	0.72	0.75	0.72	0.71	0.84	0.75	0.82	0.76	11.07

GUE scs

	CAN	GBR	USA	AUS
CAN	6.02			
GBR	0.92	13.71		
USA	0.92	0.90	0.25	
AUS	0.81	0.86	0.76	0.23

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	5.80																												
CHE	0.90	10.84																											
DEU	0.95	0.95	12.91																										
DFS	0.93	0.92	0.97	11.83																									
EST	0.89	0.88	0.94	0.92	17.77																								
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	12.91																						
NLD	0.92	0.94	0.97	0.94	0.91	0.94	0.96	4.25																					
USA	0.93	0.84	0.89	0.87	0.89	0.90	0.91	0.87	0.20																				
ISR	0.85	0.82	0.83	0.81	0.84	0.82	0.79	0.79	0.87	0.24																			
ITA	0.90	0.89	0.94	0.92	0.93	0.94	0.91	0.90	0.88	0.81	5.95																		
AUS	0.79	0.85	0.81	0.81	0.75	0.83	0.86	0.83	0.73	0.65	0.76	0.25																	
HUN	0.89	0.88	0.93	0.90	0.91	0.91	0.89	0.87	0.91	0.86	0.93	0.72	1.35																
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	0.80	0.89	0.84	0.80	0.85	0.75	0.80	0.73	0.78	0.83	0.45														
ESP	0.93	0.90	0.95	0.94	0.90	0.95	0.93	0.91	0.91	0.85	0.94	0.76	0.92	0.96	0.81	11.93													
ZAF	0.90	0.88	0.91	0.89	0.86	0.93	0.90	0.87	0.89	0.80	0.92	0.82	0.90	0.91	0.83	0.94	26.31												
NZL	0.74	0.79	0.76	0.77	0.70	0.79	0.82	0.78	0.67	0.63	0.71	0.89	0.65	0.73	0.76	0.72	0.79	0.40											

