Introduction

The latest routine international evaluation for udder traits took place as scheduled at the Interbull Centre. Data from thirty-two (32) countries were included in this evaluation.

International genetic evaluations for udder health traits of bulls from Australia, Austria-Germany, Belgium, Canada, 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:

FRA (ALL)	Base change. HOL/SIM/MON: French and Montbeliards breeding organisations have made the choice to suspend the publication of EBVs for bulls that entered progeny testing and produced daughters but were not subsequently placed on the market as public breeding bulls based on their progeny test results. As consequence, around 1000 bulls are now missing or their publication status have changed from official to unofficial
ITA (HOL, JER)	Base change. HOL: Applied a yearly cutoff of data causing some bulls to be missings
IRL (ALL)	minor change in data edits where individual milk records where the sire is unknown, are excluded from the evaluation unless the cow has at least 3 tests within a given lactation. Pedigree verification
POL (HOL)	New definition of UPG groups, pedigree pruning, new genetic base, applied new coding for status and type of proof according to new recommendation from Interbull Centre. Added filtering requiring cows to have records in first lactation, removal of records from small CG or CG without any phenotypic variation, causing drops in reliability
AUS (ALL)	Decrease in information due to pedigree updates and change in status of some bulls that do not qualify for inclusion any longer.
DFS (ALL)	Small drops in information due to editings
CAN (ALL)	Base change
ISR (HOL)	Base change
EST (ALL)	New genetic base: cows born in years 2018-2022 are now considered, updated definition of herd (dairy groups within big cowbarns of some owners have different herd code), causing drops in EDC due to daughters of bull having smaller number of herdmates in the new herds
USA (ALL)	Drops in herds/daugthers/EDC are related to pedigree correctness and daughter-herd-year minimum edits.
DEU (ALL)	Base change. MAS: Changes in the data caused drops in information for several bulls causing few bulls to be missing as no longer qualifying.
JPN (HOL)	Base change
CHE (ALL)	Base change, drops in information due to manual edits. BSW MAS: Slight drops in reliability due to a correction of a bug
GBR (ALL)	Base change
SVN (ALL)	Base change. Estimated variance components and heritability. HOL/SIM: Time period for data inclusion has been shifted forward by five years (data from 2015 to 2025 are used).
BEL (HOL)	Slight drops in information due to pedigree verification.
ITA (BSW)	Base change
NZL (ALL)	Pedigree verification causing slight change in information and reliability
ESP (HOL)	Base change
NLD (ALL)	Base change. Minor change in EDC calculation leading to a small drop in EDC.
LTU (ALL)	Base change
PRT (HOL)	The Pedigree was updated, some parents were removed due to lab results. Adopted the new classification of type of proofs as recommended by the Interbull.

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.

Direct Gestation Length (ges) has been added as the fifth trait in the calving evaluation starting from the August 2025 MACE routine evaluation, and therefore added in the calv{BRD}{RUNID}.itb and calv{BRD}{RUNID}.ipr.

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

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 (April Routine Evaluation 2026).
Number of records for milk somatic cells by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS		156	9120	1822	870	
BEL			2488			
CAN	297	113	14640	962	913	
CHE	3369		3604	109		3857
CZE			4715			
DEA	6364					26236
DEU			25456		324	
DFS			15189	2447	8466	
ESP			5045			
EST			1666		516	
FRA	529		17924			514
FRM						3823
GBR	167	323	8117	841	643	111
HUN			3582			218
IRL			3432			
ISR			1933			

ITA	2317		9581	61		2007
JPN			7477			
KOR			1770			
LTU			1024		389	
LVA			1532		682	
NLD	280		18023	324	120	603
NOR					4489	
NZL	89		9706	5557	1534	
POL			13500			
PRT			3776			
SVK			1246			
SVN	381		727			668
URY			2305			
USA	1254	772	44231	5693	817	123
ZAF			1207	632	126	
CAM					50	
No.Records	15047	1364	233016	18448	19939	39229
Pub. Proofs	11784	1087	162324	14764	18573	34981

