

## Introduction

The latest international evaluation for dairy production traits took place as scheduled at the Interbull Centre. Data from thirty-three (33) countries were included in this evaluation.

International genetic evaluations for milk, fat and protein yields of bulls from Australia, Austria-Germany, Belgium, Canada, Croatia, Czech Republic, Denmark-Finland-Sweden, Estonia, France, Hungary, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Netherlands, New Zealand, Norway, Poland, Republic of South Africa, Slovak Republic, Slovenia, Spain, Switzerland, the United Kingdom, the United States of America, Portugal, Korea, and Uruguay were computed. Brown Swiss, Guernsey, Holstein, Jersey, Red Dairy Cattle and Simmental breed data were included in this evaluation.

## Changes in national procedures

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

HRV (HOL,SIM)	Data now provided by the new organization HAPIH
ITA (BSW)	Base change. Updated the data and pedigree editing procedures and fixed effects.
MEX (HOL)	No longer participating
BEL (HOL)	Few bulls missing due to no longer having enough daughters. Some bulls changed in ToP due to the new program assigning such values.
AUS (ALL)	Change in information due to data clean up: pedigree changes or changes in status of a bull causing a good number of bulls to be no longer qualified.
DFS (JER)	Few bulls missing due to update in pedigree
JPN (HOL)	Small decrease in information due to pedigree's update
FRA (BSW,HOL)	Base change
ITA (SIM)	Base change
SVN (ALL)	Base change
GBR (ALL)	Base change
EST (HOL,RDC)	Small changes in information due to pedigree updates
DEA (ALL)	Change of base to cow base group instead of the former defined bull base group.
CHE (ALL)	Slight changes in number of daughters, number of herds and EDC are due to manual edits in the database.
USA (BSW,RDC)	Drops in information due to editing of data
ITA (HOL)	Cut-off of one year of data causing decrease in information. Base change
IRL (ALL)	Changes in number of daughters, edc and herd numbers due to pedigree changes
DEU (ALL)	Base change, few bulls lost daughters/herds/EDC due to data editing
LVA (RDC)	Updating the genetic base code to use breed code RDC rather than Ayrshire
NZL (ALL)	Drops in information due to continuous DNA parentage testing
CAN (ALL)	Base change
URY (HOL)	FAT: Changes in database for fat percent cause drops in information
LTU (HOL)	Base change

## INTERBULL CHANGES COMPARED TO THE PREVIOUS ROUTINE RUN

### Post-processing Windows:

According to the decision taken by ITC in Orlando (2015) to review the post-processing windows every 5 years, during the 2020 the relative working group has been re-activated and new windows have been identified.

As before, the upper bounds have been set to 0.99 as these were judged to have very little effect on evaluations while the lower values have been reduced to the 10th percentile. This reduction would provide post-processed correlations to be closer to the real estimated ones. Over the past five years, in fact, the previous adopted lower value (25th percentile) had been found too high causing estimated and post-processed correlations to differ significantly from each other. The new lower values have been applied to all breeds and traits.

The weight assigned to the magnitude of the changes tested by each country has also been revised. The new weight will allow post-processed correlations to take more in consideration the value of the new estimated ones even when no changes are applied by the countries.

The new weights are as follows:

No changes    :: 2

Small changes:: 1  
Big changes :: 0

More information can be read on [https://interbull.org/ib/rg\\_procedure](https://interbull.org/ib/rg_procedure)

#### DATA AND METHOD OF ANALYSIS

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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

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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

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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 dairy production traits (April Routine Evaluation 2021).  
Number of records for milk yield by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS	213	142	8495	1827	764	
BEL			2161			
CAN	268	103	13149	809	846	
CHE	3075		3604	95		3415
CZE			4869			
DEA	6182					25055
DEU			22996	195	280	
DFS			13587	2255	7864	
ESP			4110			
EST			1247		465	
FRA	419		17545			489
FRM						4877
GBR	175	353	7669	934	662	94
HUN			3539			237
IRL			2893	161	61	100
ISR			1558			
ITA	2231		9162	172		1862
JPN			6328			
KOR			1550			
LTU			1283		438	
LVA			1339		723	
NLD	203		16131	193	88	444
NOR					4222	
NZL	62	61	8318	5167	1451	
POL			11386			
PRT			2465			
SVK			1153			
SVN	405		638			692
URY			1100			
USA	1151	798	40373	5018	752	77
ZAF			1318	729	143	

HRV			865			959
CAM				44		
No. Records	14384	1457	210831	17555	18803	38301
Pub. Proofs	11589	1157	155235	14076	16746	34539

^LAPPENDIX I. Sire standard deviations in diagonal and genetic correlations below diagonal

BSW mil

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	655.61										
FRA	0.89	630.03									
USA	0.92	0.88	640.62								
CHE	0.91	0.88	0.87	488.05							
ITA	0.88	0.81	0.88	0.86	605.19						
DEA	0.87	0.82	0.86	0.94	0.89	463.94					
NLD	0.88	0.86	0.87	0.85	0.86	0.87	662.80				
SVN	0.78	0.77	0.77	0.76	0.72	0.75	0.76	9.28			
NZL	0.67	0.73	0.68	0.70	0.65	0.66	0.70	0.66	375.87		
GBR	0.86	0.88	0.86	0.87	0.82	0.81	0.85	0.77	0.69	275.27	
AUS	0.74	0.76	0.71	0.70	0.67	0.67	0.73	0.70	0.83	0.73	390.34