IRL	0.81	0.90	0.86	0.86	0.80	0.86	0.88	0.88	0.77	0.73	0.80	0.81	0.81	0.85	0.75	0.83	0.82	0.79	0.12										
CZE	0.91	0.87	0.94	0.92	0.91	0.92	0.90	0.89	0.89	0.81	0.93	0.72	0.95	0.94	0.80	0.94	0.90	0.67	0.77	18.19									
SVK	0.84	0.84	0.90	0.89	0.88	0.89	0.83	0.83	0.84	0.80	0.89	0.69	0.92	0.92	0.77	0.90	0.88	0.61	0.80	0.92	0.40								
POL	0.88	0.86	0.93	0.91	0.91	0.90	0.88	0.88	0.84	0.79	0.90	0.73	0.93	0.93	0.77	0.91	0.85	0.67	0.81	0.91	0.87	13.35							
LTU	0.83	0.85	0.90	0.88	0.91	0.86	0.83	0.85	0.78	0.83	0.86	0.72	0.86	0.91	0.77	0.88	0.84	0.67	0.78	0.89	0.89	0.87	0.34						
LVA	0.87	0.90	0.93	0.93	0.94	0.90	0.90	0.90	0.85	0.80	0.91	0.79	0.92	0.94	0.79	0.90	0.88	0.77	0.84	0.91	0.86	0.92	0.88	480.51					
PRT	0.77	0.77	0.78	0.77	0.77	0.78	0.78	0.77	0.77	0.75	0.77	0.65	0.78	0.78	0.77	0.78	0.78	0.63	0.74	0.80	0.77	0.77	0.77	0.77	0.45				
KOR	0.88	0.82	0.87	0.89	0.86	0.87	0.89	0.83	0.86	0.81	0.86	0.78	0.84	0.86	0.81	0.86	0.82	0.73	0.71	0.84	0.78	0.85	0.80	0.87	0.77	0.33			
SVN	0.81	0.82	0.87	0.87	0.83	0.84	0.83	0.82	0.77	0.74	0.84	0.75	0.82	0.88	0.77	0.83	0.79	0.66	0.86	0.79	0.82	0.84	0.82	0.87	0.77	0.78	10.39		
HRV	0.77	0.77	0.79	0.77	0.83	0.77	0.77	0.78	0.77	0.76	0.79	0.66	0.83	0.82	0.77	0.80	0.78	0.58	0.74	0.78	0.78	0.83	0.81	0.84	0.77	0.78	0.78	11.63	
URY	0.77	0.80	0.83	0.80	0.78	0.81	0.78	0.78	0.77	0.75	0.78	0.76	0.79	0.82	0.77	0.79	0.83	0.74	0.75	0.77	0.80	0.81	0.79	0.78	0.77	0.77	0.78	0.77	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	7.72																												
CHE	0.93	11.10																											
DEU	0.90	0.88	9.41																										
DFS	0.94	0.88	0.89	12.22																									
EST	0.80	0.85	0.82	0.85	17.79																								
FRA	0.95	0.94	0.91	0.93	0.81	1.14																							
GBR	0.88	0.89	0.82	0.84	0.76	0.88	2.35																						
NLD	0.84	0.91	0.80	0.84	0.81	0.87	0.82	5.02																					
USA	0.87	0.83	0.85	0.83	0.77	0.89	0.82	0.79	2.52																				
ISR	0.75	0.74	0.75	0.79	0.85	0.73	0.69	0.75	0.72	0.24																			
ITA	0.85	0.90	0.75	0.80	0.82	0.86	0.79	0.90	0.75	0.73	7.44																		
AUS	0.67	0.74	0.63	0.66	0.75	0.64	0.66	0.63	0.63	0.68	0.63	0.13																	
HUN	0.84	0.87	0.75	0.82	0.90	0.82	0.80	0.85	0.76	0.84	0.89	0.73	1.35																
BEL	0.88	0.94	0.82	0.87	0.92	0.88	0.82	0.88	0.76	0.82	0.89	0.82	0.93	0.52															
JPN	0.74	0.82	0.68	0.72	0.76	0.73	0.69	0.79	0.68	0.75	0.73	0.74	0.80	0.85	0.45														
ESP	0.85	0.91	0.75	0.84	0.87	0.86	0.81	0.87	0.75	0.83	0.88	0.78	0.93	0.96	0.84	11.93													
ZAF	0.83	0.89	0.77	0.78	0.81	0.83	0.79	0.84	0.75	0.79	0.85	0.84	0.90	0.93	0.85	0.94	26.03												
NZL	0.62	0.68	0.62	0.62	0.71	0.62	0.62	0.62	0.62	0.72	0.62	0.87	0.71	0.75	0.76	0.75	0.80	0.40											
IRL	0.77	0.86	0.75	0.78	0.85	0.77	0.76	0.77	0.65	0.78	0.78	0.89	0.86	0.93	0.82	0.91	0.91	0.88	0.11										
CZE	0.85	0.90	0.78	0.82	0.90	0.83	0.81	0.86	0.73	0.81	0.89	0.75	0.94	0.95	0.82	0.94	0.92	0.71	0.87	18.19									
SVK	0.83	0.86	0.79	0.80	0.88	0.83	0.78	0.86	0.76	0.79	0.90	0.72	0.92	0.93	0.77	0.90	0.89	0.71	0.84	0.92	0.39								
POL	0.84	0.88	0.75	0.83	0.92	0.82	0.80	0.82	0.72	0.80	0.85	0.76	0.93	0.95	0.79	0.92	0.86	0.71	0.89	0.92	0.88	13.33							
LTU	0.78	0.79	0.73	0.78	0.88	0.78	0.74	0.75	0.68	0.78	0.79	0.69	0.86	0.90	0.78	0.86	0.82	0.71	0.82	0.89	0.87	0.87	0.33						
LVA	0.78	0.83	0.73	0.81	0.92	0.78	0.78	0.82	0.72	0.81	0.83	0.82	0.92	0.93	0.77	0.90	0.85	0.77	0.90	0.92	0.87	0.93	0.87	479.42					
PRT	0.72	0.81	0.68	0.73	0.77	0.73	0.69	0.74	0.68	0.76	0.72	0.68	0.81	0.83	0.77	0.80	0.81	0.71	0.81	0.83	0.77	0.78	0.77	0.80	0.45				
KOR	0.77	0.81	0.68	0.78	0.83	0.77	0.74	0.72	0.69	0.79	0.71	0.80	0.84	0.87	0.83	0.87	0.82	0.74	0.82	0.84	0.77	0.87	0.82	0.87	0.77	0.33			
SVN	0.78	0.82	0.73	0.80	0.81	0.78	0.76	0.75	0.68	0.73	0.78	0.78	0.81	0.89	0.76	0.82	0.79	0.72	0.88	0.82	0.79	0.84	0.83	0.88	0.78	0.77	10.40		
HRV	0.68	0.77	0.68	0.68	0.83	0.70	0.73	0.76	0.70	0.78	0.80	0.68	0.84	0.83	0.77	0.80	0.79	0.71	0.78	0.79	0.78	0.82	0.83	0.84	0.77	0.76	0.78	11.37	
URY	0.69	0.74	0.72	0.68	0.79	0.68	0.69	0.72	0.68	0.75	0.70	0.74	0.80	0.83	0.77	0.79	0.84	0.76	0.84	0.81	0.82	0.83	0.79	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	5.95									
DFS	0.90	12.59								
GBR	0.92	0.93	11.69							
NLD	0.92	0.94	0.95	4.11						
USA	0.90	0.82	0.87	0.84	0.17					
AUS	0.76	0.84	0.83	0.85	0.72	0.23				
ZAF	0.85	0.87	0.86	0.89	0.83	0.79	20.98			
NZL	0.66	0.71	0.76	0.77	0.64	0.88	0.72	0.38		
CHE	0.87	0.85	0.84	0.89	0.81	0.71	0.81	0.66	13.69	
ITA	0.87	0.91	0.87	0.88	0.86	0.75	0.86	0.65	0.85	5.39