^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	6.94									
FRA	0.91	1.02								
NLD	0.89	0.92	3.71							
USA	0.88	0.90	0.84	0.21						
CHE	0.89	0.95	0.94	0.79	10.48					
DEA	0.86	0.97	0.92	0.84	0.97	11.94				
NZL	0.69	0.75	0.74	0.65	0.71	0.62	0.37			
ITA	0.88	0.90	0.89	0.82	0.95	0.92	0.65	14.78		
GBR	0.93	0.96	0.93	0.89	0.93	0.93	0.79	0.89	11.43	
SVN	0.80	0.79	0.81	0.79	0.78	0.78	0.64	0.79	0.81	11.14

BSW mas

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	6.84									
FRA	0.81	0.94								
NLD	0.80	0.72	4.15							
USA	0.82	0.84	0.74	2.69						
CHE	0.88	0.86	0.85	0.80	11.76					
DEA	0.90	0.69	0.88	0.71	0.88	11.95				
NZL	0.69	0.64	0.64	0.64	0.68	0.73	0.37			
ITA	0.87	0.73	0.82	0.74	0.89	0.92	0.69	14.78		
GBR	0.83	0.82	0.83	0.80	0.79	0.72	0.64	0.76	2.27	
SVN	0.79	0.72	0.75	0.72	0.71	0.84	0.75	0.81	0.74	11.15

GUE scs

	CAN	GBR	USA	AUS
CAN	6.01			
GBR	0.92	13.75		
USA	0.92	0.90	0.25	
AUS	0.84	0.90	0.80	0.27

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	URY
CAN	5.82																											
CHE	0.91	10.81																										