BSW fat

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	27.97										
FRA	0.88	26.63									
USA	0.90	0.89	23.62								
CHE	0.86	0.87	0.84	19.31							
ITA	0.88	0.83	0.86	0.86	23.14						
DEA	0.84	0.84	0.84	0.94	0.87	17.32					
NLD	0.86	0.85	0.86	0.83	0.85	0.86	26.42				
SVN	0.77	0.77	0.78	0.76	0.71	0.76	0.76	9.65			
NZL	0.67	0.71	0.71	0.72	0.62	0.78	0.67	0.71	16.85		
GBR	0.86	0.89	0.86	0.88	0.82	0.81	0.86	0.77	0.70	10.36	
AUS	0.73	0.72	0.73	0.67	0.67	0.68	0.69	0.68	0.79	0.71	15.44

BSW pro

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	23.43										
FRA	0.84	20.19									
USA	0.89	0.86	18.91								
CHE	0.84	0.83	0.83	15.50							
ITA	0.85	0.80	0.83	0.84	21.18						
DEA	0.83	0.79	0.82	0.92	0.88	14.47					
NLD	0.85	0.82	0.84	0.82	0.82	0.84	21.73				
SVN	0.76	0.75	0.76	0.74	0.74	0.74	0.75	9.03			
NZL	0.57	0.62	0.60	0.63	0.54	0.69	0.60	0.59	12.59		
GBR	0.84	0.84	0.83	0.84	0.80	0.79	0.84	0.76	0.62	7.96	
AUS	0.70	0.68	0.67	0.65	0.64	0.65	0.67	0.66	0.77	0.68	11.96

GUE mil

	CAN	USA	AUS	GBR	NZL
CAN	763.45				
USA	0.94	781.76			
AUS	0.79	0.75	468.18		
GBR	0.86	0.82	0.74	244.02	
NZL	0.70	0.68	0.83	0.70	299.13





JER fat												
	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	27.04											
DFS	0.89	11.16										
USA	0.90	0.89	26.54									
NZL	0.67	0.68	0.71	11.94								
AUS	0.77	0.70	0.76	0.79	13.71							
GBR	0.82	0.81	0.82	0.66	0.70	9.54						
NLD	0.87	0.85	0.84	0.66	0.69	0.83	25.44					
ZAF	0.79	0.78	0.78	0.66	0.69	0.74	0.75	13.75				
ITA	0.88	0.84	0.87	0.65	0.71	0.79	0.82	0.79	25.72			
DEU	0.92	0.91	0.90	0.68	0.73	0.85	0.90	0.79	0.87	23.35		
IRL	0.79	0.78	0.74	0.82	0.80	0.75	0.79	0.67	0.73	0.77	6.25	
CHE	0.86	0.85	0.83	0.69	0.74	0.83	0.84	0.78	0.82	0.89	0.79	16.08

JER pro												
	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	19.49											
DFS	0.90	10.54										
USA	0.89	0.90	20.32									
NZL	0.62	0.65	0.65	8.49								
AUS	0.70	0.67	0.67	0.75	10.39							
GBR	0.82	0.83	0.80	0.62	0.68	6.97						
NLD	0.87	0.87	0.84	0.63	0.68	0.82	19.84					
ZAF	0.82	0.79	0.79	0.68	0.70	0.76	0.76	10.90				
ITA	0.86	0.85	0.86	0.60	0.68	0.79	0.82	0.86	19.74			
DEU	0.89	0.93	0.90	0.60	0.66	0.83	0.91	0.78	0.85	19.17		
IRL	0.74	0.74	0.73	0.83	0.80	0.72	0.76	0.68	0.72	0.75	5.58	
CHE	0.82	0.83	0.80	0.61	0.66	0.81	0.83	0.76	0.80	0.87	0.77	11.31

RDC mil															
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	603.12														
NOR	0.88	12.03													
USA	0.92	0.91	697.60												
NZL	0.66	0.72	0.68	318.30											
AUS	0.73	0.74	0.74	0.82	413.79										
GBR	0.83	0.83	0.83	0.70	0.76	254.71									
DFS	0.90	0.91	0.88	0.66	0.73	0.82	10.30								
DEU	0.93	0.84	0.90	0.67	0.72	0.85	0.93	658.80							
ZAF	0.83	0.86	0.84	0.71	0.74	0.78	0.80	0.80	609.22						
EST	0.88	0.88	0.90	0.70	0.74	0.81	0.85	0.83	0.80	495.82					
LVA	0.79	0.81	0.80	0.65	0.70	0.78	0.79	0.78	0.79	0.82	317.90				
LTU	0.78	0.79	0.76	0.63	0.68	0.76	0.75	0.77	0.79	0.77	0.79	311.92			
IRL	0.83	0.75	0.80	0.82	0.81	0.79	0.81	0.83	0.77	0.76	0.74	0.74	177.60		
NLD	0.91	0.92	0.89	0.71	0.76	0.86	0.92	0.93	0.79	0.84	0.78	0.77	0.84	760.45	
CAM	0.86	0.88	0.93	0.73	0.77	0.85	0.85	0.85	0.86	0.86	0.85	0.84	0.82	0.85	445.33

