

## Introduction

The latest international evaluation for dairy production traits took place as scheduled at the Interbull Centre. Data from thirty-four (34) 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, Uruguay and Mexico 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 production traits are as follows:

NOR (RDC) Base changed to a rolling cow base, based on cows born 3 to 8 years ago. Std is based on bulls born 5 to 12 years ago, but the limits will be updated only every second year.  
JPN (HOL) Small changes in information due to additional records and pedigree changes.  
IRL (ALL) rewritten the code for assigning Proof Type/Status of Bull/Publishable as it was based on a very old code and lots of recent AI bulls were not getting any values for these fixed a bug in the calculation of number daughters/herds. Previously the numbers of daughters/herds were too high in some cases.  
Relabeled the base to X05CC07, so as to have a more correct label for base description. This is done across other traits also. Note the actual base hasnt changed, we just made the label more accurate.  
CHE (JER) The change of herd-year-season assignment for certain data records is causing a very small change in EDC for certain bulls.  
DEU (HOL, RDC, JER) Small changes in information due to data editings and pedigree corrections.  
BEL (HOL) Definition of genetic groups were updated/improved. Genetic groups are always based on selection path, type of breed, degree of Holsteinisation, origin (North-America vs Europe) and time. Periods of time were updated and improved.  
LTU (HOL) Correction of base definition  
DEA (SIM) Inclusion of SIM SVK raw data into the joint evaluation of DEU+AUT+CZE. New phantom parent groups, new fixed effect groups to accomodate the inclusion of SIM SVK in the model.  
SVN (HOL, BSW, SIM) Small drop in information due to changes in data base related to the pedigree completeness as well as phenotypic data improvement  
ESP (HOL) Drops in information for some bulls higher than usual due to updating the database used for extracting the data.  
USA (HOL) Drops in information caused by data editings affecting mostly 20+ years old bulls which have now dropped below the threshold of number of daughters needed to be included in the evaluations.  
ITA (SIM) Estimated new genetic parameters considering all the data set (and not only a sample like the previous time), using the same repeatability model. Changed also the solver moving from blupf90 to mix99. Regarding the edc, changed the w  
MEX (HOL) Correcting additive genetic variance used for EBV calculation for fat.

## INTERBULL CHANGES COMPARED TO THE PREVIOUS ROUTINE RUN

### Subsetting:

As decided by the ITC in Orlando, new subsetting was introduced in the september test run. Sub-setting is necessary for operational purposes and restrictions of time scales. To minimize the effect of subsetting, larger subsets with 10-12 countries and with 4 link providing countries have been applied.

### Window:

According to the decision taken by ITC in Orlando, the following changes have been introduced in regards to the windows used for post processing:

The upper bounds have been set to 0.99 as these were judged to have very little effect on evaluations. The lower values have been set to about the 25% percentile value. The largest changes are for the lower values for conformation traits, with the lowest window being 40% for OFL otherwise it is about 50% for all other confirmation traits. It is anticipated that these low values may not have large impact on evaluations since there were very few countries combinations whose estimated correlations fell between the old limit of 0.30 and these new limits.  
DATA AND METHOD OF ANALYSIS

Data were national genetic evaluations of AI sampled bulls with at least 10 daughters or 10 EDC (for clinical mastitis and maternal calving traits at least 50 daughters or 50 EDC, and for direct calving traits at least 50 calvings or 50 EDC) in at least 10 herds. Table 1 presents the amount of data included in this Interbull evaluation for all breeds.

National proofs were first de-regressed within country and then analysed jointly with a linear model including the effects of evaluation country, genetic group of bull and bull merit. Heritability estimates used in both the de-regression and international evaluation were as in each country's national evaluation.

Table 2 presents the date of evaluation as supplied by each country

Estimated genetic parameters and sire standard deviations are shown in APPENDIX I and the corresponding number of common bulls are listed in APPENDIX II.

#### SCIENTIFIC LITERATURE

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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

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Dates for the next test run can be found on  
<http://www.interbull.org/ib/servicecalendar>.  
PUBLICATION OF INTERBULL TEST RUN

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 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 (December Routine Evaluation 2019).  
 Number of records for milk yield by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS	209	136	8200	1784	734	
BEL			2062			
CAN	239	102	12687	766	825	
CHE	2981		3457	88		3282
CZE			4387			
DEA	6006					24359
DEU			28014	212	441	
DFS			13200	2162	7762	
ESP			3930			
EST			1170		445	
FRA	398		17214			473
FRM						4705
GBR	163	345	7319	904	632	94
HUN			3358			218
IRL			2789	161	59	85
ISR			1471			
ITA	2144		9594	170		1745
JPN			6101			
KOR			1407			
LTU			1192		437	
LVA			1183		709	
NLD	194		15633	166	83	407
NOR					4177	
NZL	56	60	7706	5018	1414	
POL			10679			
PRT			2431			
SVK			1129			
SVN	381		575			645
URY			1062			
USA	1115	789	39107	4784	720	64
ZAF			1306	719	143	
HRV			774			854
MEX			613			
CAM					42	
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No. Records	13886	1432	209750	16934	18623	36931
Pub. Proofs	11233	1142	157070	13665	16659	33543
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^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	637.30										
FRA	0.89	627.38									
USA	0.92	0.88	638.59								
CHE	0.91	0.88	0.87	544.20							
ITA	0.88	0.83	0.88	0.86	602.59						
DEA	0.88	0.82	0.86	0.94	0.90	462.10					
NLD	0.88	0.87	0.87	0.85	0.85	0.86	653.11				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	9.30			

NZL	0.70	0.75	0.70	0.74	0.70	0.73	0.71	0.74	339.46		
GBR	0.86	0.88	0.86	0.87	0.82	0.82	0.86	0.83	0.71	256.50	
AUS	0.73	0.75	0.71	0.72	0.70	0.70	0.74	0.72	0.81	0.73	391.96

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BSW fat

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	26.94										
FRA	0.89	26.91									
USA	0.90	0.89	23.67								
CHE	0.86	0.87	0.84	21.41							
ITA	0.89	0.83	0.86	0.86	22.95						
DEA	0.86	0.83	0.84	0.94	0.88	17.33					
NLD	0.87	0.86	0.86	0.84	0.85	0.86	25.73				
SVN	0.82	0.81	0.82	0.81	0.81	0.81	0.82	9.67			
NZL	0.71	0.73	0.70	0.73	0.70	0.81	0.70	0.74	16.09		
GBR	0.86	0.89	0.86	0.88	0.82	0.82	0.87	0.83	0.71	8.98	
AUS	0.72	0.72	0.71	0.70	0.70	0.70	0.70	0.72	0.82	0.71	15.13

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BSW pro

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	22.99										
FRA	0.84	20.29									
USA	0.89	0.86	18.87								
CHE	0.85	0.84	0.83	17.89							
ITA	0.85	0.82	0.83	0.84	21.18						
DEA	0.85	0.81	0.82	0.92	0.89	14.45					
NLD	0.86	0.83	0.84	0.83	0.82	0.84	21.65				
SVN	0.82	0.81	0.82	0.81	0.81	0.81	0.82	9.18			
NZL	0.70	0.70	0.70	0.71	0.70	0.74	0.70	0.74	11.00		
GBR	0.84	0.85	0.83	0.85	0.81	0.82	0.85	0.83	0.70	7.28	
AUS	0.70	0.70	0.69	0.70	0.69	0.70	0.70	0.72	0.81	0.70	11.55