JER mas

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE	ITA
CAN	7.34									
DFS	0.92	11.77								
GBR	0.77	0.84	1.96							
NLD	0.83	0.83	0.81	4.69						

USA	0.80	0.75	0.73	0.71	2.53					
AUS	0.65	0.65	0.65	0.72	0.64	0.12				
ZAF	0.72	0.71	0.72	0.82	0.70	0.82	20.97			
NZL	0.63	0.63	0.63	0.67	0.63	0.86	0.73	0.38		
CHE	0.82	0.79	0.75	0.79	0.75	0.71	0.79	0.72	13.66	
ITA	0.80	0.75	0.77	0.88	0.74	0.69	0.81	0.69	0.83	5.39

RDC scs

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	6.07													
DFS	0.93	12.96												
GBR	0.94	0.91	11.77											
NOR	0.85	0.92	0.81	13.60										
USA	0.92	0.85	0.88	0.78	0.22									
DEU	0.94	0.96	0.95	0.91	0.88	14.38								
AUS	0.80	0.85	0.86	0.82	0.71	0.83	0.26							
EST	0.89	0.89	0.89	0.84	0.84	0.92	0.80	18.20						
ZAF	0.82	0.86	0.85	0.87	0.86	0.91	0.76	0.86	25.29					
NZL	0.74	0.74	0.78	0.70	0.68	0.76	0.87	0.69	0.75	0.42				
LTU	0.83	0.88	0.85	0.88	0.79	0.88	0.81	0.87	0.86	0.71	0.36			
LVA	0.86	0.87	0.90	0.84	0.83	0.92	0.81	0.94	0.87	0.73	0.86	433.32		
NLD	0.92	0.94	0.93	0.86	0.86	0.96	0.83	0.86	0.87	0.77	0.85	0.86	4.21	
CAM	0.88	0.88	0.88	0.87	0.85	0.88	0.82	0.87	0.88	0.79	0.87	0.87	0.88	6.16

RDC mas

	CAN	DFS	GBR	NOR	USA	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	8.80												
DFS	0.87	13.35											
GBR	0.87	0.82	2.10										
NOR	0.79	0.69	0.72	13.60									
USA	0.80	0.73	0.79	0.78	0.22								
AUS	0.67	0.64	0.68	0.88	0.68	0.15							
EST	0.80	0.71	0.79	0.85	0.79	0.82	18.20						
ZAF	0.83	0.79	0.83	0.86	0.80	0.78	0.82	25.37					
NZL	0.64	0.63	0.64	0.73	0.70	0.88	0.75	0.76	0.42				
LTU	0.75	0.71	0.74	0.85	0.77	0.82	0.89	0.83	0.78	0.36			
LVA	0.78	0.72	0.79	0.86	0.76	0.82	0.95	0.86	0.77	0.90	435.86		
NLD	0.84	0.80	0.84	0.85	0.84	0.75	0.82	0.84	0.67	0.79	0.82	4.94	
CAM	0.82	0.83	0.83	0.87	0.81	0.89	0.87	0.87	0.84	0.87	0.87	0.84	6.16