RDC fat															
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	23.60														
NOR	0.87	11.52													
USA	0.90	0.83	26.49												
NZL	0.65	0.77	0.69	12.84											
AUS	0.72	0.73	0.76	0.81	15.13										
GBR	0.83	0.81	0.84	0.69	0.73	8.56									
DFS	0.90	0.89	0.87	0.69	0.73	0.83	10.31								
DEU	0.92	0.88	0.91	0.67	0.72	0.87	0.91	25.13							
ZAF	0.80	0.85	0.83	0.63	0.68	0.76	0.77	0.77	19.52						
EST	0.86	0.82	0.88	0.70	0.71	0.81	0.83	0.85	0.80	19.62					
LVA	0.79	0.80	0.80	0.63	0.68	0.78	0.78	0.80	0.79	0.84	13.79				

LTU	0.77	0.79	0.77	0.66	0.71	0.76	0.75	0.76	0.79	0.78	0.78	14.78			
IRL	0.81	0.74	0.80	0.80	0.80	0.78	0.81	0.80	0.68	0.81	0.70	0.74	7.45		
NLD	0.89	0.87	0.88	0.66	0.71	0.86	0.91	0.93	0.76	0.83	0.79	0.77	0.81	28.05	
CAM	0.86	0.86	0.94	0.68	0.76	0.85	0.86	0.85	0.86	0.86	0.85	0.85	0.82	0.86	22.50

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RDC      pro  
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	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	18.34														
NOR	0.86	11.46													
USA	0.89	0.89	19.88												
NZL	0.56	0.71	0.63	9.38											
AUS	0.67	0.72	0.69	0.76	12.00										
GBR	0.82	0.82	0.82	0.59	0.70	6.83									
DFS	0.89	0.88	0.86	0.61	0.67	0.81	10.44								
DEU	0.90	0.85	0.89	0.56	0.67	0.84	0.92	19.60							
ZAF	0.80	0.85	0.80	0.65	0.70	0.75	0.77	0.77	16.31						
EST	0.83	0.82	0.87	0.60	0.69	0.80	0.80	0.83	0.78	15.29					
LVA	0.78	0.80	0.78	0.55	0.65	0.77	0.76	0.77	0.78	0.78	9.33				
LTU	0.76	0.78	0.75	0.53	0.64	0.75	0.74	0.75	0.78	0.76	0.76	9.39			
IRL	0.75	0.76	0.76	0.78	0.79	0.75	0.75	0.75	0.68	0.71	0.69	0.68	5.45		
NLD	0.87	0.92	0.85	0.60	0.68	0.84	0.90	0.92	0.77	0.81	0.77	0.76	0.77	25.97	
CAM	0.85	0.86	0.91	0.72	0.77	0.85	0.85	0.85	0.86	0.86	0.85	0.85	0.80	0.85	11.28

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SIM      mil  
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	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	567.97											
DEA	0.87	508.16										
FRM	0.95	0.85	613.92									
ITA	0.81	0.77	0.78	503.69								
SVN	0.79	0.77	0.80	0.76	8.58							
FRA	0.92	0.88	0.85	0.85	0.80	667.11						
HUN	0.85	0.79	0.85	0.85	0.78	0.85	416.59					
NLD	0.88	0.93	0.89	0.81	0.76	0.88	0.85	762.60				
IRL	0.82	0.73	0.85	0.71	0.73	0.87	0.78	0.80	177.50			
GBR	0.88	0.87	0.87	0.81	0.75	0.86	0.82	0.86	0.78	226.37		
HRV	0.76	0.74	0.85	0.74	0.75	0.75	0.77	0.75	0.71	0.75	10.96	
USA	0.88	0.82	0.83	0.88	0.79	0.91	0.90	0.89	0.80	0.84	0.76	544.57

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SIM      fat  
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	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	22.74											
DEA	0.87	19.20										
FRM	0.93	0.89	24.07									
ITA	0.81	0.81	0.79	19.82								
SVN	0.79	0.77	0.78	0.76	8.79							
FRA	0.90	0.90	0.86	0.85	0.78	27.13						
HUN	0.81	0.80	0.85	0.86	0.86	0.78	16.55					
NLD	0.87	0.93	0.89	0.80	0.76	0.87	0.81	28.20				
IRL	0.76	0.73	0.82	0.69	0.72	0.84	0.70	0.78	7.59			
GBR	0.91	0.86	0.86	0.81	0.74	0.88	0.81	0.86	0.76	8.20		
HRV	0.73	0.70	0.83	0.70	0.71	0.73	0.74	0.71	0.69	0.73	10.84	
USA	0.86	0.86	0.83	0.89	0.78	0.91	0.89	0.88	0.76	0.86	0.74	20.64