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GUE mil

	CAN	USA	AUS	GBR	NZL
CAN	768.56				
USA	0.94	704.67			
AUS	0.80	0.75	468.64		
GBR	0.87	0.83	0.75	241.15	
NZL	0.71	0.70	0.83	0.71	326.85

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GUE fat

	CAN	USA	AUS	GBR	NZL
CAN	30.56				
USA	0.93	25.16			
AUS	0.78	0.74	17.50		
GBR	0.86	0.84	0.74	12.72	
NZL	0.71	0.70	0.82	0.70	16.48

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GUE pro

	CAN	USA	AUS	GBR	NZL
CAN	23.43				
USA	0.91	19.38			
AUS	0.72	0.69	13.44		
GBR	0.86	0.83	0.71	7.68	
NZL	0.70	0.69	0.82	0.69	10.88

HOL	mil																													
	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	MEX
CAN	779.02																													
DEU	0.92	612.20																												
DFS	0.94	0.93	11.21																											
FRA	0.91	0.90	0.92	657.02																										
ITA	0.89	0.87	0.88	0.88	573.89																									
NLD	0.92	0.92	0.93	0.90	0.87	668.01																								
USA	0.93	0.90	0.92	0.91	0.91	0.90	670.57																							
CHE	0.89	0.90	0.91	0.93	0.88	0.91	0.89	630.09																						
GBR	0.87	0.83	0.86	0.87	0.82	0.87	0.85	0.89	270.91																					
NZL	0.69	0.69	0.69	0.74	0.69	0.70	0.69	0.74	0.70	313.67																				
AUS	0.76	0.74	0.71	0.77	0.71	0.75	0.73	0.77	0.74	0.81	415.91																			
BEL	0.85	0.87	0.82	0.83	0.80	0.83	0.81	0.81	0.81	0.69	0.76	496.12																		
IRL	0.83	0.83	0.83	0.89	0.80	0.86	0.82	0.88	0.82	0.83	0.81	0.80	182.61																	
ESP	0.93	0.92	0.91	0.92	0.89	0.91	0.92	0.90	0.84	0.68	0.76	0.86	0.84	543.08																
CZE	0.86	0.88	0.84	0.80	0.81	0.81	0.83	0.80	0.80	0.68	0.70	0.82	0.73	0.84	699.30															
SVN	0.82	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.70	0.69	0.81	0.70	0.81	0.81	11.05														
EST	0.89	0.86	0.90	0.86	0.84	0.85	0.88	0.86	0.81	0.71	0.75	0.81	0.76	0.86	0.85	0.82	539.10													
ISR	0.83	0.83	0.84	0.83	0.84	0.82	0.84	0.84	0.82	0.63	0.66	0.83	0.68	0.84	0.83	0.84	0.84	382.57												
HUN	0.86	0.85	0.86	0.87	0.90	0.85	0.90	0.85	0.82	0.69	0.68	0.80	0.79	0.86	0.82	0.81	0.84	0.84	664.23											
POL	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.85	0.82	0.68	0.73	0.82	0.81	0.90	0.85	0.81	0.87	0.83	0.88	417.64										
ZAF	0.84	0.80	0.81	0.83	0.80	0.81	0.83	0.81	0.80	0.69	0.77	0.81	0.78	0.83	0.80	0.81	0.82	0.84	0.81	0.81	534.06									
JPN	0.94	0.91	0.93	0.91	0.89	0.91	0.93	0.89	0.84	0.69	0.75	0.84	0.82	0.91	0.84	0.82	0.87	0.87	0.85	0.90	0.83	629.28								
LVA	0.80	0.80	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.69	0.69	0.81	0.71	0.80	0.80	0.81	0.81	0.83	0.81	0.80	0.81	0.81	436.03							
SVK	0.80	0.81	0.82	0.81	0.81	0.81	0.80	0.81	0.81	0.69	0.69	0.81	0.73	0.81	0.80	0.82	0.82	0.85	0.84	0.82	0.81	0.82	0.81	385.20						
LTU	0.81	0.80	0.81	0.81	0.81	0.81	0.80	0.82	0.81	0.70	0.70	0.81	0.72	0.81	0.81	0.82	0.82	0.84	0.81	0.80	0.82	0.81	0.81	0.82	365.40					
PRT	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.68	0.68	0.80	0.72	0.80	0.80	0.81	0.81	0.83	0.80	0.80	0.80	0.80	0.80	0.80	0.81	592.05				
KOR	0.86	0.80	0.84	0.82	0.80	0.81	0.85	0.81	0.81	0.71	0.73	0.82	0.74	0.84	0.80	0.82	0.84	0.84	0.80	0.80	0.81	0.86	0.81	0.81	0.82	0.80	491.75			
URY	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.81	0.80	0.76	0.73	0.80	0.72	0.80	0.80	0.82	0.81	0.84	0.80	0.80	0.80	0.80	0.81	0.81	0.81	0.80	0.80	167.32		
HRV	0.81	0.80	0.81	0.81	0.80	0.81	0.80	0.81	0.81	0.69	0.69	0.81	0.69	0.80	0.80	0.81	0.81	0.83	0.81	0.80	0.80	0.81	0.81	0.82	0.81	0.80	0.82	0.81	11.44	
MEX	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.81	0.80	0.69	0.69	0.80	0.69	0.80	0.80	0.82	0.82	0.84	0.80	0.80	0.80	0.80	0.81	0.81	0.82	0.80	0.80	0.80	0.81	381.32