DEU	0.95	0.95	12.92																								
DFS	0.94	0.92	0.97	11.83																							
EST	0.90	0.88	0.93	0.92	17.60																						
FRA	0.95	0.94	0.97	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	0.95	4.23																			
USA	0.93	0.84	0.89	0.88	0.89	0.90	0.91	0.87	0.20																		
ISR	0.85	0.82	0.83	0.81	0.83	0.83	0.79	0.79	0.87	0.24																	
ITA	0.90	0.89	0.94	0.92	0.92	0.94	0.90	0.89	0.88	0.80	5.99																
AUS	0.83	0.88	0.85	0.85	0.79	0.88	0.90	0.87	0.77	0.69	0.80	0.28															
HUN	0.89	0.88	0.92	0.90	0.91	0.91	0.89	0.87	0.91	0.86	0.93	0.76	1.28														
BEL	0.92	0.92	0.97	0.96	0.93	0.96	0.93	0.94	0.89	0.80	0.94	0.83	0.92	0.52													
JPN	0.85	0.79	0.83	0.85	0.81	0.89	0.84	0.80	0.85	0.75	0.81	0.76	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	0.80	0.92	0.96	0.81	11.96											
ZAF	0.90	0.88	0.91	0.89	0.86	0.93	0.90	0.87	0.89	0.80	0.92	0.85	0.90	0.91	0.83	0.94	26.36										
NZL	0.74	0.80	0.76	0.77	0.69	0.79	0.83	0.78	0.68	0.63	0.70	0.91	0.64	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	0.78	0.73	0.80	0.85	0.81	0.85	0.76	0.83	0.82	0.79	0.12								
CZE	0.91	0.87	0.94	0.92	0.90	0.92	0.90	0.89	0.89	0.81	0.93	0.76	0.95	0.94	0.80	0.94	0.90	0.67	0.77	17.87							
SVK	0.84	0.84	0.89	0.89	0.87	0.88	0.83	0.82	0.84	0.78	0.89	0.72	0.92	0.91	0.77	0.90	0.88	0.60	0.79	0.92	0.40						
POL	0.89	0.87	0.93	0.92	0.92	0.91	0.89	0.88	0.85	0.80	0.91	0.78	0.93	0.94	0.78	0.92	0.86	0.68	0.82	0.92	0.86	14.33					
LTU	0.83	0.85	0.90	0.88	0.90	0.86	0.83	0.85	0.78	0.82	0.86	0.76	0.86	0.91	0.77	0.88	0.84	0.68	0.77	0.89	0.88	0.87	0.34				
LVA	0.87	0.89	0.93	0.93	0.94	0.91	0.91	0.90	0.86	0.80	0.91	0.84	0.92	0.94	0.79	0.91	0.88	0.76	0.83	0.91	0.86	0.92	0.88	478.17			
PRT	0.77	0.77	0.78	0.77	0.77	0.77	0.77	0.77	0.77	0.75	0.77	0.68	0.78	0.78	0.77	0.78	0.78	0.62	0.73	0.79	0.77	0.77	0.77	0.77	0.45		
KOR	0.87	0.82	0.87	0.89	0.85	0.87	0.89	0.83	0.86	0.80	0.86	0.82	0.84	0.86	0.81	0.86	0.82	0.75	0.72	0.84	0.77	0.85	0.79	0.88	0.77	0.33	
SVN	0.79	0.81	0.85	0.84	0.79	0.82	0.79	0.80	0.77	0.73	0.84	0.77	0.79	0.85	0.77	0.79	0.77	0.61	0.81	0.80	0.80	0.81	0.80	0.82	0.77	0.77	11.38
URY	0.77	0.80	0.83	0.79	0.78	0.81	0.78	0.78	0.77	0.75	0.78	0.79	0.78	0.82	0.77	0.79	0.83	0.74	0.75	0.77	0.81	0.81	0.79	0.78	0.77	0.77	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	URY
CAN	7.76																											
CHE	0.93	11.10																										
DEU	0.89	0.88	9.49																									
DFS	0.94	0.88	0.88	12.18																								
EST	0.80	0.84	0.80	0.84	17.62																							
FRA	0.95	0.94	0.90	0.92	0.79	1.14																						
GBR	0.88	0.89	0.82	0.84	0.77	0.88	2.34																					
NLD	0.84	0.90	0.80	0.84	0.80	0.86	0.83	5.01																				
USA	0.87	0.82	0.84	0.83	0.76	0.89	0.82	0.79	2.56																			
ISR	0.74	0.72	0.72	0.79	0.82	0.72	0.70	0.73	0.71	0.24																		
ITA	0.85	0.90	0.76	0.80	0.82	0.87	0.80	0.90	0.75	0.71	7.38																	
AUS	0.75	0.78	0.65	0.73	0.78	0.70	0.72	0.69	0.64	0.73	0.70	0.20																
HUN	0.84	0.85	0.74	0.82	0.89	0.82	0.81	0.85	0.76	0.83	0.90	0.78	1.28															
BEL	0.87	0.93	0.81	0.87	0.92	0.87	0.83	0.88	0.75	0.80	0.89	0.87	0.93	0.52														
JPN	0.74	0.81	0.68	0.72	0.76	0.72	0.69	0.79	0.68	0.75	0.73	0.80	0.79	0.84	0.45													
ESP	0.85	0.90	0.74	0.84	0.87	0.86	0.81	0.86	0.75	0.82	0.88	0.85	0.93	0.96	0.83	11.96												
ZAF	0.83	0.88	0.75	0.77	0.80	0.83	0.80	0.83	0.74	0.77	0.85	0.88	0.90	0.93	0.85	0.94	26.04											
NZL	0.62	0.67	0.62	0.62	0.70	0.62	0.62	0.62	0.62	0.71	0.62	0.90	0.71	0.76	0.76	0.75	0.80	0.40										
IRL	0.77	0.85	0.75	0.77	0.84	0.77	0.77	0.77	0.65	0.77	0.78	0.92	0.85	0.93	0.82	0.91	0.90	0.88	0.11									
CZE	0.84	0.88	0.77	0.82	0.89	0.83	0.81	0.86	0.73	0.80	0.89	0.80	0.94	0.95	0.82	0.94	0.91	0.71	0.87	17.87								
SVK	0.82	0.84	0.77	0.80	0.87	0.82	0.79	0.86	0.75	0.76	0.90	0.77	0.92	0.92	0.77	0.89	0.88	0.71	0.83	0.92	0.39							
POL	0.84	0.87	0.73	0.83	0.92	0.82	0.80	0.83	0.72	0.80	0.86	0.83	0.93	0.95	0.80	0.93	0.86	0.71	0.89	0.93	0.87	14.34						
LTU	0.77	0.77	0.72	0.78	0.87	0.76	0.74	0.75	0.68	0.77	0.78	0.76	0.86	0.89	0.77	0.86	0.80	0.70	0.81	0.89	0.86	0.87	0.33					
LVA	0.78	0.82	0.72	0.80	0.91	0.77	0.78	0.82	0.71	0.79	0.83	0.84	0.92	0.93	0.77	0.90	0.85	0.77	0.90	0.91	0.86	0.93	0.87	479.42				
PRT	0.71	0.79	0.68	0.72	0.77	0.72	0.69	0.74	0.68	0.75	0.72	0.74	0.80	0.82	0.77	0.79	0.81	0.71	0.80	0.83	0.77	0.78	0.76	0.80	0.45			
KOR	0.76	0.81	0.68	0.78	0.83	0.76	0.74	0.73	0.70	0.80	0.72	0.84	0.84	0.87	0.83	0.87	0.83	0.76	0.83	0.85	0.78	0.87	0.82	0.87	0.77	0.33		
SVN	0.76	0.78	0.74	0.78	0.76	0.77	0.73	0.71	0.67	0.70	0.76	0.77	0.78	0.84	0.75	0.79	0.73	0.69	0.82	0.83	0.74	0.82	0.81	0.82	0.76	0.76	11.36	
URY	0.69	0.74	0.71	0.68	0.78	0.68	0.70	0.71	0.68	0.74	0.70	0.79	0.79	0.83	0.77	0.79	0.84	0.76	0.83	0.80	0.81	0.82	0.78	0.81	0.77	0.77	0.74	0.20