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SIM      pro  
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	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	16.94											
DEA	0.86	15.50										
FRM	0.93	0.85	19.00									
ITA	0.78	0.76	0.77	15.84								
SVN	0.77	0.75	0.77	0.74	8.69							
FRA	0.89	0.85	0.85	0.81	0.78	21.23						





CAN	0	72	50	35	14
USA	63	0	66	95	32
AUS	47	62	0	40	27
GBR	28	96	33	0	16
NZL	11	29	27	14	0

GUE

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	USA	AUS	GBR	NZL
CAN	0	72	50	35	14
USA	63	0	66	95	32
AUS	47	62	0	40	27
GBR	28	96	33	0	16
NZL	11	29	27	14	0

GUE

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	USA	AUS	GBR	NZL
CAN	0	72	50	35	14
USA	63	0	66	95	32
AUS	47	62	0	40	27
GBR	28	96	33	0	16
NZL	11	29	27	14	0

HOL

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL	ESP	CZE	SVN	EST	ISR	HUN	POL	ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	HRV
CAN	0	2395	1517	1512	1700	1588	3583	925	1748	773	1471	854	568	1331	1227	228	275	140	1082	1513	516	1347	518	444	327	1045	727	507	323
DEU	1805	0	2637	2376	2455	3276	3508	1186	2083	976	1662	1250	854	1536	1965	342	437	169	1266	2607	561	1388	813	693	649	1218	646	483	657
DFS	1304	1929	0	1664	1529	2165	2154	753	1594	856	1333	906	732	1058	1368	272	310	155	952	1692	515	977	508	417	390	940	511	427	427
FRA	1002	1234	882	0	1601	1993	2523	705	1560	804	1298	953	730	1168	1342	215	271	127	969	1726	482	1197	443	430	312	931	544	409	305
ITA	1345	1564	1128	824	0	1664	2512	720	1521	684	1159	799	597	1225	1265	246	283	138	1014	1648	448	1117	512	384	349	958	596	414	384
NLD	1525	3022	1900	1224	1313	0	2563	931	1803	1066	1502	1327	877	1144	1647	289	384	164	1007	1963	524	1059	571	551	422	1057	508	435	463
USA	4017	2505	1637	1325	1705	2247	0	1050	2314	1104	1976	1011	790	1583	1810	263	362	198	1393	2218	648	1952	690	558	441	1312	892	688	409
CHE	790	1056	673	611	632	906	940	0	747	415	645	630	397	585	580	152	176	66	457	723	273	485	300	244	195	512	282	222	216
GBR	1981	1576	1203	947	1119	1571	2072	677	0	946	1451	892	959	1102	1164	228	267	152	906	1424	520	1045	451	390	336	959	522	455	346
NZL	780	749	609	471	485	971	1052	343	818	0	1222	533	710	552	678	138	146	113	519	686	370	570	261	265	194	572	330	369	226
AUS	1494	1236	972	862	827	1318	1981	556	1248	1228	0	775	727	916	930	191	226	118	760	1095	487	903	404	316	273	792	471	445	308
BEL	854	1287	849	929	763	1530	904	635	882	435	682	0	517	703	741	194	206	86	569	863	343	560	320	306	221	672	318	256	284
IRL	531	736	595	563	485	816	703	399	975	613	622	510	0	505	560	124	139	100	449	611	333	438	221	210	162	490	241	273	187
ESP	865	987	790	832	846	1020	1027	465	859	418	644	682	477	0	933	206	218	112	797	1109	456	919	393	325	250	834	501	369	292
CZE	932	1564	924	851	892	1515	1454	429	844	506	631	610	444	683	0	239	288	136	1006	1465	439	891	476	528	353	852	513	415	391
SVN	168	331	219	147	207	250	201	109	168	97	134	155	94	151	180	0	99	50	176	284	102	179	130	92	86	173	107	78	125
EST	168	314	191	128	158	277	246	96	151	75	114	132	72	100	181	59	0	52	215	349	111	213	206	122	124	200	127	112	133
ISR	99	131	113	65	85	124	185	39	105	91	74	55	75	65	103	36	32	0	120	153	66	110	75	52	60	105	64	70	70
HUN	1016	1003	758	645	850	851	1360	366	784	407	576	492	393	635	936	131	131	82	0	1023	404	741	359	328	245	725	478	380	272
POL	1318	2368	1381	1129	1265	1830	2129	588	1204	521	835	797	501	782	1230	255	250	115	912	0	426	1010	667	464	475	1029	592	430	495
ZAF	480	439	395	338	337	446	637	224	457	310	429	293	300	409	313	73	56	43	336	322	0	429	175	183	120	443	276	277	158
JPN	672	593	512	411	510	542	840	301	521	290	487	354	270	421	395	97	77	45	397	529	283	0	366	314	234	698	569	396	236
LVA	318	672	326	212	327	394	571	156	268	149	204	198	130	210	325	78	126	49	265	547	101	156	0	193	248	414	248	191	275
SVK	311	511	222	224	218	385	371	124	221	159	159	187	104	163	455	50	54	22	230	324	100	108	100	0	140	327	213	185	148
LTU	176	602	226	115	183	264	300	86	174	92	123	114	79	100	239	46	64	29	149	370	49	75	171	72	0	245	155	125	176
PRT	1092	1115	830	777	873	1062	1372	453	878	469	632	681	444	799	717	137	140	76	721	1030	399	409	320	226	157	0	478	403	327
KOR	702	439	368	311	473	361	1023	196	381	240	342	232	168	351	376	66	61	38	387	492	208	331	146	131	67	397	0	306	153
URY	501	361	310	243	310	348	859	167	385	294	342	201	225	301	322	48	68	37	326	370	237	242	115	122	74	367	249	0	144
HRV	191	680	333	189	281	420	309	137	245	132	194	234	128	218	294	97	97	48	201	445	107	109	215	74	123	267	69	96	0