HOL	fat																													
	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	MEX
CAN	31.03																													
DEU	0.92	22.89																												
DFS	0.93	0.92	11.08																											
FRA	0.91	0.90	0.91	26.63																										
ITA	0.89	0.87	0.86	0.89	23.73																									
NLD	0.90	0.92	0.91	0.88	0.85	25.32																								
USA	0.93	0.91	0.90	0.91	0.88	0.88	24.86																							
CHE	0.87	0.89	0.90	0.90	0.84	0.89	0.86	25.10																						
GBR	0.86	0.86	0.87	0.89	0.83	0.87	0.87	0.89	9.32																					
NZL	0.68	0.68	0.69	0.70	0.69	0.68	0.69	0.71	0.70	12.70																				
AUS	0.73	0.72	0.70	0.74	0.69	0.69	0.73	0.70	0.72	0.81	14.43																			
BEL	0.84	0.87	0.81	0.84	0.80	0.83	0.81	0.81	0.81	0.70	0.74	20.20																		
IRL	0.81	0.80	0.84	0.85	0.74	0.82	0.79	0.83	0.80	0.82	0.80	0.82	6.95																	
ESP	0.91	0.90	0.87	0.91	0.90	0.88	0.93	0.85	0.85	0.68	0.74	0.82	0.79	21.77																
CZE	0.84	0.87	0.84	0.81	0.81	0.80	0.84	0.80	0.80	0.68	0.69	0.80	0.69	0.84	22.09															
SVN	0.81	0.80	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.70	0.69	0.81	0.70	0.81	0.81	10.86														
EST	0.87	0.87	0.90	0.87	0.88	0.85	0.86	0.85	0.81	0.77	0.76	0.86	0.82	0.85	0.85	0.82	21.04													
ISR	0.83	0.82	0.82	0.82	0.82	0.82	0.84	0.83	0.82	0.63	0.64	0.82	0.63	0.83	0.83	0.84	0.84	14.41												
HUN	0.85	0.85	0.81	0.87	0.90	0.82	0.90	0.81	0.82	0.69	0.68	0.80	0.69	0.88	0.81	0.81	0.81	0.83	25.83											
POL	0.89	0.91	0.87	0.90	0.89	0.86	0.90	0.81	0.82	0.68	0.69	0.83	0.76	0.92	0.86	0.80	0.89	0.83	0.88	16.85										
ZAF	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.81	0.80	0.69	0.69	0.80	0.68	0.80	0.80	0.81	0.82	0.83	0.80	0.80	17.63									
JPN	0.92	0.90	0.92	0.90	0.86	0.89	0.90	0.88	0.85	0.69	0.69	0.83	0.81	0.86	0.82	0.81	0.87	0.83	0.80	0.88	0.80	24.16								
LVA	0.80	0.80	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.69	0.69	0.81	0.69	0.80	0.80	0.81	0.83	0.83	0.81	0.80	0.81	0.81	18.76							
SVK	0.80	0.80	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.69	0.69	0.81	0.69	0.81	0.80	0.82	0.85	0.85	0.82	0.82	0.81	0.81	0.81	14.97						
LTU	0.81	0.80	0.81	0.81	0.81	0.81	0.80	0.82	0.81	0.70	0.70	0.81	0.70	0.81	0.81	0.82	0.82	0.84	0.81	0.80	0.82	0.81	0.81	0.82	15.93					
PRT	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.68	0.68	0.80	0.68	0.80	0.80	0.81	0.81	0.83	0.80	0.80	0.80	0.80	0.80	0.81	23.56					
KOR	0.84	0.81	0.81	0.81	0.80	0.81	0.86	0.81	0.81	0.69	0.75	0.81	0.71	0.85	0.81	0.82	0.82	0.84	0.80	0.83	0.81	0.84	0.81	0.81	0.82	0.80	19.87			

URY	0.80	0.80	0.80	0.81	0.80	0.80	0.80	0.81	0.80	0.75	0.70	0.80	0.75	0.80	0.80	0.82	0.84	0.84	0.80	0.80	0.80	0.80	0.81	0.81	0.81	0.80	0.80	6.80		
HRV	0.81	0.80	0.81	0.81	0.80	0.81	0.80	0.81	0.81	0.69	0.69	0.81	0.69	0.80	0.81	0.81	0.81	0.83	0.81	0.80	0.81	0.81	0.81	0.81	0.81	0.80	0.82	0.81	11.76	
MEX	0.81	0.81	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.70	0.69	0.81	0.69	0.81	0.81	0.83	0.84	0.86	0.81	0.81	0.81	0.81	0.83	0.82	0.85	0.81	0.81	0.81	0.82	13.35

HOL pro

	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	MEX
CAN	21.76																													
DEU	0.89	16.70																												
DFS	0.92	0.92	10.66																											
FRA	0.87	0.85	0.91	18.09																										
ITA	0.86	0.83	0.86	0.84	17.60																									
NLD	0.88	0.90	0.89	0.85	0.83	18.98																								
USA	0.91	0.88	0.91	0.88	0.88	0.86	17.44																							
CHE	0.84	0.85	0.87	0.91	0.84	0.85	0.85	18.75																						
GBR	0.85	0.82	0.86	0.86	0.80	0.86	0.84	0.87	7.17																					
NZL	0.68	0.69	0.69	0.69	0.69	0.68	0.68	0.69	0.69	9.02																				
AUS	0.68	0.68	0.68	0.69	0.68	0.68	0.68	0.69	0.69	0.80	10.79																			
BEL	0.80	0.83	0.80	0.80	0.80	0.81	0.80	0.81	0.81	0.69	0.68	14.56																		
IRL	0.74	0.74	0.76	0.81	0.72	0.78	0.75	0.80	0.77	0.80	0.80	0.72	5.58																	
ESP	0.90	0.88	0.88	0.88	0.86	0.87	0.90	0.85	0.84	0.69	0.68	0.80	0.77	15.61																
CZE	0.80	0.81	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.69	0.68	0.80	0.68	0.80	16.90															
SVN	0.81	0.80	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.70	0.69	0.81	0.70	0.81	0.81	10.40														
EST	0.82	0.85	0.87	0.81	0.81	0.82	0.83	0.82	0.81	0.71	0.70	0.81	0.70	0.81	0.82	15.90														
ISR	0.83	0.83	0.83	0.83	0.83	0.82	0.83	0.84	0.82	0.63	0.63	0.83	0.62	0.83	0.83	0.84	0.84	9.90												
HUN	0.82	0.81	0.83	0.85	0.86	0.81	0.87	0.82	0.80	0.69	0.68	0.80	0.68	0.81	0.80	0.81	0.81	0.83	21.04											
POL	0.85	0.85	0.86	0.83	0.83	0.83	0.84	0.80	0.80	0.68	0.68	0.80	0.72	0.86	0.80	0.80	0.86	0.83	0.84	11.32										
ZAF	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.81	0.80	0.69	0.71	0.81	0.69	0.80	0.80	0.82	0.82	0.84	0.80	0.80	13.36									
JPN	0.91	0.87	0.91	0.87	0.87	0.87	0.91	0.86	0.83	0.69	0.68	0.80	0.75	0.88	0.80	0.81	0.84	0.83	0.80	0.87	0.80	17.12								
LVA	0.80	0.80	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.70	0.69	0.81	0.69	0.81	0.80	0.81	0.81	0.83	0.81	0.80	0.81	0.81	13.19							
SVK	0.80	0.80	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.69	0.69	0.81	0.69	0.81	0.80	0.82	0.82	0.85	0.83	0.81	0.81	0.81	0.81	10.74						
LTU	0.81	0.80	0.81	0.81	0.81	0.81	0.80	0.82	0.81	0.70	0.70	0.81	0.70	0.81	0.83	0.82	0.82	0.85	0.81	0.80	0.80	0.81	0.81	0.82	10.89					
PRT	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.68	0.68	0.80	0.68	0.80	0.80	0.81	0.81	0.83	0.80	0.80	0.80	0.80	0.80	0.80	0.81	17.59				
KOR	0.83	0.80	0.81	0.81	0.80	0.81	0.81	0.81	0.81	0.69	0.69	0.81	0.69	0.83	0.80	0.82	0.82	0.84	0.80	0.80	0.81	0.82	0.81	0.81	0.82	0.80	13.68			
URY	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.81	0.80	0.72	0.69	0.80	0.69	0.80	0.80	0.82	0.81	0.84	0.80	0.80	0.80	0.80	0.81	0.81	0.81	0.80	0.80	5.24		
HRV	0.81	0.80	0.81	0.81	0.80	0.81	0.80	0.81	0.81	0.70	0.69	0.81	0.69	0.81	0.81	0.81	0.81	0.84	0.81	0.80	0.80	0.81	0.81	0.82	0.81	0.80	0.82	0.81	11.18	
MEX	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.70	0.69	0.81	0.70	0.81	0.81	0.83	0.84	0.87	0.81	0.81	0.81	0.81	0.83	0.82	0.85	0.81	0.81	0.81	0.83	10.99