JER scs

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE	ITA
CAN	5.96									
DFS	0.90	12.54								
GBR	0.92	0.93	11.62							
NLD	0.92	0.94	0.95	4.16						
USA	0.90	0.83	0.88	0.84	0.17					

AUS	0.78	0.86	0.86	0.87	0.74	0.26				
ZAF	0.85	0.86	0.86	0.89	0.83	0.82	21.07			
NZL	0.66	0.72	0.77	0.78	0.65	0.90	0.72	0.37		
CHE	0.86	0.85	0.85	0.89	0.81	0.72	0.81	0.66	13.81	
ITA	0.87	0.91	0.86	0.87	0.86	0.78	0.86	0.65	0.85	5.22

JER mas

	CAN	DFS	GBR	NLD	USA	AUS	ZAF	NZL	CHE	ITA
CAN	7.47									
DFS	0.91	11.72								
GBR	0.77	0.84	1.98							
NLD	0.82	0.84	0.81	4.75						
USA	0.80	0.75	0.73	0.71	2.57					
AUS	0.68	0.68	0.68	0.78	0.64	0.19				
ZAF	0.72	0.71	0.72	0.83	0.70	0.87	21.08			
NZL	0.63	0.63	0.63	0.68	0.63	0.90	0.75	0.37		
CHE	0.82	0.78	0.74	0.77	0.74	0.72	0.79	0.72	13.80	
ITA	0.81	0.76	0.78	0.86	0.74	0.71	0.81	0.69	0.83	5.22

RDC scs

	CAN	DFS	GBR	NOR	USA	DEU	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	6.05													
DFS	0.93	12.96												
GBR	0.94	0.92	11.77											
NOR	0.85	0.92	0.82	13.60										
USA	0.92	0.85	0.88	0.78	0.22									
DEU	0.94	0.96	0.95	0.90	0.88	14.52								
AUS	0.85	0.88	0.89	0.85	0.75	0.86	0.29							
EST	0.89	0.89	0.90	0.84	0.84	0.91	0.84	17.13						
ZAF	0.82	0.86	0.85	0.87	0.86	0.91	0.79	0.86	25.11					
NZL	0.74	0.75	0.79	0.72	0.68	0.76	0.89	0.70	0.74	0.42				
LTU	0.83	0.89	0.85	0.89	0.79	0.88	0.83	0.86	0.86	0.73	0.36			
LVA	0.87	0.87	0.90	0.83	0.84	0.92	0.83	0.95	0.88	0.72	0.86	431.66		
NLD	0.92	0.94	0.93	0.87	0.86	0.96	0.87	0.86	0.87	0.77	0.85	0.87	4.23	
CAM	0.88	0.88	0.88	0.87	0.86	0.88	0.83	0.87	0.88	0.79	0.87	0.87	0.89	6.17