HOL

common bulls below diagonal		common three quarter sib group above diagonal																											
	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL	ESP	CZE	SVN	EST	ISR	HUN	POL	ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	HRV
CAN	0	2395	1517	1512	1701	1588	3583	925	1748	773	1471	854	568	1331	1227	228	275	140	1082	1513	516	1343	518	444	327	1044	727	507	322
DEU 1805	0	2637	2376	2456	3276	3508	1186	2083	976	1662	1250	854	1536	1965	342	437	169	1266	2607	561	1384	813	693	649	1217	646	483	656	
DFS 1304 1929	0	1664	1531	2165	2154	753	1594	856	1333	906	732	1058	1368	272	310	155	952	1692	515	974	508	417	390	940	511	427	426		
FRA 1002 1234 882	0	1602	1993	2523	705	1560	804	1298	953	731	1168	1342	215	271	127	969	1726	482	1193	443	430	312	930	544	409	305			
ITA 1349 1567 1132 826	0	1665	2514	721	1522	684	1160	800	597	1225	1266	246	283	138	1014	1649	448	1114	513	385	349	957	596	415	383				
NLD 1525 3022 1900 1224 1315	0	2563	931	1803	1066	1502	1327	879	1144	1647	289	384	164	1007	1963	524	1054	571	551	422	1057	508	435	462					
USA 4017 2505 1637 1325 1710 2247	0	1050	2314	1104	1976	1011	790	1583	1810	362	198	1393	2218	648	1948	690	558	441	1311	892	688	408							
CHE 790 1056 673 611 634 906 940	0	747	415	645	630	397	585	580	152	176	66	457	723	273	481	300	244	195	512	282	222	215							
GBR 1981 1576 1203 947 1122 1571 2072 677	0	946	1451	892	960	1102	1164	228	267	152	906	1424	520	1041	451	390	336	958	522	455	346								
NZL 780 749 609 471 486 971 1052 343 818	0	1222	533	710	552	678	138	146	113	519	686	370	570	261	265	194	572	330	369	225									
AUS 1494 1236 972 862 829 1318 1981 556 1248 1228	0	775	727	916	930	191	226	118	760	1095	487	900	404	316	273	792	471	445	308										
BEL 854 1287 849 929 765 1530 904 635 882 435 682	0	517	703	741	194	206	86	569	863	343	558	320	306	221	672	318	256	283											
IRL 531 736 595 563 486 818 703 399 976 613 622 510	0	505	560	124	139	100	449	611	333	437	221	210	162	490	241	273	186												
ESP 865 987 790 832 848 1020 1027 465 859 418 644 682 477	0	933	206	218	112	797	1109	456	917	393	325	250	834	501	369	292													
CZE 932 1564 924 851 895 1515 1454 429 844 506 631 610 444 683	0	239	288	136	1006	1465	439	889	476	528	353	852	513	415	390														
SVN 168 331 219 147 207 250 201 109 168 97 134 155 94 151 180	0	99	50	176	284	102	178	130	92	86	173	107	78	125															
EST 168 314 191 128 158 277 246 96 151 75 114 132 72 100 181 59	0	52	215	349	111	210	206	122	124	199	127	112	133																
ISR 99 131 113 65 85 124 185 39 105 91 74 55 75 65 103 36 32	0	120	153	66	109	75	52	60	105	64	70	70																	
HUN 1016 1003 758 645 851 851 1360 366 784 407 576 492 393 635 936 131 131 82	0	1023	404	739	359	328	245	724	478	380	272																		
POL 1318 2368 1381 1129 1267 1830 2129 588 1204 521 835 797 501 782 1230 255 250 115 912	0	426	1006	667	464	475	1028	592	430	494																			
ZAF 480 439 395 338 339 445 636 224 456 310 429 293 300 409 313 73 56 43 336 322	0	428	175	183	120	442	276	277	158																				
JPN 666 588 508 406 506 536 832 297 516 288 481 351 269 418 392 96 74 44 395 524 282	0	365	313	234	695	568	395	236																					
LVA 318 672 326 212 328 394 571 156 268 149 204 198 130 210 325 78 126 49 265 547 101 155	0	193	248	414	248	191	275																						
SVK 311 511 222 224 220 385 371 124 221 159 159 187 104 163 455 50 54 22 230 324 100 107 100	0	140	326	213	185	148																							
LTU 176 602 226 115 183 264 300 86 174 92 123 114 79 100 239 46 64 29 149 370 49 75 171 72	0	245	155	125	176																								
PRT 1091 1114 830 775 875 1062 1371 453 878 469 632 681 444 799 717 137 139 76 720 1029 399 406 320 225 157	0	477	403	325																									
KOR 701 438 367 310 474 360 1021 195 380 239 341 231 168 350 376 66 61 38 387 492 208 329 146 131 67 395	0	306	153																										
URY 501 361 310 243 312 348 859 167 385 294 342 201 225 301 322 48 68 37 326 370 237 238 115 122 74 367 249	0	144																											
HRV 190 679 332 189 280 419 308 136 245 131 194 233 127 218 293 97 97 48 201 444 107 109 215 74 123 265 69 96	0																												