JER mil

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	589.12											
DFS	0.93	9.18										
USA	0.91	0.92	620.89									
NZL	0.73	0.71	0.71	284.38								
AUS	0.80	0.73	0.74	0.82	381.04							
GBR	0.84	0.83	0.82	0.69	0.71	214.49						
NLD	0.91	0.92	0.89	0.71	0.76	0.85	633.58					
ZAF	0.88	0.86	0.85	0.77	0.81	0.81	0.81	381.89				
ITA	0.90	0.87	0.88	0.73	0.78	0.82	0.85	0.88	545.55			
DEU	0.91	0.92	0.90	0.70	0.75	0.82	0.92	0.83	0.88	494.33		
IRL	0.81	0.79	0.78	0.88	0.82	0.76	0.82	0.76	0.78	0.80	184.80	
CHE	0.88	0.88	0.85	0.73	0.79	0.84	0.90	0.82	0.85	0.89	0.83	333.03

JER fat

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	26.38											
DFS	0.90	11.25										
USA	0.90	0.90	24.35									
NZL	0.69	0.70	0.71	12.11								
AUS	0.77	0.70	0.75	0.82	13.50							
GBR	0.83	0.83	0.82	0.69	0.70	11.70						

NLD	0.87	0.86	0.86	0.69	0.70	0.85	25.22					
ZAF	0.81	0.81	0.80	0.69	0.70	0.81	0.81	14.29				
ITA	0.89	0.84	0.86	0.70	0.72	0.82	0.84	0.82	25.64			
DEU	0.91	0.90	0.88	0.70	0.74	0.84	0.90	0.81	0.87	21.19		
IRL	0.79	0.78	0.75	0.82	0.81	0.75	0.80	0.71	0.74	0.78	6.42	
CHE	0.86	0.85	0.84	0.71	0.76	0.85	0.86	0.81	0.84	0.89	0.80	15.77

JER pro

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	18.93											
DFS	0.91	10.52										
USA	0.89	0.91	18.53									
NZL	0.69	0.69	0.69	8.52								
AUS	0.70	0.69	0.69	0.80	10.36							
GBR	0.83	0.85	0.82	0.69	0.69	6.66						
NLD	0.87	0.88	0.85	0.70	0.70	0.84	19.80					
ZAF	0.82	0.81	0.80	0.69	0.70	0.81	0.81	11.45				
ITA	0.86	0.84	0.85	0.70	0.70	0.81	0.83	0.86	19.52			
DEU	0.88	0.92	0.88	0.70	0.70	0.82	0.89	0.81	0.85	15.36		
IRL	0.74	0.75	0.73	0.85	0.81	0.73	0.77	0.71	0.73	0.75	5.86	
CHE	0.84	0.84	0.83	0.70	0.70	0.83	0.84	0.81	0.83	0.85	0.78	10.79

RDC mil

	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	597.48														
NOR	0.89	12.06													
USA	0.92	0.91	662.61												
NZL	0.69	0.73	0.69	319.50											
AUS	0.74	0.74	0.75	0.82	412.80										
GBR	0.84	0.83	0.83	0.70	0.77	280.35									
DFS	0.91	0.91	0.89	0.69	0.75	0.83	10.23								
DEU	0.92	0.88	0.90	0.70	0.74	0.83	0.92	584.06							
ZAF	0.82	0.88	0.84	0.70	0.75	0.81	0.81	0.81	605.42						
EST	0.88	0.89	0.89	0.75	0.75	0.82	0.86	0.85	0.83	486.03					
LVA	0.82	0.83	0.81	0.73	0.72	0.82	0.82	0.81	0.83	0.82	316.60				
LTU	0.83	0.83	0.82	0.73	0.71	0.82	0.81	0.81	0.84	0.83	0.82	311.86			
IRL	0.83	0.77	0.81	0.83	0.81	0.80	0.81	0.83	0.78	0.76	0.74	0.77	175.89		
NLD	0.92	0.92	0.89	0.71	0.77	0.86	0.93	0.93	0.81	0.85	0.82	0.83	0.84	755.73	
CAM	0.89	0.90	0.95	0.76	0.78	0.88	0.89	0.89	0.89	0.90	0.89	0.89	0.84	0.89	475.10

RDC fat

	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	23.28														
NOR	0.88	11.49													
USA	0.91	0.84	24.58												
NZL	0.69	0.77	0.69	13.47											
AUS	0.72	0.74	0.77	0.83	15.46										
GBR	0.84	0.82	0.84	0.69	0.73	9.91									
DFS	0.90	0.89	0.89	0.69	0.75	0.84	10.26								
DEU	0.91	0.90	0.90	0.70	0.74	0.86	0.90	23.03							
ZAF	0.81	0.87	0.84	0.70	0.70	0.81	0.81	0.81	19.50						
EST	0.87	0.84	0.88	0.78	0.74	0.83	0.85	0.85	0.83	18.84					
LVA	0.82	0.83	0.81	0.73	0.72	0.82	0.81	0.82	0.83	0.83	13.65				
LTU	0.83	0.83	0.82	0.73	0.71	0.82	0.81	0.81	0.84	0.83	0.82	14.79			
IRL	0.81	0.74	0.80	0.82	0.81	0.79	0.81	0.80	0.70	0.82	0.73	0.76	7.19		
NLD	0.90	0.87	0.88	0.70	0.72	0.87	0.91	0.92	0.81	0.85	0.82	0.83	0.82	27.01	
CAM	0.89	0.89	0.95	0.76	0.79	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.84	0.89	22.87

RDC pro

	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	17.95														
NOR	0.88	11.47													
USA	0.89	0.88	18.84												
NZL	0.69	0.73	0.69	9.53											
AUS	0.69	0.74	0.70	0.80	12.04										
GBR	0.83	0.82	0.83	0.69	0.72	7.65									
DFS	0.89	0.88	0.88	0.69	0.70	0.83	10.33								
DEU	0.90	0.88	0.88	0.70	0.70	0.83	0.91	17.29							
ZAF	0.81	0.88	0.81	0.70	0.72	0.81	0.81	0.81	16.22						
EST	0.83	0.83	0.86	0.75	0.73	0.83	0.82	0.84	0.83	14.83					
LVA	0.82	0.83	0.81	0.73	0.72	0.82	0.81	0.81	0.83	0.82	9.27				
LTU	0.83	0.83	0.82	0.73	0.71	0.82	0.81	0.81	0.85	0.83	0.82	9.38			
IRL	0.75	0.76	0.76	0.81	0.81	0.76	0.76	0.75	0.69	0.74	0.72	0.74	5.41		
NLD	0.88	0.92	0.85	0.70	0.71	0.85	0.89	0.91	0.81	0.83	0.82	0.83	0.78	25.92	
CAM	0.89	0.89	0.92	0.77	0.79	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.83	0.89	11.94