SIM scs

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA
FRM	1.06										
FRA	0.89	1.05									
ITA	0.87	0.88	12.05								
NLD	0.91	0.93	0.83	4.03							
CHE	0.93	0.93	0.86	0.93	10.43						
DEA	0.91	0.96	0.84	0.92	0.89	12.28					
HUN	0.87	0.91	0.91	0.88	0.88	0.88	16.38				
SVN	0.83	0.80	0.79	0.80	0.82	0.79	0.82	9.33			
GBR	0.90	0.95	0.87	0.95	0.90	0.93	0.89	0.83	10.77		
HRV	0.86	0.78	0.78	0.78	0.79	0.77	0.81	0.78	0.78	9.71	
USA	0.85	0.90	0.86	0.86	0.84	0.82	0.91	0.78	0.90	0.78	0.20

SIM mas

	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA
ITA	12.01								
NLD	0.78	4.32							
CHE	0.88	0.84	10.05						
DEA	0.84	0.89	0.74	12.28					
HUN	0.88	0.85	0.85	0.88	16.38				

SVN	0.78	0.75	0.81	0.80	0.82	9.33			
GBR	0.76	0.82	0.88	0.74	0.80	0.76	2.47		
HRV	0.77	0.70	0.77	0.77	0.82	0.78	0.73	9.71	
USA	0.76	0.81	0.82	0.81	0.76	0.71	0.80	0.73	0.19

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^LAPPENDIX II. Number of common bulls

BSW scs

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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	99	60	204	160	172	36	156	78	37
FRA	91	0	107	141	206	276	32	244	82	56
NLD	55	93	0	99	129	189	37	160	59	54
USA	202	104	90	0	343	365	42	256	106	46
CHE	137	163	118	321	0	696	40	552	96	90
DEA	154	225	177	333	587	0	58	786	102	123
NZL	36	25	30	39	31	52	0	50	30	14
ITA	138	207	134	185	496	685	40	0	104	112
GBR	77	77	55	105	78	76	28	83	0	32
SVN	33	53	53	36	85	111	13	105	28	0

BSW mas

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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	88	56	62	85	170	36	155	37	37
FRA	81	0	79	29	84	235	26	211	42	55
NLD	49	68	0	24	66	171	37	147	31	53
USA	63	28	22	0	32	55	16	48	20	13
CHE	78	70	61	28	0	297	21	256	28	73
DEA	154	185	158	49	263	0	58	785	52	123
NZL	36	22	30	15	17	52	0	50	15	14
ITA	137	176	121	38	229	685	40	0	56	112
GBR	35	40	29	18	24	41	13	47	0	22
SVN	33	51	52	12	70	111	13	105	20	0

GUE scs

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common bulls below diagonal
common three quarter sib group above diagonal

	CAN	GBR	USA	AUS
CAN	0	36	81	57
GBR	31	0	95	48
USA	73	97	0	78
AUS	55	41	76	0

GUE mas

HOL scs

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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	1014	2856	1939	379	1776	1983	2027	4349	195	2162	1739	1278	982	1599	1566	506	918	609	1280	483	1950	339	604	1362	831	251	355	955
CHE	940	0	1302	861	217	815	808	1067	1144	74	832	723	487	696	545	643	257	476	422	517	252	807	148	282	606	313	156	226	366
DEU	2343	1241	0	3275	587	2809	2375	4069	4093	213	2970	1911	1511	1464	1627	1832	550	1154	894	2033	741	3331	611	874	1558	732	414	731	964
DFS	1777	818	2621	0	457	2005	1845	2734	2712	194	1925	1542	1149	1081	1185	1314	506	1006	781	1412	462	2189	410	584	1229	590	309	496	797
EST	259	132	449	324	0	334	360	515	495	70	403	284	274	249	260	272	113	181	152	346	144	486	122	210	266	152	109	153	195
FRA	1356	765	1786	1297	185	0	1754	2363	2798	151	1776	1468	1111	1151	1364	1467	501	918	732	1318	477	2173	304	505	1204	625	238	391	710
GBR	2241	776	1894	1490	224	1244	0	2095	2647	188	1721	1634	1026	1012	1194	1233	508	1059	998	1120	408	1752	356	500	1149	576	235	387	835
NLD	2006	1066	3951	2520	386	1738	1897	0	3110	209	2092	1720	1200	1535	1294	1420	515	1269	933	1683	600	2518	415	619	1369	593	325	530	851