RDC mas

	CAN	DFS	GBR	NOR	USA	AUS	EST	ZAF	NZL	LTU	LVA	NLD	CAM
CAN	9.30												
DFS	0.86	13.33											
GBR	0.87	0.82	2.09										
NOR	0.79	0.69	0.72	13.60									
USA	0.80	0.74	0.79	0.78	0.22								
AUS	0.72	0.66	0.72	0.89	0.71	0.21							
EST	0.80	0.71	0.80	0.85	0.78	0.84	17.13						
ZAF	0.82	0.79	0.83	0.86	0.80	0.83	0.82	25.18					
NZL	0.64	0.63	0.64	0.76	0.70	0.90	0.76	0.76	0.42				
LTU	0.75	0.71	0.74	0.86	0.78	0.86	0.88	0.83	0.79	0.36			
LVA	0.78	0.72	0.79	0.87	0.75	0.85	0.95	0.86	0.78	0.89	435.86		
NLD	0.83	0.80	0.85	0.86	0.84	0.79	0.83	0.84	0.68	0.80	0.82	4.85	
CAM	0.82	0.83	0.83	0.87	0.83	0.89	0.87	0.87	0.83	0.87	0.87	0.84	6.17

SIM scs

	FRM	FRA	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA
FRM	1.04										
FRA	0.88	1.02									
ITA	0.87	0.88	12.00								
NLD	0.91	0.93	0.84	4.01							
CHE	0.93	0.93	0.86	0.93	10.45						
DEA	0.91	0.96	0.84	0.92	0.89	12.28					
HUN	0.87	0.91	0.91	0.87	0.88	0.89	17.67				

SVN	0.85	0.79	0.78	0.79	0.82	0.79	0.81	10.19		
GBR	0.90	0.96	0.87	0.95	0.90	0.93	0.89	0.81	10.74	
HRV	0.86	0.78	0.77	0.78	0.81	0.77	0.80	0.78	0.81	9.72
USA	0.85	0.90	0.86	0.86	0.84	0.82	0.91	0.78	0.90	0.81	0.20

SIM mas

	ITA	NLD	CHE	DEA	HUN	SVN	GBR	HRV	USA
ITA	11.95								
NLD	0.77	4.24							
CHE	0.88	0.85	10.04						
DEA	0.84	0.89	0.75	12.28					
HUN	0.89	0.85	0.84	0.89	17.67				
SVN	0.78	0.74	0.80	0.79	0.81	10.19			
GBR	0.77	0.82	0.88	0.74	0.81	0.75	2.47		
HRV	0.77	0.69	0.80	0.77	0.81	0.78	0.78	9.72	
USA	0.76	0.81	0.82	0.82	0.76	0.70	0.80	0.79	0.19

^LAPPENDIX II. Number of common bulls

BSW scs

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	101	63	208	163	177	37	159	80	40
FRA	92	0	107	142	212	279	34	248	83	61
NLD	58	93	0	103	133	196	40	168	62	58
USA	206	104	94	0	349	371	45	261	110	49
CHE	140	168	121	327	0	721	41	567	96	98
DEA	158	227	184	339	613	0	62	804	104	132
NZL	37	26	33	42	32	56	0	52	31	15
ITA	141	209	142	190	511	702	42	0	104	115
GBR	79	79	58	107	79	77	29	83	0	34
SVN	35	58	57	39	93	118	14	107	29	0

BSW mas

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	FRA	NLD	USA	CHE	DEA	NZL	ITA	GBR	SVN
CAN	0	90	59	63	87	175	37	158	37	40
FRA	82	0	83	29	89	241	28	218	42	60
NLD	52	72	0	27	69	178	39	151	31	57
USA	64	28	25	0	32	56	16	49	20	14
CHE	80	75	64	28	0	320	22	269	28	81
DEA	158	190	165	50	287	0	62	802	52	132
NZL	37	23	32	15	18	56	0	52	16	15
ITA	140	181	125	39	242	702	42	0	56	115
GBR	35	40	29	18	24	41	14	47	0	22
SVN	35	56	56	13	78	118	14	107	20	0