SIM mil

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	604.89											
DEA	0.87	508.67										
FRM	0.96	0.87	616.86									
ITA	0.83	0.80	0.81	528.51								
SVN	0.83	0.81	0.83	0.81	8.67							
FRA	0.92	0.89	0.89	0.86	0.82	670.51						
HUN	0.85	0.82	0.89	0.87	0.83	0.87	406.74					
NLD	0.89	0.94	0.89	0.83	0.82	0.89	0.85	753.12				
IRL	0.82	0.73	0.85	0.73	0.74	0.88	0.79	0.80	183.83			
GBR	0.88	0.87	0.87	0.82	0.81	0.87	0.82	0.86	0.78	215.98		
HRV	0.82	0.80	0.89	0.80	0.81	0.81	0.83	0.81	0.73	0.81	10.79	
USA	0.89	0.83	0.87	0.89	0.81	0.91	0.89	0.90	0.80	0.84	0.81	568.12

SIM fat

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	24.16											
DEA	0.88	19.23										
FRM	0.94	0.90	24.23									
ITA	0.83	0.82	0.81	21.15								
SVN	0.83	0.81	0.83	0.81	8.93							
FRA	0.90	0.91	0.89	0.86	0.82	27.13						
HUN	0.81	0.82	0.88	0.87	0.83	0.86	15.39					
NLD	0.88	0.93	0.89	0.82	0.82	0.88	0.82	27.95				
IRL	0.74	0.73	0.81	0.71	0.73	0.84	0.70	0.78	7.89			
GBR	0.91	0.86	0.86	0.83	0.81	0.89	0.82	0.86	0.76	8.15		
HRV	0.82	0.80	0.88	0.80	0.82	0.81	0.83	0.81	0.73	0.81	10.79	
USA	0.86	0.85	0.84	0.90	0.81	0.91	0.90	0.88	0.77	0.86	0.81	19.38

SIM pro

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	18.40											
DEA	0.85	15.49										
FRM	0.93	0.87	19.15									
ITA	0.82	0.80	0.81	16.67								
SVN	0.83	0.81	0.83	0.81	8.79							
FRA	0.89	0.86	0.88	0.83	0.82	21.32						
HUN	0.82	0.82	0.88	0.85	0.83	0.85	13.14					
NLD	0.85	0.93	0.87	0.82	0.82	0.85	0.81	23.90				
IRL	0.75	0.73	0.81	0.71	0.74	0.80	0.69	0.75	6.48			
GBR	0.85	0.86	0.86	0.81	0.81	0.86	0.80	0.85	0.75	6.65		



HRV	0.82	0.80	0.88	0.80	0.82	0.81	0.83	0.81	0.73	0.81	10.66	
USA	0.85	0.83	0.82	0.87	0.81	0.88	0.87	0.86	0.75	0.84	0.81	15.50

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^LAPPENDIX II. Number of common bulls  
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BSW  
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common bulls below diagonal											
common three quarter sib group above diagonal											
	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	84	170	130	124	140	51	34	26	67	91
FRA	72	0	120	160	189	213	83	56	22	58	64
USA	159	80	0	314	237	321	79	42	31	95	124
CHE	106	116	293	0	453	578	94	79	26	74	111
ITA	107	146	168	394	0	709	125	98	29	81	116
DEA	116	156	285	475	603	0	145	105	35	79	122
NLD	48	68	71	87	106	140	0	44	25	43	54
SVN	30	55	34	75	97	97	45	0	11	25	30
NZL	24	18	27	20	21	29	18	10	0	21	28
GBR	59	45	79	53	54	52	32	18	18	0	59
AUS	90	48	117	76	87	89	41	23	21	50	0

BSW  
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common bulls below diagonal											
common three quarter sib group above diagonal											
	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	84	170	130	124	140	51	34	26	67	91
FRA	72	0	120	160	189	213	83	56	22	58	64
USA	159	80	0	314	237	321	79	42	31	95	124
CHE	106	116	293	0	453	578	94	79	26	74	111
ITA	107	146	168	394	0	709	125	98	29	81	116
DEA	116	156	285	475	603	0	145	105	35	79	122
NLD	48	68	71	87	106	140	0	44	25	43	54
SVN	30	55	34	75	97	97	45	0	11	25	30
NZL	24	18	27	20	21	29	18	10	0	21	28
GBR	59	45	79	53	54	52	32	18	18	0	59
AUS	90	48	117	76	87	89	41	23	21	50	0

BSW  
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common bulls below diagonal											
common three quarter sib group above diagonal											
	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	84	170	130	124	140	51	34	26	67	91
FRA	72	0	120	160	189	213	83	56	22	58	64
USA	159	80	0	314	237	321	79	42	31	95	124
CHE	106	116	293	0	453	578	94	79	26	74	111
ITA	107	146	168	394	0	709	125	98	29	81	116
DEA	116	156	285	475	603	0	145	105	35	79	122
NLD	48	68	71	87	106	140	0	44	25	43	54
SVN	30	55	34	75	97	97	45	0	11	25	30
NZL	24	18	27	20	21	29	18	10	0	21	28
GBR	59	45	79	53	54	52	32	18	18	0	59
AUS	90	48	117	76	87	89	41	23	21	50	0

GUE  
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common bulls below diagonal					
common three quarter sib group above diagonal					
	CAN	USA	AUS	GBR	NZL