USA	4995	1075	3228	2298	376	1695	2472	2864	0	321	3080	2304	1634	1159	2261	1850	634	1311	852	1878	609	2941	455	824	1714	1009	288	453	1402
ISR	140	43	162	143	39	92	140	162	316	0	190	146	149	103	148	135	66	140	116	158	62	214	68	93	135	81	54	78	117
ITA	2007	775	2378	1713	267	1249	1473	1946	2745	136	0	1276	1277	931	1284	1479	396	734	572	1431	431	2334	388	625	1240	685	317	444	798
AUS	1776	641	1499	1174	152	1067	1450	1530	2380	94	1050	0	851	872	1047	1031	482	1375	758	889	338	1331	284	456	995	532	191	338	816
HUN	1226	408	1260	975	168	845	891	1051	1649	102	1180	655	0	639	848	936	393	577	457	1024	362	1291	290	433	909	535	193	303	607
BEL	986	712	1519	1033	161	1195	998	1768	1052	66	952	775	562	0	645	805	339	598	528	685	326	1022	202	333	811	359	190	312	418
JPN	937	381	827	722	107	584	672	776	1192	75	729	631	515	442	0	1051	429	650	447	921	346	1235	255	429	873	648	186	270	689
ESP	1116	543	1265	1069	140	1245	995	1310	1315	82	1144	765	780	796	559	0	449	636	510	940	353	1454	268	437	1057	573	223	340	626
ZAF	465	216	429	389	56	398	444	439	618	42	320	420	315	288	299	401	0	368	295	332	180	411	103	164	448	267	73	158	327
NZL	902	401	902	738	95	609	919	1165	1270	113	593	1381	446	490	371	492	298	0	779	627	273	836	204	292	682	349	142	255	640
IRL	539	404	733	618	77	576	957	833	738	89	489	626	364	486	285	459	246	646	0	451	212	665	157	220	502	234	114	194	397
CZE	968	362	1584	1006	223	868	755	1495	1525	124	1137	589	909	525	475	643	216	438	302	0	460	1650	324	469	894	528	246	414	607
SVK	340	129	557	251	61	276	237	430	417	26	278	169	253	200	136	184	97	164	100	365	0	513	114	173	362	222	84	159	261
POL	1826	705	3174	1917	368	1659	1579	2427	3046	170	2140	1075	1204	962	737	1135	316	660	523	1421	371	0	475	755	1347	697	346	570	842
LTU	208	64	567	258	62	134	202	269	335	35	220	137	189	99	96	118	39	106	80	214	51	375	0	218	265	171	88	163	204
LVA	392	148	716	374	118	275	290	431	731	62	414	236	318	197	195	245	94	164	120	309	83	616	146	0	484	286	126	280	318
PRT	1424	550	1476	1156	177	1102	1063	1386	1845	88	1229	846	911	827	560	1037	401	561	423	739	247	1383	166	382	0	568	197	372	671
KOR	811	223	519	447	74	402	424	441	1141	42	580	389	430	271	412	417	198	259	156	374	133	594	77	173	488	0	122	173	457
SVN	196	113	406	254	66	180	172	283	234	38	281	133	147	151	106	162	52	98	86	180	39	305	40	73	156	77	0	129	118
HRV	218	149	755	399	110	285	276	486	350	54	350	214	225	251	129	260	108	153	131	310	79	527	109	216	309	82	103	0	217
URY	921	287	729	582	112	481	695	705	1695	68	622	647	481	328	422	495	293	536	307	411	154	707	108	185	578	354	67	134	0