GUE scs

common bulls below diagonal
common three quarter sib group above diagonal

	CAN	GBR	USA	AUS
CAN	0	36	82	58
GBR	31	0	95	48
USA	74	97	0	79
AUS	56	41	77	0

GUE mas

HOL scs

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	URY
CAN	0	1041	2919	1985	433	1767	2020	2093	4453	205	2181	1764	1308	1000	1621	1597	507	944	629	1307	492	2094	349	617	1515	831	230	975
CHE	967	0	1331	876	229	822	816	1087	1165	76	836	731	497	706	555	659	257	482	428	527	257	873	148	290	668	314	146	385
DEU	2412	1270	0	3346	659	2744	2416	4184	4171	223	2950	1939	1552	1501	1650	1869	551	1182	914	2064	751	3790	634	897	1813	732	393	983
DFS	1827	833	2694	0	518	1988	1872	2800	2763	204	1916	1559	1177	1107	1208	1340	507	1031	796	1442	470	2541	423	601	1440	590	288	820
EST	316	143	517	380	0	348	392	570	561	80	444	307	300	264	277	288	114	206	161	372	150	562	132	214	304	156	105	209
FRA	1384	781	1803	1326	201	0	1749	2366	2759	152	1683	1467	1107	1158	1348	1485	501	924	738	1296	462	2294	302	502	1349	619	214	716
GBR	2279	784	1940	1512	256	1254	0	2138	2705	196	1701	1660	1045	1029	1210	1252	509	1087	1085	1142	413	1922	366	513	1272	575	204	856
NLD	2076	1087	4065	2584	437	1780	1935	0	3192	218	2095	1749	1236	1568	1315	1451	517	1307	955	1718	614	2819	436	633	1586	594	307	869
USA	5141	1099	3320	2354	447	1729	2530	2955	0	348	3090	2335	1676	1176	2287	1889	635	1352	869	1921	628	3188	469	848	1935	1009	261	1437
ISR	146	43	169	150	42	93	143	171	345	0	190	152	153	105	152	136	66	150	120	165	62	242	74	96	152	81	51	125
ITA	2043	777	2410	1737	311	1254	1476	1982	2810	135	0	1257	1292	922	1270	1487	375	723	564	1428	435	2491	401	635	1374	671	299	787
AUS	1802	649	1525	1190	174	1071	1475	1556	2415	98	1052	0	859	880	1059	1050	482	1395	772	896	342	1441	287	463	1099	532	166	832
HUN	1258	417	1304	1003	190	858	907	1088	1696	104	1208	662	0	650	861	956	394	589	464	1040	369	1398	301	445	1009	535	175	620
BEL	1004	720	1551	1056	172	1204	1017	1799	1069	66	949	781	570	0	654	821	338	609	540	702	330	1153	209	343	914	361	174	432
JPN	957	391	848	740	117	587	684	796	1218	79	741	643	525	446	0	1067	430	665	459	934	349	1317	252	439	947	648	165	700
ESP	1143	556	1290	1090	153	1273	1012	1335	1352	83	1159	783	792	812	571	0	449	645	516	960	355	1595	271	443	1187	574	199	638
ZAF	466	216	430	390	56	398	444	439	619	42	303	420	315	288	300	401	0	369	296	333	180	449	102	164	468	267	53	326
NZL	927	405	925	758	113	616	943	1193	1309	117	598	1399	457	499	384	499	299	0	808	642	276	926	211	299	746	352	123	656
IRL	564	410	757	635	81	586	1049	856	759	89	489	639	369	498	295	467	246	675	0	463	215	746	160	223	570	235	101	406
CZE	995	370	1621	1033	243	873	776	1529	1573	128	1160	595	923	540	488	659	216	450	312	0	474	1765	338	479	1010	530	224	610
SVK	346	132	569	257	64	269	241	442	435	26	287	172	259	204	137	185	97	165	101	379	0	560	116	178	400	222	77	263
POL	1970	791	3878	2340	447	1878	1781	2844	3298	200	2360	1192	1333	1140	798	1338	372	757	622	1570	426	0	518	827	1683	709	337	900
LTU	219	65	592	274	68	141	212	290	346	39	240	142	196	108	99	123	38	109	86	228	53	421	0	222	289	170	87	203
LVA	403	154	735	387	121	284	299	444	754	65	426	240	326	206	201	250	94	168	122	315	85	712	149	0	533	287	116	325
PRT	1561	619	1760	1373	211	1323	1191	1638	2052	101	1377	939	1008	947	609	1211	418	609	479	853	271	1827	188	435	0	584	186	703
KOR	811	224	519	447	76	402	423	441	1141	42	569	389	430	271	413	418	198	259	157	376	133	606	76	174	503	0	107	460
SVN	178	108	389	236	63	166	147	270	210	34	270	116	133	139	95	146	37	86	79	162	35	305	40	68	146	71	0	102
URY	937	298	744	597	122	489	709	721	1736	70	617	662	488	338	429	503	292	546	313	416	153	765	108	190	599	355	55	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	URY
CAN	0	339	863	1104	291	1018	1164	469	1607	138	1390	956	880	666	1013	1071	252	545	348	894	277	1435	255	373	966	595	188	596
CHE	301	0	318	319	103	319	307	201	302	30	318	258	164	265	217	251	66	181	137	193	78	345	70	89	235	134	88	134
DEU	706	294	0	1188	326	978	907	684	833	106	1041	674	688	691	626	816	200	462	336	822	248	1775	331	429	748	332	302	395
DFS	1129	298	1073	0	470	1512	1587	939	1320	184	1320	1310	1076	992	1132	1248	489	952	699	1316	386	2289	383	470	1313	543	256	692
EST	218	64	244	348	0	297	365	249	359	79	359	280	291	253	270	283	111	200	140	365	136	547	125	188	291	151	103	194
FRA	864	293	763	1028	174	0	1351	622	1008	129	1170	1055	977	1000	1074	1275	411	736	583	1150	351	2008	256	391	1157	528	201	552