CAN	0	71	47	32	14
USA	62	0	62	91	31
AUS	45	58	0	38	27
GBR	27	93	33	0	15
NZL	11	29	27	13	0

GUE

common bulls below diagonal  
common three quarter sib group above diagonal

CAN	0	71	47	32	14
USA	62	0	62	91	31
AUS	45	58	0	38	27
GBR	27	93	33	0	15
NZL	11	29	27	13	0

GUE

common bulls below diagonal  
common three quarter sib group above diagonal

CAN	0	71	47	32	14
USA	62	0	62	91	31
AUS	45	58	0	38	27
GBR	27	93	33	0	15
NZL	11	29	27	13	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	MEX
CAN	0	2457	1402	1440	1629	1457	3325	869	1620	720	1368	797	543	1280	1102	206	249	122	1006	1348	511	1298	469	427	291	1021	676	494	294	374
DEU	1727	0	2750	2544	2485	3487	3670	1164	2123	959	1670	1265	873	1541	1896	310	416	155	1243	2406	593	1450	730	730	620	1237	621	501	604	353
DFS	1169	1796	0	1596	1522	2016	2011	701	1505	794	1238	848	711	1000	1226	248	281	139	882	1529	507	930	455	403	355	913	471	414	388	287
FRA	928	1288	804	0	1666	1927	2444	659	1497	774	1235	911	710	1122	1225	205	251	122	930	1602	477	1169	405	418	285	910	509	401	281	297
ITA	1225	1493	1058	821	0	1641	2521	695	1504	707	1146	789	622	1219	1237	232	264	128	981	1525	476	1128	477	387	322	978	568	432	355	327
NLD	1368	3174	1716	1147	1255	0	2412	869	1686	997	1415	1259	853	1080	1462	256	347	148	951	1756	517	1018	503	530	382	1033	469	423	419	301
USA	3641	2449	1457	1248	1564	2059	0	988	2154	1027	1827	955	759	1526	1629	240	334	174	1288	2003	642	1884	612	534	396	1284	833	668	367	448
CHE	728	1013	618	568	607	844	874	0	689	387	598	593	387	554	523	142	160	58	434	661	270	453	273	230	170	498	259	212	200	175
GBR	1831	1531	1096	883	1066	1439	1878	621	0	892	1351	847	917	1055	1040	210	243	132	853	1298	514	1000	407	369	297	938	485	439	322	320
NZL	723	738	552	444	490	905	966	322	759	0	1160	504	685	521	597	127	133	104	489	628	366	538	241	253	174	556	311	350	211	196
AUS	1363	1201	864	808	792	1228	1785	524	1142	1157	0	739	700	869	831	176	207	103	706	998	481	857	365	307	244	776	435	429	286	268
BEL	789	1314	783	889	742	1450	839	604	837	410	646	0	501	662	654	176	189	82	540	799	336	534	295	296	205	654	287	248	261	200
IRL	508	754	575	550	510	792	674	388	937	590	602	499	0	493	506	119	129	95	431	579	331	426	205	202	153	485	229	264	178	174
ESP	812	970	734	789	858	952	968	441	819	396	610	644	464	0	845	189	199	107	755	1026	450	880	356	313	229	816	466	360	272	282
CZE	795	1453	784	733	838	1283	1246	365	698	418	530	512	371	571	0	217	250	121	905	1314	399	811	426	469	315	793	467	379	353	274
SVN	148	298	202	140	192	220	181	101	154	90	122	145	88	139	159	0	94	46	160	252	100	163	118	82	77	166	98	76	108	67
EST	146	294	165	114	142	249	218	88	134	66	102	120	66	93	157	56	0	46	192	309	106	194	185	112	112	191	110	102	120	70
ISR	89	126	108	63	80	118	160	36	90	87	66	54	70	63	89	36	28	0	106	135	64	97	65	47	53	99	56	67	65	41
HUN	938	970	687	609	817	783	1242	345	737	385	526	463	380	596	806	122	116	78	0	935	398	694	324	313	218	705	444	370	252	287
POL	1117	2112	1200	992	1110	1594	1862	538	1066	474	736	732	472	702	1071	224	219	106	822	0	418	947	588	446	424	1000	550	417	444	314
ZAF	469	457	384	331	360	435	627	219	448	304	420	286	296	399	266	70	54	43	327	310	0	423	171	183	118	434	268	274	152	213
JPN	623	562	469	391	482	501	780	282	485	272	451	331	263	396	342	90	66	41	370	485	277	0	333	300	207	681	532	385	210	293
LVA	281	587	284	187	306	341	501	139	240	139	185	180	125	197	293	75	117	46	245	481	99	141	0	179	222	394	220	184	244	139
SVK	298	548	207	215	221	364	350	117	209	151	154	181	102	155	381	48	52	20	221	306	100	103	92	0	133	320	207	181	139	126
LTU	154	584	200	95	163	227	261	73	148	76	105	102	73	93	209	42	56	26	132	328	46	64	157	68	0	233	140	118	164	69
PRT	1067	1140	800	759	892	1038	1341	439	856	458	614	659	438	780	653	132	135	74	700	1001	391	396	311	222	150	0	455	392	309	335
KOR	639	408	326	285	446	326	947	180	349	226	316	209	163	326	332	61	54	35	364	458	202	309	128	126	58	383	0	293	135	254
URY	485	361	297	233	321	334	834	159	365	276	321	193	214	289	283	45	64	34	317	355	231	229	111	118	69	357	237	0	138	236
HRV	170	617	293	166	253	373	275	127	225	123	175	215	122	202	254	84	87	45	186	391	99	95	193	69	113	247	58	87	0	113
MEX	390	292	240	231	299	251	535	154	288	157	222	188	152	255	227	50	49	26	274	294	197	226	95	75	29	350	237	222	74	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	MEX
CAN	0	2457	1402	1440	1632	1457	3325	869	1620	720	1368	797	543	1280	1102	206	249	122	1006	1348	511	1295	469	427	291	1021	676	494	294	142
DEU	1727	0	2750	2544	2488	3487	3670	1164	2122	959	1670	1265	873	1541	1896	310	416	155	1243	2406	593	1447	730	730	620	1237	621	501	604	134
DFS	1169	1796	0	1596	1525	2016	2011	701	1504	794	1238	848	711	1000	1226	248	281	139	882	1529	507	928	455	403	355	913	471	414	388	121
FRA	928	1288	804	0	1668	1927	2444	659	1496	774	1235	911	711	1122	1225	205	251	122	930	1602	477	1166	405	418	285	910	509	401	281	124
ITA	1231	1498	1063	826	0	1644	2524	696	1506	710	1148	791	624	1222	1238	232	264	129	983	1526	478	1127	477	388	322	979	568	433	355	122
NLD	1368	3174	1716	1147	1260	0	2412	869	1685	997	1415	1259	855	1080	1462	256	347	148	951	1756	517	1014	503	530	382	1033	469	423	419	127
USA	3641	2449	1457	1248	1571	2059	0	988	2154	1027	1827	955	759	1526	1629	240	334	174	1288	2003	642	1881	612	534	396	1283	833	668	367	148
CHE	728	1013	618	568	608	844	874	0	688	387	598	593	387	554	523	142	160	58	434	661	270	450	273	230	170	498	259	212	200	96
GBR	1831	1531	1096	883	1072	1439	1878	621	0	891	1350	846	918	1055	1039	210	243	132	853	1297	514	997	406	369	297	937	485	439	321	131
NZL	723	738	552	444	496	905	966	322	759	0	1160	504	685	521	597	127	133	104	489	628	366	538	241	253	174	556	311	350	211	102
AUS	1363	1201	864	808	796	1228	1785	524	1142	1157	0	739	700	869	831	176	207	103	706	998	481	855	365	307	244	775	435	429	286	119
BEL	789	1314	783	889	745	1450	839	604	837	410	646	0	501	662	654	176	189	82	540	799	336	533	295	296	205	654	287	248	261	106
IRL	508	754	575	550	515	794	674	388	938	590	602	499	0	493	506	119	129	95	431	579	331	425	205	202	153	485	229	264	178	91
ESP	812	970	734	789	862	952	968	441	819	396	610	644	464	0	845	189	199	107	755	1026	450	879	356	313	229	816	466	360	272	120
CZE	795	1452	783	733	841	1282	1246	365	698	418	530	511	371	570	0	217	250	121	905	1314	399	809	426	469	315	793	467	379	353	96
SVN	148	298	202	140	192	220	181	101	154	90	122	145	88	139	159	0	94	46	160	252	100	162	118	82	77	166	98	76	108	36
EST	146	294	165	114	142	249	218	88	134	66	102	120	66	93	157	56	0	46	192	309	106	191	185	112	112	191	110	102	120	27
ISR	89	126	108	63	82	118	160	36	90	87	66	54	70	63	89	36	28	0	106	135	64	96	65	47	53	99	56	67	65	15
HUN	938	970	687	609	821	783	1242	345	737	385	526	463	380	596	806	122	116	78	0	935	398	692	324	313	218	705	444	370	252	111
POL	1117	2112	1200	992	1113	1594	1862	538	1066	474	736	732	472	702	1070	224	219	106	822	0	418	943	588	446	424	1000	550	417	444	104
ZAF	469	457	384	331	363	435	626	219	447	304	420	286	296	399	266	70	54	43	327	310	0	422	171	183	118	434	268	274	152	104
JPN	619	559	467	387	480	497	774	279	481	271	447	329	262	394	340	89	63	40	368	480	276	0	332	299	207	678	531	384	210	127
LVA	281	587	284	187	306	341	501	139	240	139	185	180	125	197	293	75	117	46	245	481	99	140	0	179	222	394	220	184	244	44
SVK	298	548	207	215	223	364	350	117	209	151	154	181	102	155	380	48	52	20	221	306	100	102	92	0	133	320	207	181	139	58
LTU	154	584	200	95	163	227	261	73	148	76	105	102	73	93	209	42	56	26	132	328	46	64	157	68	0	233	140	118	164	25
PRT	1067	1140	800	758	894	1038	1340	439	856	458	613	659	438	780	653	132	135	74	700	1001	391	393	311	222	150	0	455	392	309	126
KOR	638	408	325	285	445	326	945	180	349	225	315	209	163	325	331	60	54	35	364	457	202	307	128	126	58	383	0	293	135	99
URY	485	361	297	233	323	334	834	159	365	276	321	193	214	289	283	45	64	34	317	355	231	226	111	118	69	357	237	0	138	103
HRV	170	616	292	166	252	372	275	127	225	122	174	214	122	202	253	83	87	44	186	390	99	95	193	69	112	247	58	87	0	46
MEX	174	146	126	125	129	137	190	95	153	99	125	117	100	136	79	28	16	11	116	104	114	126	29	42	7	149	100	108	30	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	MEX
CAN	0	2457	1402	1440	1629	1457	3319	869	1620	720	1368	797	543	1280	1102	206	249	122	1006	1348	511	1294	469	427	291	1021	676	494	294	141
DEU	1727	0	2750	2544	2485	3487	3666	1164	2122	959	1670	1265	873	1541	1896	310	416	155	1243	2406	593	1447	730	730	620	1237	621	501	604	133
DFS	1169	1796	0	1596	1522	2016	2009	701	1504	794	1238	848	711	1000	1226	248	281	139	882	1529	507	928	455	403	355	913	471	414	388	120
FRA	928	1288	804	0	1666	1927	2443	659	1496	774	1235	911	711	1122	1225	205	251	122	930	1602	477	1166	405	418	285	910	509	401	281	123
ITA	1225	1493	1058	821	0	1641	2521	695	1503	707	1146	789	622	1219	1237	232	264	128	981	1525	476	1126	477	387	322	978	568	432	355	120
NLD	1368	3174	1716	1147	1255	0	2411	869	1685	997	1415	1259	855	1080	1462	256	347	148	951	1756	517	1013	503	530	382	1033	469	423	419	126
USA	3638	2447	1457	1248	1564	2059	0	988	2153	1027	1824	954	759	1525	1629	240	334	174	1288	2003	642	1878	612	533	396	1284	834	668	367	147
CHE	728	1013	618	568	607	844	874	0	688	387	598	593	387	554	523	142	160	58	434	661	270	449	273	230	170	498	259	212	200	95
GBR	1831	1531	1096	883	1066	1439	1878	621	0	891	1350	846	918	1055	1039	210	243	132	853	1297	514	997	406	369	297	937	485	439	321	130
NZL	723	738	552	444	490	905	966	322	759	0	1160	504	685	521	597	127	133	104	489	628	366	538	241	253	174	556	311	350	211	101
AUS	1363	1201	864	808	792	1228	1784	524	1142	1157	0	739	700	869	831	176	207	103	706	998	481	855	365	307	244	776	435	429	286	118
BEL	789	1314	783	889	742	1450	838	604	837	410	646	0	501	662	654	176	189	82	540	799	336	533	295	296	205	654	287	248	261	105
IRL	508	754	575	550	510	794	674	388	938	590	602	499	0	493	506	119	129	95	431	579	331	425	205	202	153	485	229	264	178	90
ESP	812	970	734	789	858	952	968	441	819	396	610	644	464	0	845	189	199	107	755	1026	450	879	356	313	229	816	466	360	272	119
CZE	795	1452	783	733	838	1282	1246	365	698	418	530	511	371	570	0	217	250	121	905	1314	399	809	426	469	315	793	467	379	353	95
SVN	148	298	202	140	192	220	181	101	154	90	122	145	88	139	159	0	94	46	160	252	100	162	118	82	77	166	98	76	108	36
EST	146	294	165	114	142																									