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common bulls below diagonal		common three quarter sib group above diagonal																											
	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL	ESP	CZE	SVN	EST	ISR	HUN	POL	ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	HRV
CAN	0	2395	1517	1512	1700	1588	3577	925	1748	773	1471	854	568	1331	1227	228	275	140	1082	1513	516	1341	518	444	327	1044	727	507	323
DEU 1805	0	2637	2376	2455	3276	3506	1186	2083	976	1662	1250	854	1536	1965	342	437	169	1266	2607	561	1383	813	693	649	1217	646	483	657	
DFS 1304 1929	0	1664	1529	2165	2152	753	1594	856	1333	906	732	1058	1368	272	310	155	952	1692	515	974	508	417	390	940	511	427	427		
FRA 1002 1234 882	0	1601	1993	2522	705	1560	804	1298	953	731	1168	1342	215	271	127	969	1726	482	1193	443	430	312	930	544	409	305			
ITA 1346 1565 1129 825	0	1664	2512	720	1521	684	1159	799	597	1225	1265	246	283	138	1014	1648	448	1113	512	384	349	957	596	414	384				
NLD 1525 3022 1900 1224 1314	0	2562	931	1803	1066	1502	1327	879	1144	1647	289	384	164	1007	1963	524	1052	571	551	422	1057	508	435	463					
USA 4014 2505 1637 1325 1706 2247	0	1050	2313	1104	1973	1010	790	1582	1810	362	198	1393	2218	648	1944	690	557	441	1311	893	688	409							
CHE 790 1056 673 611 633 906 939	0	747	415	645	630	397	585	580	152	176	66	457	723	273	479	300	244	195	512	282	222	216							
GBR 1981 1576 1203 947 1120 1571 2072 677	0	946	1451	892	960	1102	1164	228	267	152	906	1424	520	1040	451	390	336	958	522	455	346								
NZL 780 749 609 471 486 971 1052 343 818	0	1222	533	710	552	678	138	146	113	519	686	370	570	261	265	194	572	330	369	226									
AUS 1494 1236 972 862 828 1318 1980 556 1248 1228	0	775	727	916	930	191	226	118	760	1095	487	899	404	316	273	792	471	445	308										
BEL 854 1287 849 929 764 1530 903 635 882 435 682	0	517	703	741	194	206	86	569	863	343	558	320	306	221	672	318	256	284											
IRL 531 736 595 563 486 818 703 399 976 613 622 510	0	505	560	124	139	100	449	611	333	437	221	210	162	490	241	273	187												
ESP 865 987 790 832 847 1020 1027 465 859 418 644 682 477	0	933	206	218	112	797	1109	456	916	393	325	250	834	501	369	292													
CZE 932 1564 924 851 893 1515 1454 429 844 506 631 610 444 683	0	239	288	136	1006	1465	439	889	476	528	353	852	513	415	391														
SVN 168 331 219 147 207 250 201 109 168 97 134 155 94 151 180	0	99	50	176	284	102	178	130	92	86	173	107	78	125															
EST 168 314 191 128 158 277 246 96 151 75 114 132 72 100 181 59	0	52	215	349	111	209	206	122	124	199	127	112	133																
ISR 99 131 113 65 85 124 185 39 105 91 74 55 75 65 103 36 32	0	120	153	66	109	75	52	60	105	64	70	70																	
HUN 1016 1003 758 645 851 851 1360 366 784 407 576 492 393 635 936 131 131 82	0	1023	404	739	359	328	245	724	478	380	272																		
POL 1318 2368 1381 1129 1265 1830 2129 588 1204 521 835 797 501 782 1230 255 250 115 912	0	426	1005	667	464	475	1028	592	430	495																			
ZAF 480 439 395 338 338 445 636 224 456 310 429 293 300 409 313 73 56 43 336 322	0	428	175	183	120	442	276	277	158																				
JPN 665 586 507 406 506 534 829 296 515 288 480 350 269 418 392 96 73 44 395 522 282	0	364	313	234	695	568	395	236																					
LVA 318 672 326 212 327 394 571 156 268 149 204 198 130 210 325 78 126 49 265 547 101 155	0	193	248	414	248	191	275																						
SVK 311 511 222 224 219 385 370 124 221 159 159 187 104 163 455 50 54 22 230 324 100 107 100	0	140	326	213	185	148																							
LTU 176 602 226 115 183 264 300 86 174 92 123 114 79 100 239 46 64 29 149 370 49 75 171 72	0	245	155	125	176																								
PRT 1091 1114 830 775 873 1062 1370 453 878 469 631 681 444 799 717 137 139 76 720 1029 399 405 319 225 157	0	477	403	326																									
KOR 702 439 368 311 473 361 1024 196 381 240 342 232 168 351 376 66 61 38 387 492 208 329 146 131 67 396	0	306	153																										
URY 501 361 310 243 310 348 859 167 385 294 342 201 225 301 322 48 68 37 326 370 237 238 115 122 74 367 249	0	144																											
HRV 191 680 333 189 281 420 309 137 245 132 194 234 128 218 294 97 97 48 201 445 107 109 215 74 123 266 69 96	0																												