GBR	1191	287	755	1305	246	1020	0	699	1410	195	1359	1403	1001	961	1110	1186	467	1000	925	1101	361	1826	334	420	1187	535	197	749
NLD	456	191	631	962	186	536	686	0	486	112	602	529	456	657	441	554	207	571	377	773	192	1164	199	253	621	231	158	332
USA	1848	263	717	1349	300	835	1527	451	0	265	1663	1117	1098	669	1191	1061	351	708	440	1121	327	1956	310	499	1192	715	200	854
ISR	90	14	71	129	42	78	141	89	260	0	159	145	149	104	150	136	64	149	97	165	60	240	69	77	152	80	50	118
ITA	1236	281	824	1222	252	900	1203	560	1718	106	0	929	1077	758	1042	1208	298	591	410	1154	326	1900	319	420	1113	572	240	611
AUS	1026	231	561	992	170	789	1246	478	1233	92	813	0	791	782	971	974	444	1254	666	816	286	1292	255	367	993	476	158	711
HUN	847	128	562	919	190	747	884	391	1166	102	1026	622	0	635	851	946	382	583	415	1034	346	1373	287	375	987	515	169	553
BEL	697	259	700	941	170	1017	975	686	646	66	776	706	567	0	633	808	330	594	493	690	302	1125	196	297	892	352	174	402
JPN	725	162	410	678	117	521	668	335	969	79	664	610	525	446	0	1067	427	657	432	934	323	1303	236	390	926	623	163	623
ESP	772	203	589	1010	153	1063	989	527	896	83	943	743	790	812	571	0	440	643	480	959	325	1585	253	400	1169	560	197	580
ZAF	237	52	156	374	56	325	429	185	394	42	254	396	315	288	300	400	0	363	284	328	168	439	95	162	456	254	53	300
NZL	483	156	375	692	112	512	845	519	682	117	499	1212	455	496	384	498	297	0	719	642	264	910	200	266	731	342	123	609
IRL	345	134	303	531	74	481	905	358	424	70	366	557	336	464	271	438	234	589	0	426	191	666	144	200	517	229	87	355
CZE	704	137	642	911	243	725	761	730	1064	128	950	544	923	540	488	659	216	450	276	0	447	1746	320	417	991	512	224	555
SVK	195	29	149	219	64	211	232	107	233	26	219	154	255	198	137	185	96	163	96	379	0	511	104	158	378	207	73	234
POL	1391	297	1922	2077	444	1628	1730	1221	2219	199	1814	1102	1325	1131	798	1338	372	752	557	1570	414	0	489	672	1638	681	332	818
LTU	169	28	277	259	67	128	208	131	238	39	192	140	195	108	99	123	38	107	70	228	52	415	0	190	269	154	83	184
LVA	229	34	340	284	107	203	250	157	417	49	258	185	279	176	177	223	94	147	107	272	79	575	127	0	461	258	104	278
PRT	999	205	686	1241	210	1146	1149	649	1302	101	1127	855	999	944	609	1211	417	607	446	853	264	1802	186	374	0	563	185	642
KOR	584	104	241	414	76	360	408	173	778	42	504	356	426	271	413	418	197	255	158	376	130	593	74	157	498	0	106	413
SVN	145	66	302	206	63	159	145	128	160	34	211	114	132	139	95	146	37	86	67	162	35	305	40	61	146	71	0	98
URY	572	96	304	533	122	403	673	273	941	70	503	625	473	336	429	503	289	542	295	416	152	748	108	171	589	346	55	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	173	209	71	561	309	168	236	49	29
DFS	169	0	229	216	274	193	171	213	66	34
GBR	208	222	0	129	295	265	181	280	79	38
NLD	64	220	122	0	146	94	90	123	45	23
USA	593	260	319	151	0	570	314	467	82	38
AUS	317	165	267	84	619	0	251	510	65	37
ZAF	164	154	183	86	328	240	0	221	59	34
NZL	246	193	287	117	540	562	229	0	62	33
CHE	43	65	75	38	83	55	52	53	0	26
ITA	25	33	37	21	38	33	31	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	66	98	26	120	133	80	112	32	21
DFS	62	0	155	175	84	146	150	173	62	31
GBR	96	148	0	98	108	187	145	213	69	37
NLD	19	172	94	0	59	81	85	110	42	23
USA	111	77	110	53	0	178	135	171	47	24
AUS	123	115	188	73	186	0	226	454	57	35
ZAF	73	130	146	82	146	223	0	216	56	34
NZL	105	146	219	104	169	501	226	0	58	33
CHE	30	59	65	36	41	50	51	52	0	26
ITA	16	29	34	21	23	31	31	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	214	102	8	232	14	114	3	70	104	22	10	8	0
DFS	221	0	143	158	237	75	232	162	51	218	113	136	74	0
GBR	102	137	0	91	143	16	114	19	40	108	31	16	51	0
NOR	7	133	95	0	92	21	89	38	0	64	28	22	60	0
USA	221	235	138	93	0	32	163	34	59	147	44	28	57	32
DEU	13	66	16	20	30	0	50	37	1	27	27	39	23	0
AUS	114	204	109	78	166	49	0	52	34	182	50	41	53	14
EST	2	150	17	37	32	36	47	0	0	26	28	55	32	0
ZAF	72	48	35	0	53	1	34	0	0	35	5	2	3	0
NZL	103	215	104	63	147	26	182	24	30	0	31	22	36	13
LTU	21	100	29	25	39	27	47	27	5	29	0	48	22	0
LVA	10	94	16	20	25	32	37	47	2	18	43	0	20	0
NLD	8	72	50	59	56	22	51	31	3	35	21	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	35	3	86	32	0	35	41	18	7	3	0
DFS	93	0	102	158	229	221	162	46	214	112	126	70	0
GBR	34	99	0	78	105	74	15	26	77	25	14	41	0
NOR	3	132	82	0	92	86	38	0	64	28	19	53	0
USA	86	227	104	93	0	130	34	54	144	44	25	53	32
AUS	32	196	73	76	132	0	50	29	156	45	38	50	12
EST	0	150	14	37	32	46	0	0	26	28	49	29	0