LVA	281	587	284	187	306	341	501	139	240	139	185	180	125	197	293	75	117	46	245	481	99	140	0	179	222	394	220	184	244	44
SVK	298	548	207	215	221	364	349	117	209	151	154	181	102	155	380	48	52	20	221	306	100	102	92	0	133	320	207	181	139	58
LTU	154	584	200	95	163	227	261	73	148	76	105	102	73	93	209	42	56	26	132	328	46	64	157	68	0	233	140	118	164	25
PRT	1067	1140	800	758	892	1038	1340	439	856	458	614	659	438	780	653	132	135	74	700	1001	391	393	310	222	150	0	455	392	309	125
KOR	638	408	325	285	445	326	947	180	349	225	315	209	163	325	331	60	54	35	364	457	202	307	128	126	58	383	0	293	135	99
URY	485	361	297	233	321	334	834	159	365	276	321	193	214	289	283	45	64	34	317	355	231	226	111	118	69	357	237	0	138	102
HRV	170	617	293	166	253	373	275	127	225	123	175	215	122	202	254	84	87	45	186	391	99	95	193	69	113	247	58	87	0	45
MEX	172	144	125	124	127	136	188	94	151	98	124	116	99	135	77	28	15	11	115	103	113	124	29	42	7	148	100	106	29	0

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	78	427	174	256	155	36	156	70	78	9	36
DFS	64	0	152	125	123	147	101	130	96	122	31	54
USA	447	122	0	354	475	229	81	296	100	134	37	63
NZL	181	99	428	0	443	207	72	202	84	94	101	49
AUS	262	88	516	490	0	213	67	232	84	94	49	51
GBR	153	128	245	206	211	0	76	164	103	105	59	67
NLD	31	99	86	65	58	68	0	70	55	69	24	38
ZAF	151	105	309	207	220	161	65	0	90	92	31	55
ITA	67	93	107	82	79	104	55	83	0	74	20	45
DEU	75	114	135	87	84	99	63	86	76	0	20	47
IRL	6	24	38	112	46	60	22	30	19	20	0	16
CHE	29	50	63	40	42	64	32	48	42	43	12	0

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	78	427	174	256	151	36	156	70	78	9	36
DFS	64	0	152	125	123	144	101	130	96	122	31	54
USA	447	122	0	354	475	224	81	296	100	134	37	63
NZL	181	99	428	0	443	205	72	202	84	94	101	50
AUS	262	88	516	490	0	209	67	232	84	94	49	51
GBR	151	127	241	205	208	0	75	164	102	102	59	66
NLD	31	99	86	65	58	67	0	70	55	69	24	38
ZAF	151	105	309	207	220	160	65	0	90	92	31	55
ITA	67	93	107	82	79	104	55	83	0	74	20	45
DEU	75	114	135	87	84	97	63	86	76	0	20	47
IRL	6	24	38	112	46	60	22	30	19	20	0	16
CHE	29	50	63	40	42	63	32	48	42	43	12	0