HOL mas

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	333	857	1079	257	1043	1143	452	1582	131	1372	1047	864	654	994	1051	251	529	348	879	270	1360	249	373	891	595	205	250	581
CHE	297	0	311	313	94	310	301	197	297	30	308	284	162	259	212	241	66	177	137	187	76	326	70	89	212	134	87	74	126
DEU	697	282	0	1160	301	983	899	676	834	105	1034	738	668	665	622	796	201	453	337	806	242	1543	312	428	668	336	306	430	386
DFS	1107	290	1044	0	418	1524	1556	913	1293	178	1324	1411	1057	961	1112	1224	489	933	698	1293	378	1935	369	470	1129	542	285	451	669
EST	181	54	221	298	0	286	334	224	311	69	317	278	266	237	254	267	110	176	138	340	126	469	116	186	255	147	107	151	181
FRA	857	284	754	1000	161	0	1356	622	1014	128	1221	1179	983	989	1094	1263	412	735	589	1173	358	1908	254	403	1025	533	219	334	547
GBR	1171	281	750	1278	215	1008	0	677	1378	187	1359	1494	982	943	1093	1166	466	974	866	1079	354	1657	322	418	1068	534	228	362	726
NLD	438	186	621	934	164	526	663	0	469	105	583	564	441	637	427	540	208	547	374	752	188	1033	195	252	543	231	168	306	320
USA	1822	258	716	1324	250	822	1499	432	0	245	1616	1201	1071	658	1169	1040	351	679	440	1095	309	1817	294	501	1069	716	219	253	833
ISR	87	14	70	126	39	77	138	81	241	0	155	142	146	102	146	135	64	139	97	158	59	210	64	77	135	80	52	76	110
ITA	1211	270	814	1206	210	901	1206	541	1664	104	0	1040	1066	768	1062	1209	315	592	428	1144	326	1789	315	431	1026	586	259	347	611
AUS	1127	249	600	1051	155	888	1344	493	1321	93	894	0	838	845	1044	1030	465	1346	701	882	308	1301	264	396	968	512	192	325	739
HUN	834	126	535	899	168	737	869	376	1137	100	1010	653	0	621	838	926	381	572	415	1018	336	1261	277	375	883	515	188	290	540
BEL	687	253	679	919	159	1011	957	667	637	66	794	771	558	0	623	789	331	581	490	670	293	986	186	296	786	350	190	301	388
JPN	711	159	407	662	107	519	656	325	943	75	660	630	515	442	0	1051	426	643	432	921	319	1216	239	390	849	622	185	258	611
ESP	755	194	578	991	140	1043	970	515	874	82	951	764	778	796	559	0	442	634	480	939	322	1436	250	400	1036	559	220	330	568
ZAF	236	52	157	373	56	325	429	184	393	42	271	414	315	288	299	400	0	364	284	328	168	402	97	162	436	254	73	149	302
NZL	470	152	372	678	94	508	823	495	654	113	501	1347	444	486	371	491	296	0	717	627	258	817	195	266	666	339	141	245	593
IRL	345	134	306	530	73	481	846	354	424	70	382	578	336	463	271	438	234	587	0	426	189	599	145	200	468	229	103	184	352
CZE	686	133	627	891	223	721	740	710	1035	124	936	584	909	525	475	643	216	438	276	0	431	1626	307	417	872	510	245	399	548
SVK	195	28	146	215	60	218	229	106	222	26	223	166	250	192	136	184	96	161	96	365	0	458	101	155	338	206	80	147	231
POL	1315	278	1582	1673	363	1448	1534	1034	2070	169	1675	1070	1190	948	737	1134	315	654	477	1421	350	0	446	624	1289	667	340	546	759
LTU	165	28	259	241	61	120	197	125	226	35	184	139	188	98	96	118	39	104	69	214	50	365	0	192	245	154	84	151	183
LVA	229	34	340	284	105	203	250	156	420	49	267	196	279	176	177	223	94	147	107	272	78	502	130	0	436	258	117	267	275
PRT	924	184	597	1058	176	941	1027	549	1181	88	1040	839	902	823	560	1036	400	558	403	739	239	1349	164	341	0	548	196	351	614
KOR	584	104	245	413	74	359	407	172	781	42	518	383	426	271	412	417	197	255	158	374	130	580	74	157	483	0	121	161	409
SVN	162	63	300	227	66	169	170	137	176	37	224	135	147	151	106	162	52	98	76	180	39	303	40	68	156	77	0	127	113
HRV	163	46	419	366	110	246	273	274	205	54	266	212	225	247	129	260	108	153	127	310	79	520	108	214	306	81	102	0	200
URY	565	90	298	518	112	395	660	261	919	68	513	642	467	326	422	494	289	532	293	411	152	688	108	168	570	345	67	133	0

JER scs

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE	ITA
CAN	0	169	206	65	551	304	165	230	48	31
DFS	165	0	227	204	265	192	169	207	65	36
GBR	206	220	0	125	290	262	179	278	79	40
NLD	59	208	118	0	132	92	87	115	45	25
USA	581	249	314	136	0	562	308	455	80	40