ZAF	36	46	25	0	52	30	0	0	33	5	2	2	0
NZL	41	209	78	63	147	157	24	30	0	31	17	31	13
LTU	17	99	23	25	39	43	27	5	29	0	46	21	0
LVA	7	84	14	17	22	35	41	2	14	41	0	15	0
NLD	3	68	41	52	53	48	28	2	30	20	14	0	0
CAM	0	0	0	0	32	12	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	160	141	255	216	2	0	67	0	100
FRA	0	0	157	91	15	278	7	52	0	111	3
ITA	189	142	0	303	108	1146	26	167	46	347	41
NLD	168	86	294	0	97	467	13	94	49	179	35
CHE	305	12	110	100	0	400	2	1	53	3	34
DEA	250	235	1055	487	365	0	50	297	49	738	42
HUN	0	5	22	12	1	34	0	12	0	27	1
SVN	0	49	154	87	1	282	10	0	0	124	2
GBR	85	0	51	49	60	53	0	0	0	0	20
HRV	0	99	330	173	3	774	23	115	0	0	6
USA	114	3	48	36	33	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	286	12	1142	26	167	17	347	41
NLD	279	0	10	426	12	88	19	171	35
CHE	12	10	0	122	0	0	1	0	5
DEA	1054	443	115	0	50	297	21	738	41
HUN	22	10	0	34	0	12	0	27	1
SVN	154	82	0	282	10	0	0	124	2
GBR	23	21	1	26	0	0	0	0	17
HRV	330	165	0	774	23	115	0	0	6
USA	48	36	5	43	1	2	23	6	0