JER

-----  
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	78	427	174	256	154	36	156	70	78	9	36
DFS	64	0	152	125	123	146	101	130	96	122	31	54
USA	447	122	0	354	475	228	81	296	100	134	37	63
NZL	181	99	428	0	443	206	72	202	84	94	101	49
AUS	262	88	516	490	0	212	67	232	84	94	49	51
GBR	153	128	245	206	211	0	76	164	102	105	59	67
NLD	31	99	86	65	58	68	0	70	55	69	24	38
ZAF	151	105	309	207	220	161	65	0	90	92	31	55
ITA	67	93	107	82	79	104	55	83	0	74	20	45
DEU	75	114	135	87	84	99	63	86	76	0	20	47
IRL	6	24	38	112	46	60	22	30	19	20	0	16
CHE	29	50	63	40	42	64	32	48	42	43	12	0

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    6  204   84   98   80  159   15   75    2   10   17    2    6    0
NOR    6    0   69   40   63   49  126   20    0   21   19   25   47   41    0
USA  187   70    0  117  123  105  178   28   64   17   23   34   23   37   22
NZL   82   40  116    0  137   78  166   22   38    8   17   26    8   18   12
AUS   98   53  124  137    0   79  171   45   38   32   34   42   13   29   11
GBR   77   51   97   73   78    0   95   19   40    7   17   26   17   33    0
DFS  161   99  172  163  145   88    0   73   52  104  120  104   13   47    0
DEU   14   19   27   22   44   18   62    0    2   28   36   38    5   19    0
ZAF   77    0   58   33   38   35   49    2    0    0    2    5    2    3    0
EST    2   21   16    7   29    6   92   27    0    0   48   25    0   18    0
LVA   10   17   20   14   32   16   81   31    2   42    0   52    2   11    0
LTU   16   22   29   24   42   24   99   35    5   25   48    0    4   15    0
IRL    2   46   23    8   12   16   10    5    2    0    2    4    0    9    0
NLD    6   41   35   18   27   32   45   19    3   17   10   13    9    0    0
CAM    0    0   22   12   11    0    0    0    0    0    0    0    0    0    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    6  204   84   98   80  159   15   75    2   10   17    2    6    0
NOR    6    0   69   40   63   49  126   20    0   21   19   25   47   41    0
USA  187   70    0  117  123  105  178   28   64   17   23   34   23   37   22
NZL   82   40  116    0  137   78  166   22   38    8   17   26    8   18   12
AUS   98   53  124  137    0   79  171   45   38   32   34   42   13   29   11
GBR   77   51   97   73   78    0   95   19   40    7   17   26   17   33    0
DFS  161   99  172  163  145   88    0   73   52  104  120  104   13   47    0
DEU   14   19   27   22   44   18   62    0    2   28   36   38    5   19    0
ZAF   77    0   58   33   38   35   49    2    0    0    2    5    2    3    0
EST    2   21   16    7   29    6   92   27    0    0   48   25    0   18    0
LVA   10   17   20   14   32   16   81   31    2   42    0   52    2   11    0
LTU   16   22   29   24   42   24   99   35    5   25   48    0    4   15    0
IRL    2   46   23    8   12   16   10    5    2    0    2    4    0    9    0
NLD    6   41   35   18   27   32   45   19    3   17   10   13    9    0    0
CAM    0    0   22   12   11    0    0    0    0    0    0    0    0    0    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    6  204   84   98   80  159   15   75    2   10   17    2    6    0
NOR    6    0   69   40   63   49  126   20    0   21   19   25   47   41    0
USA  187   70    0  117  123  105  178   28   64   17   23   34   23   37   22
NZL   82   40  116    0  137   78  166   22   38    8   17   26    8   18   12
AUS   98   53  124  137    0   79  171   45   38   32   34   42   13   29   11
GBR   77   51   97   73   78    0   95   19   40    7   17   26   17   33    0
DFS  161   99  172  163  145   88    0   73   52  104  120  103   13   47    0
DEU   14   19   27   22   44   18   62    0    2   28   36   38    5   19    0
ZAF   77    0   58   33   38   35   49    2    0    0    2    5    2    3    0
EST    2   21   16    7   29    6   92   27    0    0   48   25    0   18    0
LVA   10   17   20   14   32   16   81   31    2   42    0   52    2   11    0
LTU   16   22   29   24   42   24   98   35    5   25   48    0    4   15    0
IRL    2   46   23    8   12   16   10    5    2    0    2    4    0    9    0
NLD    6   41   35   18   27   32   45   19    3   17   10   13    9    0    0
CAM    0    0   22   12   11    0    0    0    0    0    0    0    0    0    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	334	196	90	6	12	2	86	53	55	2	22
DEA	298	0	265	917	193	265	47	306	58	54	549	24
FRM	248	303	0	164	17	3	3	116	65	72	2	47
ITA	93	822	197	0	117	149	21	202	59	47	241	24
SVN	6	179	17	111	0	57	12	53	4	0	78	0
FRA	9	225	1	135	54	0	12	66	3	0	92	1
HUN	1	33	1	17	10	9	0	6	2	0	20	0
NLD	89	319	140	197	51	65	6	0	53	52	107	19
IRL	50	54	71	57	4	3	2	48	0	39	6	17
GBR	63	57	93	53	0	0	0	53	34	0	0	19
HRV	2	573	1	226	65	83	18	102	5	0	0	2
USA	21	27	62	30	0	1	0	21	16	27	2	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	334	196	90	6	12	2	86	53	55	2	22
DEA	298	0	265	917	193	265	47	306	58	54	547	24
FRM	248	303	0	164	17	3	3	116	65	72	2	47
ITA	93	822	197	0	117	149	21	202	59	47	239	24
SVN	6	179	17	111	0	57	12	53	4	0	78	0
FRA	9	225	1	135	54	0	12	66	3	0	92	1
HUN	1	33	1	17	10	9	0	6	2	0	20	0
NLD	89	319	140	197	51	65	6	0	53	52	107	19
IRL	50	54	71	57	4	3	2	48	0	39	6	17
GBR	63	57	93	53	0	0	0	53	34	0	0	19
HRV	2	571	1	224	65	83	18	102	5	0	0	2
USA	21	27	62	30	0	1	0	21	16	27	2	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	334	196	90	6	12	2	86	53	55	2	22
DEA	298	0	265	917	193	265	47	306	58	54	548	24
FRM	248	303	0	164	17	3	3	116	65	72	2	47
ITA	93	822	197	0	117	149	21	202	59	47	240	24
SVN	6	179	17	111	0	57	12	53	4	0	78	0
FRA	9	225	1	135	54	0	12	66	3	0	92	1
HUN	1	33	1	17	10	9	0	6	2	0	20	0
NLD	89	319	140	197	51	65	6	0	53	52	107	19
IRL	50	54	71	57	4	3	2	48	0	39	6	17
GBR	63	57	93	53	0	0	0	53	34	0	0	19
HRV	2	572	1	225	65	83	18	102	5	0	0	2
USA	21	27	62	30	0	1	0	21	16	27	2	0