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common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	0	107	452	182	268	166	40	156	70	71	9	39
DFS	99	0	194	154	155	174	125	150	108	119	36	59
USA	478	173	0	372	503	242	89	303	101	125	38	69
NZL	188	132	446	0	457	224	76	206	85	79	103	53
AUS	274	124	545	509	0	230	75	241	85	85	50	56
GBR	162	160	258	220	223	0	88	172	103	96	63	72
NLD	36	126	96	70	66	79	0	76	57	75	26	40
ZAF	152	131	317	212	228	168	72	0	92	84	33	57
ITA	67	108	108	83	79	105	56	85	0	60	19	44
DEU	68	116	125	74	76	90	71	81	61	0	20	48
IRL	6	32	39	114	47	64	24	33	18	20	0	17
CHE	32	57	69	43	45	67	34	49	42	43	12	0

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JER

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common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	0	107	452	182	268	166	40	156	70	71	9	39
DFS	99	0	194	154	155	174	125	150	108	119	36	59
USA	478	173	0	372	503	242	89	302	101	125	38	69
NZL	188	132	446	0	457	223	76	206	85	79	103	54
AUS	274	124	545	509	0	229	75	241	85	85	50	56
GBR	162	160	258	220	223	0	88	172	103	96	63	72
NLD	36	126	96	70	66	79	0	76	57	75	26	40
ZAF	152	131	316	212	228	168	72	0	92	84	33	57
ITA	67	108	108	83	79	105	56	85	0	60	19	44
DEU	68	116	125	74	76	90	71	81	61	0	20	48
IRL	6	32	39	114	47	64	24	33	18	20	0	17
CHE	32	57	69	43	45	67	34	49	42	43	12	0

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JER

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common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	0	107	452	182	268	166	40	156	70	71	9	39
DFS	99	0	194	154	155	174	125	150	108	119	36	59
USA	478	173	0	372	503	242	89	302	101	125	38	69
NZL	188	132	446	0	457	224	76	206	85	79	103	53
AUS	274	124	545	509	0	230	75	241	85	85	50	56
GBR	162	160	258	220	223	0	88	172	103	96	63	72
NLD	36	126	96	70	66	79	0	76	57	75	26	40
ZAF	152	131	316	212	228	168	72	0	92	84	33	57
ITA	67	108	108	83	79	105	56	85	0	60	19	44
DEU	68	116	125	74	76	90	71	81	61	0	20	48
IRL	6	32	39	114	47	64	24	33	18	20	0	17
CHE	32	57	69	43	45	67	34	49	42	43	12	0

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RDC

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common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	0	7	213	91	101	84	173	14	74	3	10	17	2	6	0
NOR	6	0	77	42	69	56	130	14	0	25	19	25	48	44	0
USA	196	78	0	127	134	114	198	23	63	22	24	34	24	43	24
NZL	90	42	128	0	145	85	175	17	38	11	17	27	9	20	12
AUS	102	59	135	145	0	85	188	39	37	35	37	42	14	32	12

GBR	82	59	105	80	85	0	107	14	40	9	17	26	18	37	0
DFS	178	104	194	173	162	101	0	52	51	116	126	105	14	50	0
DEU	13	13	22	17	39	14	43	0	1	23	35	29	4	15	0
ZAF	76	0	57	33	37	35	48	1	0	0	2	5	2	2	0
EST	2	25	21	10	32	8	104	23	0	0	52	25	0	18	0
LVA	10	17	21	14	35	16	84	29	2	45	0	53	2	13	0
LTU	16	22	29	25	42	24	99	28	5	25	49	0	4	14	0
IRL	2	47	24	9	13	17	11	4	2	0	2	4	0	9	0
NLD	6	43	42	20	30	36	47	14	2	17	12	13	9	0	0
CAM	0	0	24	12	12	0	0	0	0	0	0	0	0	0	0