AUS	312	164	264	82	611	0	249	504	65	39
ZAF	161	152	181	83	322	238	0	219	58	36
NZL	239	185	280	109	527	554	226	0	62	34
CHE	42	64	75	38	81	55	51	53	0	26
ITA	26	35	39	23	39	34	32	31	27	0

JER mas

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE	ITA
CAN	0	60	97	25	118	149	77	109	30	21
DFS	56	0	149	171	84	152	148	169	62	33
GBR	95	142	0	92	105	197	143	209	69	39
NLD	19	168	88	0	54	85	84	106	41	25
USA	109	74	105	48	0	199	131	166	46	25
AUS	138	119	200	78	210	0	244	498	62	38
ZAF	70	128	144	81	142	237	0	214	55	36
NZL	101	142	212	101	164	546	223	0	58	34
CHE	28	59	65	36	40	55	50	52	0	26
ITA	16	31	36	23	24	33	32	31	27	0

RDC scs

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	211	100	8	232	14	113	3	70	101	22	10	8	0
DFS	218	0	139	155	234	74	230	153	51	209	111	134	71	0
GBR	100	133	0	88	140	16	110	17	40	102	31	16	51	0
NOR	7	130	92	0	90	19	87	35	0	59	27	22	57	0
USA	221	232	135	91	0	32	160	32	59	142	43	27	55	32
DEU	13	65	16	18	30	0	49	36	1	26	26	37	22	0
AUS	113	202	106	76	163	48	0	50	34	179	48	41	52	14
EST	2	141	15	35	31	35	45	0	0	24	25	55	27	0
ZAF	72	48	35	0	53	1	34	0	0	35	5	2	3	0
NZL	100	205	98	59	143	25	179	22	30	0	29	21	32	13
LTU	21	98	29	24	38	26	45	24	5	27	0	46	20	0
LVA	10	93	16	20	24	31	37	47	2	18	41	0	20	0
NLD	8	69	50	56	54	21	50	26	3	31	19	19	0	0
CAM	0	0	0	0	32	0	14	0	0	13	0	0	0	0

RDC mas

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	92	34	3	86	37	0	35	41	18	7	3	0
DFS	92	0	100	155	226	243	153	46	207	110	126	69	0
GBR	33	97	0	74	102	73	12	27	70	25	14	40	0
NOR	3	129	78	0	90	87	35	0	59	27	19	52	0
USA	86	224	101	91	0	149	32	54	139	43	25	51	32
AUS	37	219	73	76	153	0	50	31	170	45	38	50	13
EST	0	141	11	35	31	45	0	0	24	25	49	26	0
ZAF	36	46	26	0	52	33	0	0	33	5	2	2	0
NZL	41	201	71	59	143	171	22	30	0	29	17	29	13
LTU	17	97	23	24	38	43	24	5	27	0	46	19	0
LVA	7	84	14	17	22	35	41	2	14	41	0	14	0
NLD	3	67	40	51	51	48	25	2	28	18	13	0	0
CAM	0	0	0	0	32	13	0	0	13	0	0	0	0

SIM scs

common bulls below diagonal
common three quarter sib group above diagonal

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA

FRM	0	0	165	141	248	234	2	0	67	0	98
FRA	0	0	155	89	15	276	6	61	0	111	3
ITA	192	140	0	297	107	1126	25	183	46	347	39
NLD	166	84	289	0	95	448	13	101	49	178	33
CHE	300	12	109	99	0	391	2	2	53	3	33
DEA	271	233	1035	468	357	0	50	315	49	739	42
HUN	0	5	22	12	1	34	0	14	0	26	1
SVN	0	57	169	93	2	299	12	0	0	138	2
GBR	85	0	51	49	60	53	0	0	0	0	20
HRV	0	99	330	172	3	774	23	128	0	0	6
USA	112	3	46	34	32	43	1	2	27	6	0

SIM mas

common bulls below diagonal
common three quarter sib group above diagonal

	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA
ITA	0	282	12	1122	25	183	17	347	39
NLD	275	0	10	415	12	96	19	171	33
CHE	12	10	0	115	0	0	1	0	5
DEA	1034	432	108	0	50	315	21	739	41
HUN	22	10	0	34	0	14	0	26	1
SVN	169	89	0	299	12	0	0	138	2
GBR	23	21	1	26	0	0	0	0	17
HRV	330	165	0	774	23	128	0	0	6
USA	46	34	5	43	1	2	23	6	0