RDC

common bulls below diagonal															
common three quarter sib group above diagonal															
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	0	7	213	91	101	84	173	14	74	3	10	17	2	6	0
NOR	6	0	77	42	69	56	130	14	0	25	19	25	48	44	0
USA	196	78	0	127	134	114	198	23	63	22	24	34	24	43	24
NZL	90	42	128	0	145	85	175	17	38	11	17	27	9	20	12
AUS	102	59	135	145	0	85	188	39	37	35	37	42	14	32	12
GBR	82	59	105	80	85	0	107	14	40	9	17	26	18	37	0
DFS	178	104	194	173	162	101	0	52	51	116	126	105	14	50	0
DEU	13	13	22	17	39	14	43	0	1	23	35	29	4	15	0
ZAF	76	0	57	33	37	35	48	1	0	0	2	5	2	2	0
EST	2	25	21	10	32	8	104	23	0	0	52	25	0	18	0
LVA	10	17	21	14	35	16	84	29	2	45	0	53	2	13	0
LTU	16	22	29	25	42	24	99	28	5	25	49	0	4	14	0
IRL	2	47	24	9	13	17	11	4	2	0	2	4	0	9	0
NLD	6	43	42	20	30	36	47	14	2	17	12	13	9	0	0
CAM	0	0	24	12	12	0	0	0	0	0	0	0	0	0	0

RDC

common bulls below diagonal															
common three quarter sib group above diagonal															
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	0	7	213	91	101	84	173	14	74	3	10	17	2	6	0
NOR	6	0	77	42	69	56	130	14	0	25	19	25	48	44	0
USA	196	78	0	127	134	114	198	23	63	22	24	34	24	43	24
NZL	90	42	128	0	145	85	175	17	38	11	17	27	9	20	12
AUS	102	59	135	145	0	85	188	39	37	35	37	42	14	32	12
GBR	82	59	105	80	85	0	107	14	40	9	17	26	18	37	0
DFS	178	104	194	173	162	101	0	52	51	116	126	104	14	50	0
DEU	13	13	22	17	39	14	43	0	1	23	35	29	4	15	0
ZAF	76	0	57	33	37	35	48	1	0	0	2	5	2	2	0
EST	2	25	21	10	32	8	104	23	0	0	52	25	0	18	0
LVA	10	17	21	14	35	16	84	29	2	45	0	53	2	13	0
LTU	16	22	29	25	42	24	98	28	5	25	49	0	4	14	0
IRL	2	47	24	9	13	17	11	4	2	0	2	4	0	9	0
NLD	6	43	42	20	30	36	47	14	2	17	12	13	9	0	0
CAM	0	0	24	12	12	0	0	0	0	0	0	0	0	0	0

SIM

common bulls below diagonal												
common three quarter sib group above diagonal												
	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	0	361	213	94	6	12	2	91	56	55	2	29
DEA	330	0	284	997	225	272	52	341	64	54	642	33
FRM	265	335	0	173	17	3	3	123	71	72	2	58
ITA	97	912	207	0	133	156	24	226	62	47	301	31
SVN	6	208	17	127	0	60	15	66	4	0	108	1
FRA	9	232	1	141	57	0	12	74	4	0	105	2
HUN	1	36	1	20	13	9	0	8	2	0	23	0
NLD	93	360	146	221	63	71	8	0	55	52	142	24

IRL	53	58	76	60	4	4	2	50	0	39	7	17
GBR	63	57	93	53	0	0	0	53	34	0	0	19
HRV	2	673	1	289	96	95	21	139	6	0	0	3
USA	28	39	73	36	1	2	0	26	16	27	3	0

SIM

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common bulls below diagonal  
common three quarter sib group above diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	0	360	213	94	6	12	2	91	56	55	2	29
DEA	330	0	284	997	225	272	52	341	64	54	640	33
FRM	265	335	0	173	17	3	3	123	71	72	2	58
ITA	97	912	207	0	133	156	24	226	62	47	299	31
SVN	6	208	17	127	0	60	15	66	4	0	108	1
FRA	9	232	1	141	57	0	12	74	4	0	105	2
HUN	1	36	1	20	13	9	0	8	2	0	23	0
NLD	93	360	146	221	63	71	8	0	55	52	142	24
IRL	53	58	76	60	4	4	2	50	0	39	7	17
GBR	63	57	93	53	0	0	0	53	34	0	0	19
HRV	2	671	1	287	96	95	21	139	6	0	0	3
USA	28	39	73	36	1	2	0	26	16	27	3	0

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SIM

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common bulls below diagonal  
common three quarter sib group above diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	0	360	213	94	6	12	2	91	56	55	2	29
DEA	330	0	284	997	225	272	52	341	64	54	641	33
FRM	265	335	0	173	17	3	3	123	71	72	2	58
ITA	97	912	207	0	133	156	24	226	62	47	300	31
SVN	6	208	17	127	0	60	15	66	4	0	108	1
FRA	9	232	1	141	57	0	12	74	4	0	105	2
HUN	1	36	1	20	13	9	0	8	2	0	23	0
NLD	93	360	146	221	63	71	8	0	55	52	142	24
IRL	53	58	76	60	4	4	2	50	0	39	7	17
GBR	63	57	93	53	0	0	0	53	34	0	0	19
HRV	2	672	1	288	96	95	21	139	6	0	0	3
USA	28	39	73	36	1	2	0	26	16	27	3	0

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